DRY CREEK WATERSHED COORDINATED RESOURCE MANAGEMENT PLAN

PLACER AND SACRAMENTO COUNTIES, CALIFORNIA

DECEMBER 31, 2003

EXECUTIVE SUMMARY

The Dry Creek watershed covers approximately 101 square miles, ranging from just west of Auburn (Placer County) west to Steelhead Creek (north of Sacramento, Sacramento County), and south to Folsom (Sacramento County) (see Figure 1-1). Major tributaries to Dry Creek proper include: Antelope Creek, Secret Ravine, Miners Ravine, Strap Ravine Creek, Linda Creek, and Cirby Creek. Dry Creek drains to Steelhead Creek (formerly known as the Natomas East Main Drain). The watershed spans eight separate geopolitical jurisdictions that govern local land use. Its natural resources are overseen and regulated by a variety of state and federal agencies with public trust interests in public safety, resource management, and environmental protection.

Prior to 1986, it appears that only the California Department of Fish and Game conducted systematic survey work regarding the Dry Creek system. In 1986, the Placer County Flood Control and Water Conservation District, in cooperation with Sacramento County, initiated the Dry Creek Watershed Flood Control Plan, the first manifestation of a watershed-wide planning effort. Since the early- to mid-1990s, there have been numerous studies and plans compiled. These include management plans and policy documents, flood control plans and studies, and resource surveys and studies. Table ES-1, below, summarizes their geographic applicability.

Table ES-1. Geographic Applicability of Watershed-Related Documents

Document Title or Description	Whole Watershed	Lower Dry Creek	Upper Dry Creek	Clover Valley	Antelope Creek	Secret Ravine	Miners Ravine	Linda/ Cirby
MANAGEMENT PLANS AND POLICY DOCUMENTS								
1. Goal, Policy and Strategy Recommendations for Stream Management in Placer County			x					
2. Dry Creek Parkway Draft and Dry Creek Parkway Master Plan and EIR		x						
3. Kakini Parkway Project (Name later changed to Ueda Parkway.)		x						
4. Dry Creek Parkway Concept Plan			x					
5. Dry Creek Regional Greenway Concept Report	x							
6. Memorandum of Understanding Regarding the Development of Dry Creek Coordinated Resource Management Planning Initiative	x							
7. Hansen Ranch Master Plan: Drafts of Opportunities for the Hansen Ranch Master Plan and Constraints and Endangered Species Mitigation, Monitoring, and Management Plan,.		x						
8. Draft Stoneridge Open Space Management Plan						x	x	
9. Secret Ravine Adaptive Management Plan						x		
10. Dry Creek Greenway Master Plan		x						
11. City of Roseville Creek and Riparian Management and Restoration Plan			x					

Table ES-1. Geographic Applicability of Watershed-Related Documents (continued)

DOCUMENT TITLE OR DESCRIPTION	Whole Watershed	Lower Dry Creek	Upper Dry Creek	Clover Valley	Antelope Creek	Secret Ravine	Miners Ravine	Linda/ Cirby
FLOOD CONTROL PLANS AND STUDIES								
12. Dry Creek Watershed Flood Control Plan	x							
13. History and Status of Flood Control Planning for Dry Creek and the Natomas East Stream Group	x	x						
14. Dry Creek Watershed Flood Detention and Stream Restoration Feasibility Study			x					
15. Analysis of Dry Creek Alternatives to Detention	x							
16. City of Roseville Creek Maintenance program	x							
17. Preliminary Feasibility Report: Miners Ravine Off-channel Detention Basin							x	
18. Final Secret Ravine-floodplain and Restoration Feasibility Study						x		
RESOURCE SURVEYS AND STUDIES								
19. California Department of Fish and Game memos	x							
20. The Fish and Wildlife Resources of the Secret Ravine Creek Area of Placer County and Recommendations for Their Protection						x		
21. Urban Streams Study, Linda and Cirby Creeks, Placer and Sacramento Counties								x
22. Peter Moyle fish population study field notes		x				x		
23. Dry Creek Thermal Effluent analysis						x		
24. The Miners Ravine Creek Watershed Enhancement and Restoration Plan for the Reduction of Flood Hazards and the Enhancement and Protection of Environmental Resources							x	
25. Dry Creek Parkway: A Resource Assessment		x						
26. Wildlife Inventory of Dry Creek, Sacramento County		x						
27. Fisheries Habitat Evaluation of Dry Creek, Antelope Creek, Secret Ravine, and Miners Ravine			x					
28. An evaluation of Dry Creek and Its Major Tributaries in Placer County, California			x					
29. Species lists for Dry Creek CRMP Watershed Planning, Placer County, California	x							
30. Sierra Foothills Audubon Society Bird List							x	
31. Secret Ravine Existing Conditions Report						x		
32. Information on Placer County natural communities and species			x					
33. Ueda Parkway Bird List		x						
34. Secret Ravine: Existing Conditions Fisheries Report, with Emphasis on Habitat Conditions for Steelhead Trout						x		
35. CDFG memos- • Perennial Rearing Habitat for Juvenile Steelhead in the Dry Creek Drainage(Placer County) • Fishes in Secret Ravine						x	x	
36. Cirby-Linda-Dry Creek Flood Control Project Adult and Juvenile Salmonid Surveys and Water Temperature Monitoring, and Flow Measurements, Placer County, California			x					x

Table ES-1. Geographic Applicability of Watershed-Related Documents (continued)

Document Title or Description	Whole Watershed	Lower Dry Creek	Upper Dry Creek	Clover Valley	Antelope Creek	Secret Ravine	Miners Ravine	Linda / Cirby
37. Miners Ravine Habitat Assessment							x	
38. Dry Creek Bank Erosion Management Plan, Roseville, California			x					
39. Assessment of Stressors on Fall-Run Chinook Salmon in Secret Ravine (Placer County, CA)						x		
40. Impervious Surface Analysis of the Secret Ravine Watershed, Placer County						x		
41. Dry Creek Conservancy monitoring program	x							
42. Dry Creek Watershed Management Plan Field Studies			x					
43. Miners Ravine monitoring program							x	

The content of these various studies is more thoroughly reported in Section 1.0 of the plan document. Collectively, resource concerns identified during review of the above-listed documents are categorized as shown below. Some of the concerns, such as land use, are prevalent throughout the studies.

Native species/Exotic species

- Plant diversity and numbers
- Wildlife diversity and numbers

Habitat

- Riparian
- Instream habitat
- Migration barriers
    - beavers
    - small dams

Water quality

- Turbidity
- Water temp
- Pollutants
- Wastewater treatment plant effluent

Land Use

- Impervious surfaces
- Increased stormwater flow
- Floodplain development

Channel morphology

- Channel complexity
- Erosion
- Sedimentation
- Streamside landscaping
- Channel alteration

Flow

- Low flow
- Flooding

Further, review of these documents reveals recommendations that can be categorized as grouped below. These groupings are consistent with the stated goals and objectives of the watershed management plan. Recommendations that are listed under these categories are common to many of the documents.

Protect floodplains and natural areas

- Open space greenway park and trail system
- Incorporate natural areas into developments.

Restoration and management

- Remove migration barriers
    - Beaver dams should be monitored and removed or breached if they seem to prevent passage.
- Implement a flow augmentation program.
- Increase channel complexity such as pools and instream cover
- Where channels are excessively eroding in the headwaters, the channel banks should be regraded to create the natural three-stage channel configuration (low flow, bankfull and flood channel.)
- Increase vegetative cover
- Invasive weed management strategy
- Increase groundwater recharge
- Study and regulate homeowner lakes.
- BMP's to mitigate impervious surfaces
- Design systems that require minimal maintenance and which mimic natural systems.

Education

- Homeowner education is essential.
- The opportunities and problems require a regional approach.
    - Joint Powers Authority
- Land use guidance
- Interpretive programs
- Citizen participation

- Developers notified of regulations
- Off Road Vehicle Access to the creek should be eliminated.

Data gathering

- Systematic information regarding plant and animal life resources should be gathered.
    - Studies such as this should be carried out by college programs at regular intervals throughout the watershed.
- Resident fish population should be monitored regularly as an indication of stream health.
- Water quality monitoring
- Estimate impervious cover for subwatersheds

Water Quality

- Trap urban pollutant runoff.
- Pesticide use reporting program
- Development should create no net increase in peak stormwater runoff.

Projects

- Evaluate erosion in the Sacramento County portion of Dry Creek
- Cottonwood Dam – Continue to develop potential for removal
- Implement recommendations of Dry Creek Bank Erosion Management Plan

In 1995, several developments, including the development of the Dry Creek Regional Project (which included the Dry Creek Greenway Concept Report), active support from the Trust for Public Land, National Park Service, and the California Recreation Trails Committee catalyzed the merger of the Dry Creek Parkway Citizens Advisory Committee with the Friends of the Roseville Parkway into the Dry Creek Conservancy. Shortly thereafter, the Dry Creek Conservancy established the Dry Creek Coordinated Management and Planning Group (now called the Dry Creek Watershed Council), and developed the *Memorandum of Understanding Regarding the Development of Dry Creek Coordinated Resource Management Planning Initiative*, which has been signed by several participating agencies and interest groups.

The Dry Creek Watershed Council, which meets monthly, is the stakeholders group supporting the development and implementation of this watershed plan. It has adopted the following goals for the planning effort:

1. To balance the changes resulting from past present and anticipated economic development activities with the Coordinated Resource Management Plan's Working Group interest in establishing a sustainable, natural, and healthy aquatic and terrestrial environment within the Dry Creek watershed.
2. To achieve the balance described in Goal 1 within the Dry Creek watershed after an acceptable baseline environmental condition has been identified by the plan and satisfactorily achieved by the plan's implementation.

To meet those goals, the working group identified four major objectives:

1. Develop a plan that integrates three key and interrelated attributes of the Dry Creek watershed: water quality, floodplain management, and habitat restoration.
2. Accommodate existing recreational facilities and promote the establishment of compatible, new, passive and active recreational facilities and activities within the Dry Creek watershed.
3. Protect water supply facilities that rely upon the Dry Creek watershed.
4. Promote and facilitate public education consistent with Objectives 1, 2, and 3.

This plan document is intended to compile available data regarding watershed resources and the opinions/objectives of a wide variety of stakeholders. It is intended to identify management goals and implementation strategies, and through the use of adaptive management, is intended to remain applicable to future planning and implementation efforts.

The earliest evidence of human habitation of the watershed by the Penutian speaking Nisenan dates to approximately 6000 b.c. These people occupied the area living on deer, salmon, acorns, and tubers until the Spanish arrived (around 1769). European immigration and the subsequent Gold Rush changed the region permanently. During historical times, the watershed has gradually transitioned from a largely agricultural area to a relatively densely-populated community. Past and present land use has affected watershed biology and the physical environment. Historically, growth and development has contributed to removal of native vegetation and introduction of non-native species that has greatly changed the upland and riparian ecology. Additionally, placer mining (and other mining activities) has greatly altered Secret and Miners Ravine hydrology and geomorphology.

Overall, areas within the Dry Creek Watershed have experienced significant degradation or loss of riparian habitat, in-stream habitat (fish, benthic macroinvertebrates), and flood plain/natural flood attenuation. Additionally, development has altered the natural flow regime and associated in-stream structures (e.g., bridges, dams, fences) may impede fish passage and create flooding problems.

The following major water resources issues were identified through analysis of available data:

- Loss of riparian habitat that contributes to overland sediment transport, bank erosion, reduction in aquatic organisms' food and cover, and high stream temperatures
- Channelization of streams that contributes to bank erosion, stream incising, sediment transport, and reduced aquatic habitat
- Sedimentation of streams that result in degraded aquatic habitat (fish spawning and rearing, benthic macroinvertebrates) and high turbidities

- Modified geomorphology for reduced complexity (less cover and resting places for fish, less suitable spawning and rearing conditions), reduced flood plain area and flood plain flooding, and higher bank instability.
- Water quality problems:
    - High fecal load – source unknown
    - Potentially high nutrients from the waste water treatment plant or undocumented agricultural drainage in the lower reaches of the Dry Creek mainstem
    - Toxicity - potential sediment and water toxicity; extent unknown
    - Degraded habitat
- Non-native invasive plant species that alter local ecology; and, often contribute to erosion, sediment transport, and local hydrology modifications (e.g., reduced surface cover, reduced soil stability – rooting system differences, changes in water uptake). Exact extent of impact is unknown but is expected to be an issue throughout the watershed and very difficult to manage.

Other important resource issues are associated with the loss of wildlife habitat and modifications to local and regional ecology/community dynamics that may affect species diversity and special status species support.

Land Use

Development of the watershed has also lead to increased impervious areas, reduced riparian vegetation, channelization, structures that impede flows, and reduction of the natural floodplain. These often result in higher peak flows, higher total storm flow volume, increased bank instability, and increased transport of nutrients and other pollutants to waterways.

Land use within the watershed is rapidly changing from rural to urban. In the past ten years, urban area has increased by 30 percent, with an associated reduction in undeveloped areas and farmland. Population within the watershed is expected to grow by 19 percent by 2020. Management of development to support this population growth will be crucial for protecting water resources.

While sensitive resource issues are regulated at the federal and state levels, land use management is generally regulated at the local level as general, community, and specific plans; 22 such plans, administered by seven geopolitical jurisdictions regulate land use within the watershed:

- The vast majority of these plans (in excess of 80%) prohibit development within the 100-year floodplain, and call for the establishment of pedestrian/bicycle trails.

- More than 60% of them specify protection for riparian habitats, provide for permanent preservation of open space through conservation easements, long-term maintenance/monitoring of stream corridors, and allow for density transfers in order to preserve open space.

- More than 60% call for the implementation of on-site detention for storm flows and the implementation of Best Management Practices to control erosion and resultant sedimentation.

- Only about 50% of these plans explicitly specify setback buffers from streams, or specifically reference either a Grading Ordinance or a Tree Preservation Ordinance.

It seems that there is room for improvement with respect to strengthening and making more specific the relevant local land use policies and regulations in the watershed. Opportunities to amend such local land use plans do not frequently arise, and are generally driven by the development community with defense of environmental issues generally left in the hands of local planning staff. Further, compliance with these plans and attendant mitigation measures is difficult to enforce and monitor at the watershed level due to its size (i.e., 101 square miles) and because geopolitical boundaries generally do not coincide with watershed and/or subwatershed boundaries.

In order to maximize representation of the Council's interests at the local political level, we recommend that:

- The Council organizes itself into subgroups, either according to subwatersheds or by geopolitical jurisdiction.

In order to quantify impacts or to identify priority areas for management, we suggest that:

- A detailed, comprehensive map of current land use is prepared

- A detailed, comprehensive map of the current full build out (based on a compilation of all plan area plans) is prepared for future land use management and impacts assessment.

In order to manage potential impacts of development, we recommend that:

- Guidances/regulations for development Best Management Practices (BMPs) are developed
- Guidances for home/land owner BMPs are developed
- Restrictions on development within the riparian corridor/floodplain are implemented and enforced

Geology and Soils

Geology and soils are limiting factors in the watershed; they cannot be changed and management practices must take into account any associated constraints.

Shallow soils and rock outcrops on steep slopes are common at higher elevations. It is important that these areas remain undisturbed and vegetated to prevent erosion and potential landslides. At lower elevations, soils are generally on flatter lands and underlain by a claypan or hardpan, have low permeabilities, finer texture (e.g., silts and

clays), low soil strength, and high shrink-swell potential. These soils often require artificial drainage for development or agriculture. Additionally, areas of the watershed are underlain by Mehrten Formation that may present infiltration impediments and support vernal pool ecologies.

- To minimize impacts in the watershed, local soil constraints must be identified and mitigation implemented

Ground water

Ground water is not a large component of the Dry Creek Watershed water supply and does not affect surface water resources. In fact, the lower half of the watershed is in the ground water recharge zone; surface water flow recharges the underlying ground water resources. Consequently, management of this resource should be for protection of recharge water quantity and quality rather than for use as follows:

- Surface water flow in streams should not be reduced below historical (pre development) flows as modeled by the Dry Creek Watershed Flood Control Plan
- Surface water quality should be maintained

Surface water

Understanding watershed surface water hydrology is important for determining target areas of concern for flood control, erosion control, pollutant transport, fisheries support, and other management issues. Along with natural features (soils, climate, topography), land use is a significant component of watershed hydrology.

Modification of surface permeability by development activities (e.g., increased impervious surface area or reduced permeability of pervious surfaces by changing vegetation) changes both the timing of peak flows, the magnitude of peak flows, and the total storm flow volume. These factors all affect flooding, erosion, and aquatic habitat.

Within the stream, higher peak flows and total storm flows are not being adequately conveyed through stream channels (and structures) that originally developed (or were modified) for conveyance of lower flows. This results in localized flooding. Additionally, there are several areas within the watershed that have degrading/unstable banks, incising streams, and sedimentation of the streambed due, in part, to the modified flow regime (faster flowing water has more energy for destabilizing banks and causing erosion).

Modification of watershed hydrology is also compounded by modification of the in-stream configuration by channelization, levees, dredging, structures (dams, bridges, other), and reduced floodplain area. These modifications also result in altered stream flow where flow is faster in some areas (channelized conveyances), contributing to erosion and faster peak flow timing, but slower in other areas (behind dams and other impeding structures), contributing to flooding and sediment deposition.

There are several projects currently underway within the watershed to mitigate development effects on storm flows. Additionally, many municipalities are making efforts

to improve in stream conditions during retrofitting processes for other purposes and storm management plans have, or will, identify effective BMPs for new developments.

To mitigate effects of storm water flows in the watershed, we suggest that:

- Under designed conveyances (e.g., bridge culverts) are retrofitted/enlarged to convey actual flood flow
- Flood detention measures are implemented at the regional and project level scale.
- The flood plain is restored
- Guidances be developed for local residents/land owners on BMPs to manage flow and structures (e.g., fences, personal weirs) to minimize degradation of in stream habitat and to minimize flooding potential.

Currently, there are numerous canals, aquaducts, siphons, reservoirs, ponds, dams, diversion, pipelines, and other features that are likely to affect local hydrology; however, their effects/management are not well documented. It may be that these small features are not a significant component of local hydrology, except during very low flow conditions.

Additionally, several historically intermittent drainage ways (e.g., Strap Ravine, upper portions of many tributaries) have been altered to perennial drainages due to nuisance flows (flows from artificial outfalls, irrigation runoff, and irrigation drainage). These alter the fisheries habitat and may contribute to water quality degradation (through associated pollutants and higher temperatures).

Although there are several hydrologic factors that are not well documented or have been changing, the current Dry Creek Watershed Flood Control Plan hydrologic model is still effectively able to model watershed flooding. However, its ability to model or determine local velocities and hydraulic functions, with regard to habitat and geomorphology restoration, may be somewhat limited without acquiring additional information.

To assure adequate information for determining local flow for habitat and stream restoration, we suggest that:

- Stream flow be measured in the tributaries during base flow (dry season) and during storm events (peak flow, peak flow timing, flow volume)
- Canals and other features are mapped and their management/operations determined
- The Flood Control Plan model is updated with the latest information

Geomorphology and Sedimentation

The geomorphology of a stream describes its configuration with regard to shape, complexity of the channel, flow patterns, and associated features. The natural geomorphology of a stream will change over time as a function of the local landscape,

climate, and substrate. Stream meanders, riffles, pools, gradient, depth, bank stability, and other associated features are important habitat conditions for adapted aquatic life. In the Dry Creek Watershed system, this historically included spawning and rearing habitat for Chinook and Steelhead salmon. However, anthropomorphic modifications to the stream and upland environment have greatly changed the natural geomorphology of Dry Creek Watershed.

Throughout the watershed, reaches have been straightened (meanders and streambed), flood plain area reduced (channelized flows and levees), reaches dredged, and riparian vegetation removed. These greatly modify the suitable habitat for aquatic life support (fish and benthic macroinvertebrates). Eroding banks, sediment deposition, lack of cover, lack of pools (resting places for fish), lack of riffles (spawning beds), lack of riparian vegetation (cover and food), and barriers to fish passage are common. Additionally, placer mining in Secret, Strap, and Miners Ravines accelerated stream incision down to the bedrock in the upper reaches. Additionally, reduction in the flood plain not only reduces overall flood flow storage, but it also contributes to bank erosion by not allowing flow to slow down and deposit suspended sediment as it overtops the bank.

In order to mitigate currently degraded conditions, we suggest that efforts be made to:

- Restore flood plain area and mitigate channelized sections
- Restore channel complexity by increasing flood plain area for meanders, allowing debris in the stream bed, and restoring riffle-pool habitat
- Restore riparian vegetation with native species to improve and maintain bank stability
- Develop BMPs guidances for local residents/land owners with regard to maintaining a natural riparian corridor and the impacts of various practices on stream geomorphology and fisheries support

Water Quality

Two tributaries within the watershed have been assessed for water quality impairment based on the designated uses, which include all for Dry Creek (except power supply), and most for Linda Creek (except Agriculture, Power Supply, and Fish Consumption). Slight impairment was noted for Dry Creek but Linda Creek was considered not impaired as assessed. Of particular interest to the Dry Creek Watershed Council is the quality with regard to aquatic life support. Currently, there are few numeric criteria for aquatic life support standards in this watershed. However, federal, state, and regional values can be used to indicate potential impairment.

A water quality monitoring program was recently implemented within the watershed. This is important for assessing watershed health with regard to a variety of parameters. Due to natural variations in water quality, it is important to establish long term monitoring programs to assess trends and effectiveness of and mitigation BMPs within the

watershed. Preliminary data generated by this program and other studies indicate potential for water quality impairment throughout the watershed. Specifically:

- Summer temperature impairment in some reaches. This can be mitigated through restoration of riparian vegetation for shading the streams. While not all measured temperatures exceeded temperatures for fish support, many reaches still experienced very high temperatures during the summer.
- Toxicity is indicated by either pesticides (Dry Creek) or heavy metals in sediment (Secret Ravine). Additional studies are necessary to determine extent and level of impairment
- Excessive nutrient loads are indicated in the lower reaches of Dry Creek. These may be due to either the Roseville Waste Water Treatment Plant or agricultural drainage. Further study is necessary to determine actual source and impact.

- Turbidity is generally above the US EPA recommended criteria for these aggregate ecoregions. Reduced erosion and bank erosion will help mitigate high turbidites
- Fecal coliforms exceeded water quality criteria during the dry season. Identification of extent and sources will be necessary for determining effective mitigation strategies.

Dissolved oxygen, conductivity (salinity), pH, ammonia, most metals, and most pesticides were within the limits for sustaining aquatic life.

In order to track trends, identify specific constraints/area impacted, and prevent further water quality degradation, it is further recommended that:

- Water quality monitoroing continue on a long term basis in conjunction with flow monitoring
- BMPs guidances are developed for local residents/land owners with regard to maintaining a natural riparian corridor and reducing contributions to water quality impairment (stream dumping, pet waste management, lawn chemical management)

Vegetation

Vegetation is a significant component of watershed health. Upland vegetation provide food and habitat for upland wildlife, increases soil infiltration, potentially increases soil moisture uptake, and provides erosion protection through soil stabilization and ground cover. Riparian vegetation filters pollutants in runoff, supports bank stability, and provides shade, cover, and food sources for aquatic organisms, and habitat and food for non-aquatic species. Native vegetation, in particular, contributes to overall species diversity and provides wildlife habitat for native wildlife.

Within the Dry Creek Watershed, much of the native vegetation has been removed and either replaced with non-native species (e.g., landscaping, agriculture), developed, or left bare. The reduction in native vegetation has contributed to significant degradation of the watershed water resources. Reduction of riparian habitat and/or replacement with non-native species (e.g., ornamentals) occurs within all tributaries. This has contributed to bank destabilization and erosion, higher water temperatures, and reduction in suitable habitat for aquatic life.

Non-native invasive species (NISs) (e.g., weeds) often have a greater impact due to their ability to quickly populate an area and out-compete native species. These species tend to be harmful to the local ecology by reducing habitat for native animal species, providing less ground cover for erosion protection, choking waterways, or other negative impacts. Control is often very difficult. Himalayan Blackberry is an NIS that is prevalent throughout the watershed riparian areas.

Vegetative management is linked to bank stability, runoff/erosion mitigation, fisheries habitat, and water quality. We suggest that we:

- Study non-native invasive plant species to determine the extent and potential management for mitigation
- Restore riparian habitat with native species to provide shade and cover, food sources, and bank stabilization along the tributary corridors
- Develop BMP guidances for home/land owners and developers to prevent further removal of native species, to encourage restoration of degraded areas, and educate the public on the impact of NISs

Fisheries

Tributaries within the Dry Creek Watershed are known to support salmonids (Chinook and Steelhead salmon) and other areas are likely to have historically supported anadromous fish, but now either have barriers to fish or habitat so degraded that fish support is no longer possible. The main stem of Dry Creek is not suitable fish habitat, but is considered only a migratory passage for Chinook and Steelhead salmon. Linda Creek has two sites that might be suitable for spawning and rearing, however, most of it is generally degraded habitat with sedimented streambed, steep eroding banks, high summer temperatures, and variable width riparian corridor. Cirby Creek is an urban stream and it is unlikely than salmonids use this tributary any more. Antelope Creek has two potential spawning areas, but is also mostly degraded habitat. Rock dams and beaver dams provide barriers to fish passage, although a few fish have been found in this tributary. Miners Ravine still supports salmonids, however it is highly degraded in many reaches and habitat is marginal. Secret Ravine also still supports salmonids and has the best fisheries habitat in the watershed.

Several studies and projects have been implemented for improving fish passage and restoring aquatic life habitat in Miners Ravine, Secret Ravine, and Cirby/Linda Creek. Regardless, due to the prevalent degradation within the watershed, we suggest that

- In-stream habitat restoration, channel complexity/geomorphology, be continued.

- Barriers to fish passage be mitigated during retrofits and stream/habitat restoration
- Riparian vegetation be restored (with native species) to provide cover, food sources, shade, bank stabilization, and reduced sediment transport.
- In-stream debris allowed for cover and benthic macroinvertebrate (fish food) food sources and habitat.
- Develop BMP guidances for home/land owners and developers to prevent further removal of native species, to encourage restoration of degraded areas, and educate the public on fisheries habitat

Key Issues and Opportunities

Recognized planning issues were derived from the discussions at regular Dry Creek Watershed Council meetings, as well as those identified by the consulting team developing the plan, based on analysis of available data. Six major issues were identified as follows:

1. Fisheries Management

   The general perception is that development throughout the watershed has had a detrimental effect upon what is believed to have been, historically, relatively productive fisheries habitat, particularly within Miners and Secret Ravines. Development is perceived to have damaged fisheries habitat. Specific causes of impairment identified include loss of riparian habitat, predation and competition, invasive aquatic plant species, flow regime changes from development and channelization, barriers to passage, in-stream structures, channelization, sedimentation, and pollution.

2. Riparian and Floodplain Habitat Management

   Although also contributing to a perceived degradation of fish habitat, the loss of riparian and floodplain habitat, in and of itself, is generally perceived to be a significant negative impact resulting from development. Specific causes of impairment include: loss of riparian and floodplain habitat area, changes to the vegetative community, changes in the flow regime, and bank erosion.

3. Water Resources Management

   Development is perceived to have negatively modified watershed hydrology and water quality by modifying flow conveyances, water storage, water supplies/amount within the watershed, and input of pollutants. Specific causes of impairment identified include: loss of conveyance capacity, changes in stream elevation, increased water use and wastewater disposal, and increased impervious surface.

4. Development and Growth

   Although development is considered a negative factor in terms of impact on watershed health indicators, it nonetheless contributes to serve the population's socioeconomic, physical, and quality of life needs. Unless population growth is curtailed, solutions must consider balance and compromise between competing issues.

5. Open Space Preservation

   Preservation of habitat, including non-riparian habitat, is important for ecological health and special status species support. Non-riparian habitat management issues must also be addressed in light of development and overall watershed management.

6. Public Education and Involvement

   In order to ensure the rehabilitation and long-term preservation of the naturally functioning watershed, it is necessary to have public support. In order to generate public support, it is necessary to educate and involve them.

In addition to addressing the perceived problems discussed above, the group has recognized that there are key opportunities to improve the existing conditions with respect to long-term management:

1. Development of Recreational Resources

   Many of the relevant local land use plan documents call for the development of trail systems and reference a regional planning effort for multi-use (i.e., bicycle and pedestrian) trails. The regional concept plan would provide linkage from the American River Parkway (near Folsom), through the Dry Creek watershed, to the Dry Creek Parkway (north of Sacramento). Linkage with existing trails there would establish a 70-mile loop. Linkage through the Dry Creek watershed would significantly contribute to recreational resources and open space enjoyment available to residents of both Sacramento and Placer Counties. Pursuit of this strategy involves several local land use jurisdictions with various levels of commitment and funding. Portions of this potential regional network, like those in Roseville and in the lowest portions of the watershed, are already in place. Although the upstream portions of Antelope Creek, Secret Ravine, and Miners Ravine may be too severely constrained by private property ownership, there may be some opportunity to develop "spur" trails into these tributary systems.

2. Restoration/Enhancement of Biological Resources

   In general terms, the potential for restoration and enhancement of biological resources resides in publicly-owned and or –controlled open spaces, typically within the regulated area of the 100-year floodplain. For the most part, such areas only exist in the lower portions of the watershed, beginning at Rocklin and Roseville and extending downstream. There, the potential exists for riparian revegetation efforts which could achieve not only fish and wildlife habitat

enhancement and open space enjoyment, but also simultaneously address bank stabilization and flood control issues.

3. Land/Conservation Easement Acquisition

   In order to permanently protect the floodplain and the investment made in such efforts as restoration and enhancement projects and drainage controls, every opportunity should be taken to acquire such open spaces, or to place them under permanent conservation easements.

Stressors and Management Goals

Evaluation of available data for the Dry Creek watershed allows for identification of potential impacts associated with each identified management issue. It also identifies data gaps that preclude adequate assessment/determination of either impacts or sources of impacts. These impacts are grouped into categories that identify potential stressors or sources. Specific stressors and potential impacts were derived from analysis of the available data. These include

1. Removal of Riparian Vegetation Due to Development
2. Removal of Upland Native Vegetation Due to Development
3. Development in the Floodplain
4. Increased Impervious Surfaces (amount and connectivity) Due to Development
5. Nuisance and Augmented Flow (ephemeral changed to perennial; intermittent flow during dry season) Due to Development
6. Agricultural Land Converted to Residential/Urban
7. Placer Mining (historic land use change)
8. Bank Erosion
9. Upland Topography And Water Storage Modifications
10. Waste Water Treatment Plant Impacts (high conductivity, high nutrients, temperature effects)
11. Temperature Impairment
12. Turbidity Impairment – can clog fish gills and affect escape predation due to visibility
13. Conductivity – not impaired but high
14. pH Impairment
15. Ammonia – not impaired but concern
16. Nutrient impairment
17. BMI indicated impairment
18. Pesticide Impairment
19. Heavy Metals impairment
20. Sediment toxicity – general
21. Barriers to Fish Passage
22. Human Structures
23. Channelization
24. Beaver dams
25. Conveyance Maintenance
26. Changes in Flow Regime
27. Waste Water Discharge
28. Agricultural and landscape drainage and runoff

29. Increased Development
30. Greater demand on water supply
31. Increased wastewater generation (increased discharge to surface water)
32. More recreation use
33. Reduction in Channel Complexity
34. Reduced floodplain area
35. Changes in Flow Regime
36. Channel Incising
37. Sedimentation
38. Removal of Non-Riparian Vegetation

In light of the identified stressors and their impact on management issues, the following specific goals were identified:

Land Use:

Preservation and Restoration of Riparian Habitat

- Preserve and revegetate riparian areas with native species
- Establish buffer zones for no development or removal of riparian vegetation
- Eradicate invasive, non-native species
- Develop guidance for planners, developers, and permitting agencies regarding bank erosion, removal of riparian vegetation, and use of invasive non-native species
- Maintain public lands/preserves as public/preserves; maintain easements and lease control
- Preservation and management of Open Spaces
- Allow floodplain flooding to occur
- Restore floodplain area and habitat
- Cattle fencing/crossings to minimize bank trampling
- Signage and public education to minimize horse and OVR channel destruction

Mapping (GIS)

- Create a current digital landuse cover with attributes
- Create a current digital cover of all plan areas and zoning/planned land use
- Map canal system, ponds, reservoirs, siphons, aquaducts, channel elevation, and which are still in use
- Digital map of impacted areas and extent: removed vegetation and eroded areas
- Locate all outfalls digitally

In-Stream Management and Restoration

- Allow floodplain flooding to occur
- Restore floodplain area

Studies

- Determine which streams have changed from ephemeral to perennial
- Assess outfalls for flow during storm events and or irrigation
- Measure water quality of WWTPs for nutrients
- Determine impact of urban v. rural uses on water quality
- Sediment studies to determine extent of sediment toxicity problem
- Determine canal management practices (flows, timing, control)
- Gage streams to determine actual flow and flow pattern

Preservation and Restoration of Upland Habitat

- Encourage revegetation with native species
- Eradicate invasive, non-native species
- Develop guidance for planners, developers, and permitting agencies regarding erosion and stormwater control and use of invasive non-native species.
- Buy up easements and replant with native species

Other

- Public education regarding irrigation and drainage management
- On-site detention: development does not change flow regime

Water Quality:

Management Practices

- Minimize discharge of surface runoff and associated pollutants
- Prevent further degradation through requiring effective water quality BMPs on future development
- Implement Integrated Pest Management Programs throughout the watershed

Studies

- Evaluate Roseville WWTP discharge for nutrient loads and impact on Dry Creek
- Institute a long term monitoring study to determine trends and potential impacts of land use on water quality (include flow discharge measurements)
- Institute first flush monitoring at several locations
- Analyze current and new data for trends (statistics)
- Continue BMI studies as improvements are implemented for overall trends assessment (also select appropriate reference site)
- Evaluate extent of sediment toxicity

Mapping (GIS):

- Map all water quality/quantity monitoring sites

Restoration:

- Assess areas for implementation of aeration mechanisms to enhance

Dissolved Oxygen.

- Restore shaded riparian habitat to lower stream temperatures
- Others as necessary, depending upon studies
- Establish riparian buffers to filter surface runoff prior to entry into streams

Flood Storage and Conveyance:

Engineering

- Retrofit old bridges and culverts for fish passage and actual flood flow conveyance
- Require new devices to meet design requirements for flow and fish passage
- Retrofit old dams for fish passage
- Screen all diversions
- Survey all potential constrictions and measure/cross-check old model dimensions
- Measure and cross-check old model in-stream cross-sections for input into flood model
- Relocate sewer and water pipes that cross stream beds

Operations and Management Practices

- Develop a beaver management plan – document known dam locations
- Remove fences within the floodplain
- Excavate sediment from behind flow constrictions

Restoration of Habitat

- Restore floodplain area (amount)
- Restore channel complexity – create meanders, riffle-run-pool habitat, add woody debris (must check hydraulics and make certain flood flows are still passed)
- Devise strategies to mitigate channelization
- Buy up easements of land with structures on it that are within the floodplain

Development BMPs

- Add off-stream regional detention for reducing flood flow peaks and peak timing; no net changes
- Add additional BMPs/restore areas to bring hydrology back to 'normal' conditions where practicable
- Develop guidance for planners, developers, and builders regarding on-site flow detention and water quality BMPs

Mapping (GIS)

- Map constrictions (road crossing, culverts), channelized areas, other flow restrictions

Studies

- Measure flows and flow pattern (hydrograph)
- Update DCW Flood Control Manual models – check land use, culverts, crossings, constrictions, other
- Document locations of channelization

Surface Water:

Studies

- Update Dry Creek Watershed Flood Control Plan model for current and projected land use studies
- Additional stream gauging to calibrate hydrologic and hydraulic model
- Stream gauging to determine actual flow hydrographs
- Stream gauging for stage-discharge relationships to determine pollutant loads when sampling for water quality
- Analyze flow data (statistical) to determine chronic problems and trends
- Determine location of all outfalls and amount of flow
- Document eroded areas

Best Management Practices

- Encourage water conservation
- Meter all water use
- Implement post construction BMPs for stormwater detention

Population Growth:

- Use ‘Smart Growth” principles
- Institute water conservation practices
- On-site detention: no net changes in flow

Public Education

- Educate public regarding good stewardship practices
- Encourage planting of native species
- Develop guidance for planners, developers, and permitting agencies, regarding bank erosion, removal of riparian vegetation, use of non-native invasive species, irrigation and drainage management
- Develop guidance for good stewardship practices and the role of individuals within the watershed.

Geomorphology:

Restoration and Design

- Restore channel complexity
- Reduce sedimentation
- Restore floodplain
- Design for both geomorphology and flood control

Vegetation:

Mapping (GIS)

- Map extent of invasive species: density, area, types
- Map preserves, other Open Space, and potential habitat

Studies

- Assess all habitat for quality and restoration potential

Restoration

- Restore and revegetate areas with native plant species
- Eradicate non-native invasive species
- Preserve large contiguous corridors/areas
- Preserve more open space
- Develop Open Space Management plans for all areas, implement, and enforce them
- Obtain grants for funding management plan implementation and enforcement (e.g., interest on grants in trust)

Education

- Prepare guidance for public regarding use of native plant species, identification of non-native invasive species, and appropriate BMPs for land surfaces/revegetation
- Educate local nurseries on what plants they may have that are non-native invasive plants
- Educate land owners regarding damaging grazing practices
- Assemble and train volunteer groups and other local citizens on eradication of invasive non-native plants and revegetation with native plants

IMPLEMENTATION

This plan is meant to provide a starting point for managing the Dry Creek Watershed. It is meant to act as a starting point in determining initial management issues and identifying management goals. In order for this plan to be successful, management goals must be prioritized and key areas of action targeted. Considering the issues, stressors, opportunities and constraints, and specific goals identified in the previous sections, the Dry Creek Watershed Council can prioritize goals and tasks for mitigation of watershed health.

With respect to policy and internal organization, the following recommendations are made:

1. The Dry Creek Watershed Council (DCWC) should provide continuous long term management of the Watershed Management Plan. It must provide ongoing assessment of progress toward assessment and project goals.

2. The DCWC should develop an MOU among watershed entities to cooperate to implement the WMP.

    a. The DCWC should develop a budget for implementing the WMP based on administration and projects. Local plans and projects should budget for coordination of the watershed management plan. Funds can come both from organizational budgets and for grants funding projects and administration.

    b. Entities should agree to share resource data and GIS files. Plans, data and other information should be compiled on CD and /or posted on a website for unrestricted access.

    c. Entities should agree to coordinate projects to reduce competition for funding.

    d. Local jurisdictions should adopt measures to streamline approval and permitting of WMP sponsored projects.

3. Divide the watershed into sub watersheds to facilitate assessment and project implementation. Sub watersheds should be prioritized for assessment and project development and implementation. Assessment of impervious cover should be a priority in each sub watershed.

4. Catalogue all public and private land areas that have open space associated with them such as school, parks, cemeteries, golf courses, open space, mitigation areas, preserves, any easement protected areas, any other set aside areas. Describe and map these areas to provide a basis for evaluating the overall condition of the remaining natural area of the watershed, and for developing management strategies that will improve watershed function, especially corridors for wildlife.

5. The plan should develop target values for water quality parameters habitat values, stormwater hydrographs and other parameters.

6. The plan should develop management standards and specific projects to be recommended to local jurisdictions that will help reach target values as sufficient information is available.

7. The DCWC must make an effort to inform watershed residents of the WMP and involve them in plan implementation.

Table ES-2 briefly summarizes projects and plans actively being undertaken by various entities within the watershed.

Table ES-2. Projects and Plans Ongoing within the Dry Creek Watershed

Project Name	Project Description	Year Start	Year End	Geography/Subwatershed	Physical Improvement	Reports/Documents	Agency Sponsor
Dry Creek CRMP and Miners Ravine Restoration	Coordinated Resource Management Plan, Water Quality Monitoring Program, Miners Ravine Restoration Project.	1999	2003	All	Yes	Yes	Placer County
Dry Creek Parkway Master Plan	Policy document for habitat management, flood control, and development of recreation in Sacramento County Parkway.	2001	2002	Dry	No	Yes	Sacramento County, Regional Parks, Recreation, and Open Space
Dry Creek Greenway Master Plan	Master Concept Plan to link American River Parkway to Ueda Parkway (Folsom to Sacramento).	2003	2005	All	No	Yes	Placer County
Ueda Parkway Trail	Development of recreational trail.			Dry			City of Sacramento
Dry Creek Restoration Project	Restore a 1.4-mile reach of Dry Creek from the Riverside Avenue Bridge upstream to Adelante High School. Includes restoration and erosion control work at two erosion sites and a complete study and analysis of this reach of Dry Creek, as well as hydraulic improvements in the down stream reach that will improve flood protection in the immediate area.	2000	2003	Dry	Yes	Yes	Dry Creek Conservancy
Secret Ravine Habitat Restoration #1	Spawning gravel restoration.	1998	2001	Secret	Yes	No	Dry Creek Conservancy
Dry Creek Stewardship Project	Community stewardship; GIS; Project support for CDFG restoration, Miners Ravine detention, Roseville Riparian Management; flow loggers, DCC capacity building.			All	No	Yes	Dry Creek Conservancy
Roseville Creek and Riparian Management and Restoration Plan	Inventory creek resources; identify and address stakeholder issues and values; and, identify and prioritize restoration sites and typical guidelines for all creeks within the City of Roseville.	2003	2004	All	No	Yes	City of Roseville
Secret Ravine Habitat Restoration #2	Revegetate and repair off-road vehicle damage; education.	2000	2004	Secret	Yes	No	Dry Creek Conservancy
Steelhead Creek Stewardship Project	Physical/chemical monitoring	2002	2006	Dry	No	Yes	Dry Creek Conservancy

Table ES-2. Projects and Plans Ongoing within the Dry Creek Watershed (continued)

Project Name	Project Description	Year Start	Year End	Geography/Subwatershed	Physical Improvement	Reports/Documents	Agency Sponsor
Miners Ravine Flood Protection Project	Design and construction of 20-acre off-channel detention basin facility for flood control and channel restoration purposes.	2003	2006	Miners	Yes	Yes	Placer County, Flood Control and Water Conservation District
Secret Ravine Floodplain Restoration	Feasibility studies and engineering design of floodplain restoration projects at three proposed sites.	2002	2006	Secret	Yes	Yes	Placer County, Flood Control and Water Conservation District
Miners Ravine Anadromous Fish Habitat Survey	Reconaissance level survey of fish habitat quality from Miners Ravine confluence to King Road, and identification of fish migration barriers.	2001	2002	Miners	No	Yes	CDWR/Fish Passage Improvement Program
Dry Creek (Secret Ravine) Ecological Risk Assessment	. Identification of stressors to fish habitat in Secret Ravine	2002	2003	Secret	No	Yes	California Environmental Protection Agency
NPDES Phase II-Stormwater Management Plan, Roseville	Public outreach and involvement, illicit discharge detection and elimination, construction site runoff control, new development and redevelopment, municipal operations, and reporting and monitoring to satisfy NPDES "Phase II' regulations.	1999	2008	All	No	Yes	City of Roseville
NPDES Phase II-Stormwater Management Plan, Placer County	Implementation of Phase II regulations.	1999	2008	All	No	Yes	Placer County
NPDES Phase II-Stormwater Management Plan, Rocklin	Implementation of Phase II regulations.	1999	2008	Secret Antelope	No	Yes	City of Rocklin
99 319(h) Dry Creek Conservancy Watershed Stewardship	Demo restoration; Volunteer monitoring support.	1999					Dry Creek Conservancy
99 319(h) Sediment and Erosion Technical Workshops		2000	2003	All	No	No	Placer County Resource Conservation District
Antelope Creek Restoration Project	Creek bank stabilization; revegetation.	2003		Antelope	Yes	No	City of Rocklin

Table ES-2. Projects and Plans Ongoing within the Dry Creek Watershed (continued)

Project Name	Project Description	Year Start	Year End	Geography/Subwatershed	Physical Improvement	Reports/Documents	Agency Sponsor
Cirby/Linda Confluence Pipeline Improvement	Part of the Dry Creek Urban Streams Restoration Project. Improvements include modifications to in stream boulders to improve fish passage over an existing sewer line which can be a migration barrier during low flow conditions.	2002	2004	Cirby Linda	Yes	No	City of Roseville
CVRWQCB Bioassessment Study in Placer County	Bioassessment in Effluent-Dominated Waterbodies (BMI)	2000	2001	All	No	Yes	CVRWQCB
Dry Creek Watershed Flood Control and Environmental Enhancement	Hayer dam renovation, floodplain acquisition, invasive species removal, Miners Ravine off-channel detention.	2001	2005	Dry Miners	Yes	Yes	Placer County, Flood Control and Water Conservation District
Enwood Riparian Habitat Preserve	Riparian revegetation.	1998	2010	Dry	Yes	No	Roseville Coalition of Neighborhood Associations
ERP Stewardship Strategy	Watershed Stewardship Strategy Plan Database	1998	2002	Out	No	Yes	Placer County
Placer Legacy, West Placer County Agriculture	Characterization of existing agricultural conditions, water supply, and conservation measures.	2002	2002	All	No	Yes	Placer County
Placer Legacy, West Placer Watershed Coordination	Full-time Watershed Coordinator; PGE/CC ERP; Monitoring/Education	2003	2005	All	No	Yes	Placer County
Placer Legacy, West Placer Wetlands Assessment and Conservation	Ground-truthing of aerial photos and development of GIS data.	2002	2003	All	No	Yes	Placer County
Secret Ravine Adaptive Management Plan	Adaptive Management Plan for improvement of fish habitat on Secret Ravine	2000	2001	Secret	No	Yes	Dry Creek Conservancy
Secret Ravine Habitat Restoration #3	Instream fish habitat restoration.	2004	2005	Secret	Yes		Dry Creek Conservancy
Secret Ravine Water Line Improvement	Removal of an abandoned water line crossing Secret Ravine. The water line and related concrete encasement can impede fish migration during low flows.	Hold	Hold	Secret	Yes	Yes	CDWR, Fish Passage Improvement Program
Sediment Analysis	NWFAR roads, culverts, bridges, sediment impacts	Proposal	Proposal	Out	No	Yes	American River Watershed Group

The current projects and actions will be used to target and prioritize specific goals and to identify initial actions arising from this Plan. Data from these on-going projects will assist in the follow-up determination of actions and assignment of priorities.

In light of DCWC's recognized issues, concerns, and/or identified opportunities, the DCWC should be pursuing external actions. External actions recommended may include the pursuit of:

- Political involvement at the local level
- Participation in the regulatory processes
- Education and Public Involvement
- Site-specific improvement projects
- Landscape level (i.e., watershed or subwatershed) improvement programs
- Endorsement, adoption, and/or implementation of plans
- Identification of funding sources for implementation

Specific management goals identified above have been prioritized by the DCWC according to the following criteria:

- Urgency
- Majority of Effect
- Availability
- Implementability

This prioritization is expressed in a three-tier system, as defined below:

- Tier 1 – These goals must be considered for all actions and studies undertaken within the watershed; active effort for funding and implementation.

- Tier 2 – These goals are likely to fit under other initiatives and implementation and funding opportunities will be researched and applied.

- Tier 3 – Additional needs that are considered priority goals for the watershed. Implementation will depend upon available funding and resources.

The Dry Creek Watershed Council's prioritization of management goals is reported in Table ES-3, below. Goals are organized by major management concern, and then reported from highest to lowest priority rank.

Table ES-3. Management Goal Prioritization

SPECIFIC GOAL	PRIORITY*
PRESERVATION AND RESTORATION OF RIPARIAN HABITAT	
❑ Establish buffer zones for no development or removal of riparian vegetation	Tier I
❑ Maintain public lands/preserves as public/preserves; maintain easements and lease control	Tier I
❑ Preserve large contiguous corridors/areas	Tier I

Table ES-3. Management Goal Prioritization (continued)

❑ Revegetate and restore riparian areas with native species	Tier II
❑ Eradicate non-native invasive species	Tier II
❑ Develop Open Space Management plans for the preserved and restored riparian habitat and, for all areas, implement, and enforce them	Tier II
In-Stream Management and Restoration	
❑ Allow floodplain flooding to occur	Tier I
❑ Reduce sedimentation	Tier I
❑ Design to accommodate for both geomorphology and flood control	Tier I
❑ Restore floodplain area	Tier II
❑ Restore floodplain habitat	Tier II
❑ Assess areas for implementation of natural aeration mechanisms to enhance DO.	Tier II
❑ Restore channel complexity – create meanders, riffle-run-pool habitat, add woody debris (must check hydraulics and make certain flood flows are still passed)	Tier II
❑ Devise strategies to mitigate channelization	Tier III
❑ **Preservation and Restoration of Upland Habitat**	
❑ Preserve large contiguous corridors/areas	Tier I
❑ Restore and revegetate with native species	Tier II
❑ Eradicate invasive, non-native species	Tier II
❑ Preserve more Open Space	Tier II
❑ Buy up easements and replant with native species	Tier III
❑ **Engineering**	
❑ Require new structures to meet design requirements for flow and fish passage	Tier I
❑ Screen diversions where necessary	Tier I
❑ Relocate sewer and water pipes that cross stream beds where problematic	Tier I
❑ Retrofit old bridges and culverts for fish passage and actual flood flow conveyance	Tier II
❑ Retrofit old dams for fish passage	Tier III
❑ Survey all potential constrictions and measure/cross-check old model dimensions	Tier III
❑ Measure and cross-check old model in-stream cross-sections for input into flood model	Tier III
❑ **Best Management Practices**	
❑ Local on-site detention: development does not change flow regime; implement and enforce post construction BMPs for stormwater detention	Tier I
❑ Minimize discharge of surface runoff and associated pollutants; prevent further degradation through requiring effective water quality BMPs on future development	Tier I
❑ Establish vegetative buffers to filter surface runoff water	Tier I
❑ Use 'Smart Growth" principles	Tier I
❑ Add off-stream regional detention for reducing flood flow peaks and peak timing; no net changes	Tier II
❑ Add additional BMPs/restore areas to bring hydrology back to 'normal' conditions where practicable	Tier II
❑ Institute water conservation practices	Tier II
❑ Livestock fencing/crossings to minimize bank trampling	Tier III
❑ Implement Integrated Pest Management Programs throughout the watershed	Tier III
❑ Meter all water use	Tier III
❑ **Mapping (GIS)**	
❑ Create a current digital land use cover with attributes	Tier I
❑ Map known spawning areas	Tier I
❑ Map known special status species occurrences	Tier I
❑ Map canal system, ponds, reservoirs, siphons, aqueducts, channel elevation, and which are still in use	Tier II
❑ Digital map of impacted areas and extent: removed vegetation and eroded areas	Tier II
❑ Map all water quality/quantity monitoring sites	Tier II

Table ES-3. Management Goal Prioritization (continued)

❑ Map preserves, other Open Space, and potential habitat for preservation or restoration	Tier II
❑ Map extent of invasive species: density, area, types	Tier III
❑ Create and maintain a current digital cover of all plan areas and zoning/planned land use	Tier III
❑ Locate and characterize all outfalls digitally	Tier III
❑ Map constrictions (road crossing, culverts), channelized areas, other flow restrictions	Tier III
❑ **Studies**	
❑ Gage streams to determine actual flow and flow pattern and to calibrate hydrologic and hydraulic model	Tier I
❑ Continue BMI studies as improvements are implemented for overall trends assessment (also select appropriate reference site)	Tier I
❑ Assess all habitat for quality and restoration potential	Tier I
❑ Determine impact of land uses on water quality	Tier II
❑ Institute a long term monitoring study to determine trends and potential impacts of landuse (include flow discharge measurements)	Tier II
❑ Institute storm event monitoring at several locations	Tier II
❑ Sediment budget analysis	Tier II
❑ Determine which streams have changed from ephemeral to perennial	Tier III
❑ Assess outfalls for water flow and quality during storm events and or irrigation	Tier III
❑ Measure water quality of WWTPs for nutrients impact on streams	Tier III
❑ Studies to determine source and extent of potential toxicity problems	Tier III
❑ Determine canal management practices (flows, timing, control)	Tier III
❑ Determine stage-discharge relationships to determine pollutant loads when sampling for water quality	Tier III
❑ Update and calibrate DCW Flood Control Manual models – current and projected land use, culverts, crossings, constrictions, other	Tier III
❑ Define and analyze environmental indicators of significance to the Dry Creek watershed	Tier III
❑ Document eroded areas	Tier III
❑ **Operations and Management Practices**	
❑ Develop funding mechanisms for plan implementation (e.g., interest on grants in trust)	Tier I
❑ Develop a beaver management plan – document known dam locations	Tier II
❑ Remove fences within the floodplain	Tier II
❑ Excavate sediment upstream of flow constrictions	Tier III
❑ Develop Open Space Management plans for all Open Space areas, implement, and enforce them	Tier III
❑ Develop a comprehensive habitat management plan for the entire watershed that includes all land uses	Tier III
❑ **Education and Public Involvement**	
❑ Signage and public education to minimize recreational channel destruction	Tier I
❑ Develop construction and post-construction guidance documents for public works, planners, developers, and permitting agencies on: ❑ Landscape Management (chemical, irrigation, and drainage management practices and potential effect on streams)	Tier I
❑ Develop construction and post-construction guidance documents for public works, planners, developers, and permitting agencies on: • Erosion and Stormwater Management (on-site and regional detention and water quality treatment) ❑	Tier I
❑ Develop guidance documents for the general public on Good Stewardship and the Role of Individuals in the Dry Creek Watershed: ❑ Chemical, irrigation, and drainage management effects on surface water	Tier I
❑ Develop guidance documents for the general public on Good Stewardship and the Role of Individuals in the Dry Creek Watershed: ❑ Bank erosion: riparian vegetation and disturbance (e.g., off road vehicle crossing)	Tier I

❑ Develop guidance documents for the general public on Good Stewardship and the Role of Individuals in the Dry Creek Watershed: • Fish habitat and riparian vegetation with native species	Tier I
❑ Educate local nurseries on what plants they may have that are non-native invasive plants	Tier I
❑ Education and public involvement for: • Water quality monitoring • wildlife monitoring • education and outreach on good stewardship • habitat mapping • outfall mapping ❑ Open Space maintenance	Tier I
❑ Develop construction and post-construction guidance documents for public works, planners, developers, and permitting agencies on: ❑ Bank Erosion and Riparian Vegetation (effect of removal and the use of invasive non-native species)	Tier II
❑ Prepare guidance for public regarding use of native plant species, identification of invasive non-native species, and appropriate BMPs for land surfaces/revegetation	Tier II
❑ Educate land owners regarding damaging grazing practices	Tier III

The prioritization expressed above should guide the Dry Creek Watershed Council's allocation of resources, and pursuit of funding opportunities, and specific projects to be implemented in the watershed.

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1.0 INTRODUCTION

The Dry Creek Watershed covers approximately 101 square miles. It ranges from the unincorporated community of Newcastle (near Auburn) in Placer County, California to approximately 25 miles southwest to the point where Dry Creek drains to Steelhead Creek (a.k.a., the Natomas East Main Drain), in north Sacramento, Sacramento County, California. At its widest portion, the watershed ranges from Newcastle to approximately 13 miles south to Folsom in Sacramento County (Figure 1.1 – Dry Creek Watershed Location).

The Dry Creek Watershed Coordinated Resource Management Plan (Plan) is intended to be as comprehensive in scope as is possible, given variable stakeholder participation and the use of available information. It is intended to gather available information, analyze that information, and synthesize a cohesive statement regarding the current state of the watershed, and to identify additional information that should be gathered, technical studies that should be conducted, problems perceived by the stakeholders (both signatories to the Memorandum of Understanding (MOU) and other interested and involved parties), opportunities for prevention of other problems or improvement of existing negative conditions, funding sources for implementation, and monitoring to document current and future conditions. Further, this Plan is intended to change in response to new information and changing conditions (i.e., to incorporate adaptive management). With the application of adaptive management, this plan is intended to survive well beyond the visible planning horizon, remaining viable and vital to future planning efforts throughout the watershed.

1.1 Historical Planning Context

1.1.1 Origins of the Planning Effort

The idea of a resource management plan for the whole Dry Creek Watershed is relatively recent. For several decades, individual, localized approaches have been the focus of preservation and restoration efforts within the Dry Creek Watershed. For example, in 1965 a California Department of Fish and Game report (California Department of Fish and Game, 1965) on Secret Ravine began with this passage:

> *The landscapes in the Central Valley and in the foothills of the Sierra Nevadas, particularly around metropolitan areas such as Sacramento, are being altered profoundly by urban and suburban development. Fish and wildlife habitat has been especially affected. The clearing of woodlands and the replacement of marshes, fields, and orchards with residential tracts, shopping centers, freeways, and industrial centers is rapidly eliminating wildlife habitat. Rivers and creeks are being straightened and channelized and their banks stripped of vegetation as more urban development moves into the surrounding flood plains. Neither fish nor wildlife thrives in these new man-made biological deserts.*

Figure 1. Dry Creek Watershed Location (Robert)

Fortunately, a few last strongholds of original habitat can be found along some of the creek bottom lands. An oasis such as this exists on Secret Ravine Creek in Western Placer County. This report describes the resources and recommends adoption of protective measures.

In 1965, the City of Roseville adopted an amendment to the general plan designating some areas of creeks as greenbelts, including the portion of Secret Ravine within the Roseville City limits.

Similar initiatives in other communities have led to four major planning areas within the Dry Creek Watershed (details are included in Section 3.4.2):

1. The Ueda Parkway (a continuous chain of trails connecting Sacramento and Placer counties) sponsored by City of Sacramento and Sacramento Area Flood Control Agency (SAFCA), which includes Steelhead Creek, formerly known as the Natomas East Main Drain Canal, and the City's portion of the creek extending downstream of Rio Linda Blvd.;
2. The Dry Creek Parkway sponsored by Sacramento County, SAFCA, Sacramento Valley Conservancy, Sacramento Open Space, Walk Sacramento, and others. This portion falls mainly in the community of Rio Linda; the Rio Linda and Elverta Recreation and Parks District has been an advocate.
3. City of Roseville greenbelts, parks and open space. Friends of the Roseville Parkway advocated greenbelts and bike trails in the 1980's.
4. Placer County community planned areas. Placer County plans include trail and open space components.

These plans include open space preservation and trail segments connecting to other communities; and, together, these plans cover much of the watershed area. However, they are not a comprehensive, integrated plan. The Dry Creek Watershed management plan seeks to incorporate the projects and processes of all of these areas

The Placer County Flood Control and Water Conservation District (PCFCD) may have been the first organization to take a whole watershed approach. After devastating floods in 1986, the district teamed with Sacramento County to develop the *Dry Creek Watershed Flood Control Plan* (Placer County, 1992). The plan had a strong riparian preservation component that stressed preservation of natural floodplains as a means of preventing flooding. It stressed that natural floodplains with natural vegetation would retain waters in headwaters areas and reduce flooding in the flat low elevation areas of Sacramento County.

After extensive flooding in early 1995 Sacramento and Placer County agencies met to develop a grant proposal to the Federal Emergency Management Administration (FEMA) for flood hazard mitigation on a watershed scale. The resulting Dry Creek Regional Project (DCRP) was submitted in early 1996. It included a strong open space element, The Dry Creek Greenway Concept Report, which was developed by an advisory committee of federal, state, and local agencies and organizations, and was published in March 1996 as a component of the DCRP.

Though the multi objective greenway plan was strongly advocated by State Office of Emergency Services (OES) and FEMA representatives, local flood control engineers feared it would take funds from essential structural improvements. Local political representatives eventually persuaded FEMA to fund elevation of homes throughout the watershed and channelization in the City of Roseville. The Greenway component of the plan languished.

During development of the FEMA grant application, the greenway advisory committee called meetings to explore the idea of a Joint Powers Agreement (JPA) to manage the whole parkway. It was thought that a JPA would encourage consistent management throughout the Greenway, and would be an attractive organization for funding. This idea was rejected by local agencies who preferred to have control over their own portions of the Greenway.

About the same time, a planner with the Placer County Transportation Planning Agency, organized a group of citizens who advocated the Greenway approach and the multi-objective approach to flood control. The group called itself the Dry Creek Parkway Citizens Advisory Committee. It was a loose coalition of environmental preservation groups in Placer County. The group published a *Dry Creek Parkway Concept Plan* in January 1995 that was widely distributed, but received little notice from local planners. The plan was modeled after the successful San Diegito Parkway in San Diego. According to this plan, the Greenway was to:

> *"Provide a continuous and coordinated system of preserved lands with a connecting corridor of walking, equestrian, and bicycle trails encompassing the Dry Creek watershed from the Sacramento County border west of Roseville to the creek's sources."*

This plan focused on the Placer County portion of the watershed, since Sacramento had, by this time, already developed a draft parkway plan for the Sacramento County portion of Dry Creek. Many of the Dry Creek Parkway Concept Plan ideas were included in the FEMA proposal's greenway component.

In January 1995, the Dry Creek Parkway Citizens Advisory Committee was successful in enlisting support of Trust for Public Land (TPL) for the Parkway, and on March 11, 1995 the Citizen's Committee held a watershed-wide public meeting, supported by National Park Service Rivers, Trails, and Conservation Assistance Program (NPS-RTCA), to bring citizens, officials, and agency staff together to discuss the Dry Creek Parkway concept. Over 50 citizens and staff from Placer and Sacramento Counties attended the meeting. Major recommendations of the meeting were to form a nonprofit advocacy organization to champion the Parkway, and to seek planning and implementation funding. Continued support for the project was pledged by NPS-RTCA.

In the summer of 1995, the Dry Creek Parkway Citizens Advisory Committee was able to focus the governor appointed California Recreation Trails Committee (CRTC) meeting on the Dry Creek Greenway. The CRTC toured the watershed and passed Resolution 95-1 encouraging:

… that all park and recreation, flood control and transportation planning and funding efforts recognize the need for a multi-purpose greenway system, including off-street non motorized trails, riparian protection, flood control and recreation in the greater Sacramento region, including a system of connecting trails to the above loop trail and connections to surrounding counties and that such planning efforts provide guidance for implementation of the system.

In 1996, the Dry Creek Parkway Citizens Advisory Committee merged with Friends of the Roseville Parkway and incorporated as the Dry Creek Conservancy (DCC), a nonprofit charitable organization. Also in 1996 DCC published a map brochure and description of the watershed and the Dry Creek Greenway with funding from TPL, NPS- RTCA, Placer County, Roseville, and other public and private entities. The map brochure remains a good tool for promoting the Dry Creek Greenway concept.

Also, in 1996, DCC worked to form the Dry Creek Coordinated Management and Planning group (now called the Dry Creek Watershed Council or DCWC), a collaborative stakeholders group that had its first meeting in 1996. The group was formed with help from NPS-RTCA and the Placer County Resource Conservation District (RCD). Since 1996 DCC and local jurisdictions have been successful in securing grant funding for a number of projects, including trail planning, water quality monitoring, education, and restoration. The DCWC continues to meet regularly to coordinate grants and projects throughout the watershed. Placer County funding provides for RCD support of meeting minutes, agendas, and some facilitation.

1.1.2 Review of Documents Pertaining to Management of the Dry Creek Watershed

There have been numerous studies and management plans for areas within the Dry Creek watershed over the years. Most of them fall within one of the four planning areas defined above. The watershed-wide planning effort of this Plan should incorporate these exisiting plans into a coherent and coordinated program. Some of these plans pertain to management of set-aside land as preserves or mitigation. A major ongoing effort of the Plan is to discover, describe and map as many preserves, mitigation areas, and other set aside lands as possible. That map will provide a basis for evaluating the overall condition of the remaining natural area of the watershed, and for developing management strategies that will improve watershed function.

There are relevant policies in numerous city, county, and special district plans. These are not included here, but instead, are listed in section 3.0 of this plan. Our focus here is on documents specially developed for management of watershed resources. These will most often take into account the goals and policies of local jurisdictions. A survey of the provisions of these documents will lead us to management recommendations that others have made. We can then see how they fit with the goals and objectives of this plan.

Documents we have found particularly relevant are listed below in Table 1.1. The documents are listed chronologically by the major topic areas: plans and policies, flood control, and resource surveys and studies.

Table 1.1. Plans, Policy Documents, and Studies with Particular Relevance to the Development of the Coordinated Resource Management Plan (page 1)

Table 1.1. Plans, Policy Documents, and Studies with Particular Relevance to the Development of the Coordinated Resource Management Plan (page 2)

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Table 1.1. Plans, Policy Documents, and Studies with Particular Relevance to the Development of the Coordinated Resource Management Plan (page 19)

Conclusions from review of Dry Creek Documents

Geographic

All of the stream corridors in the watershed have been included in previous plans and resource surveys as shown in table 1.2 below.

Table 1.2. Plan and Survey Coverage of the Dry Creek Watershed

Plan Number	Whole Watershed	Tributary						
		Lower(1) Dry Creek	Upper(2) Dry Creek	Clover Valley	Antelope Creek	Secret Ravine	Miners Ravine	Linda/ Cirby
1			x					
2		x						
3		x						
4			x					
5	x							
6	x							
7		x						
8						x	x	
9						x		
10		x						
11			x					
12	x							
13	x	x						
14			x					
15	x							
16	x							
17							x	
18						x		
Survey Number	**Whole Watershed**	**Lower(1) Dry Creek**	**Upper(2) Dry Creek**	**Clover Valley**	**Antelope Creek**	**Secret Ravine**	**Miners Ravine**	**Linda/ Cirby**
19	x							
20						x		
21								x
22		x				x		
23						x		
24							x	
25		x						
26		x						
27			x					
28			x					
29	x							
30							x	
31						x		
32			x					
33		x						
34						x		
35						x	x	

Table 1.2. Plan and Survey Coverage of the Dry Creek Watershed (continued)

Survey Number	Whole Watershed	Lower(1) Dry Creek	Upper(2) Dry Creek	Clover Valley	Antelope Creek	Secret Ravine	Miners Ravine	Linda/ Cirby
36			x					X
37							x	
38			x					
39						x		
40						x		
41	x							
42			x					
43							x	

(1)Streams and corridors below Atkinson St.
(2)Streams and corridors above Atkinson St.

Policy conclusions

Review of the documents reveals recommendations that can be categorized as shown below. A comparison of these categories to WMP goals and objectives shows that all these objectives are compatible with stated goals and objectives of the WMP. as follows. Recommendations that are listed under categories are common to many of the documents.

Protect floodplains and natural areas

- Open space greenway park and trail system
- Incorporate natural areas into developments.

Restoration and management

- Remove migration barriers

  (Beaver dams should be monitored and removed or breached if they seem to prevent passage)
- Implement a flow augmentation program.
- Increase channel complexity such as pools and instream cover
- Where channels are excessively eroding in the headwaters, the channel banks should be regraded to create the natural three-stage channel configuration (low flow, bankfull and flood channel.)
- Increase vegetative cover
- Invasive weed management strategy
- Increase groundwater recharge
- Study and regulate homeowner lakes.
- BMP's to mitigate impervious surfaces
- Design systems that require minimal maintenance and which mimic natural systems.

Education

- Homeowner education is essential.
- The opportunities and problems require a regional approach.

  (Joint Powers Authority)
- Land use guidance
- Interpretive programs
- Citizen participation
- Developers notified of regulations
- Off Road Vehicle Access to the creek should be eliminated.

Data gathering

- Systematic information regarding plant and animal life resources should be gathered.

  Studies such as this should be carried out by college programs at regular intervals throughout the watershed.
- Resident fish population should be monitored regularly as an indication of stream health.
- Water quality monitoring
- Estimate impervious cover for subwatersheds

A multi-objective approach

Water Quality

- Trap urban pollutant runoff.
- Pesticide use reporting program

  Development should create no net increase in peak stormwater runoff.

Projects

- Evaluate erosion in the Sacramento County portion of Dry Creek
- Cottonwood Dam – Continue to develop potential for removal
- Implement recommendations of Dry Creek Bank Erosion Management Plan

Resource conclusions

Resource concerns found from review of the 43 Dry Creek Resource documents are categorized as shown below. Some of the concerns such as land use are prevalent throughout the studies.

Native species/Exotic species

- Plant diversity and numbers
- Wildlife diversity and numbers

Habitat

- Riparian
- Instream habitat
- Migration barriers *(e.g., beavers and small dams)*

Water quality

- Turbidity
- Water temp
- Pollutants
- Wastewater treatment plant effluent

Land use

- Impervious surfaces
- Increased stormwater flow
- Floodplain development

Channel morphology

- Channel complexity
- Erosion
- Sedimentation
- Streamside landscaping
- Channel alteration

Flow

- Low flow
- Flooding

1.2 Regional Planning Context

The Dry Creek Watershed spans several geopolitical jurisdictions, including:

- Unincorporated communities (i.e., Newcastle, Penryn-Horseshoe Bar, Granite Bay, Dry Creek-West Placer) in Placer County.

- Incorporated cities (i.e., Roseville and Rocklin) and towns (i.e., Loomis) in Placer County.

- Unincorporated communities (i.e., Orangevale, Antelope, North Highlands-Foothill Farms, Rio Linda-Elverta) and specific plan areas (i.e., East Antelope Specific Plan and the Dry Creek Parkway) in Sacramento County.

- Incorporated cities (i.e., Folsom, Citrus Heights, and Sacramento) in Sacramento County.

State and Federal regulatory agencies further complicate the regional planning context due to their overlapping regulatory interests, missions, and regulations.

State agencies with regulatory or other interest in relevant land use considerations include the following:

- The California Department of Fish and Game (CDFG) manages California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public." Besides administering the licensing programs for hunting and fishing; CDFG sponsors research efforts, actively participates in habitat management initiatives; and regulates the take of endangered species and modifications to waters of the state under the authority of the California Fish and Game Code.

- The Central Valley Regional Water Quality Control Board (CVRWQCB) is the local/regional agency through which the California State Water Resources Control Board (SWRCB) exercises its authority to protect water quality by regulating discharges into surface and groundwaters. The CVRWQCB has regulatory authority over discharges into and filling of waters of the U.S., under Sections 401 and 402 of federal Clean Water Act. At the state-level, similar authority is derived from the Porter-Cologne act. In addition, the SWRCB administers water rights and pursues water quality initiatives statewide.

- The California State Reclamation Board is the state agency primarily responsible for flood control and management of non-federal project levee systems. The Board also establishes designated floodways in order to maintain channel capacities and regulates floodplain encroachment in designated areas via a permit program. This regulatory function is sometimes delegated by cooperative agreement with local jurisdictions.

- The California Department of Water Resources (CDWR) coordinates the management and use of waters of the state. Primary concerns are water supply quality and flood control. CDWR also regulates construction and/or modifications to dams and/or reservoirs.

- The California Department of Parks and Recreation's (CDPR) is responsible for the development of recreational resources and opportunities and the administration and operation of the state park system.

- The California Environmental Protection Agency (CalEPA) has oversight over the the Air Resources Board (ARB), State Water Resources Control Board (SWRCB), Regional Water Quality Control Boards (RWQCBs), the Integrated Waste Management Board (IWMB), Department of Toxic Substances Control (DTSC), Office of Environmental Health Hazard Assessment (OEHHA), and Department of Pesticide Regulation (DPR)

Federal agencies with regulatory or other interest in relevant land use considerations include the following:

- The U.S. Army Corps of Engineers (USACE), which in addition to its other interests, is the primary federal agency responsible for regulating fill into waters of the United States. It regulates construction and fill within waters of the U.S. and associated wetlands using its authority under Section 404 of the federal Clean Water Act.

- The U.S. Fish and Wildlife Service (USFWS) is the primary federal agency that pursues the management of fish and wildlife resources and regulates the take of federally-listed species and habitats. USFWS regulates the take of endangered species and habitats pursuant to its authority under the federal Endangered Species Act. In addition, consistent with the requirements of the Fish and Wildlife Coordination Act, it functions in an advisory capacity to other federal agencies regarding a wider array of fish, wildlife, and habitat management issues.

- The National Marine Fisheries Service (NMFS) has similar responsibility and authority with respect to anadromous fish species. Under the federal Endangered Species Act, it regulates take (including habitat modification) of instream habitat for such listed species. The Magnuson-Stevens Fishery Conservation and Management Act also effectively extends the agency's authority into inland and upland areas to which modifications might result in negative effects to what is defined as Essential Fish Habitat.

- In California, the U.S. Environmental Protection Agency (USEPA) has delegated its authority under Sections 401 and 402 of the federal Clean Water Act to the California State Water Resources Control Board. However, USEPA maintains a regulatory oversight interest under Section 404, and may, where it believes that the Corps of Engineers is inappropriately exercising its authority, may usurp the normal regulatory process.

- The Federal Emergency Management Agency (FEMA) is the primary federal agency administering floodplain management programs. FEMA is responsible for delineating 100-year floodplains, and for "voluntary" regulation of development within them. Such voluntary regulation is achieved through the administration of a nationwide flood insurance program that is made available to local jurisdictions that regulate development within the floodplain.

The complicated geopolitical environment, combined with the different interests at opposite ends of the watershed (e.g., flood control downstream versus development pressure upstream), call for a balanced approach to resource management, consistent with the diverse interests of stakeholders.

1.3 Dry Creek Watershed Council Participants

The Dry Creek Watershed Council (DCWC), formerly known as the Dry Creek Coordinated Resource Management Planning (CRMP) Planning Group initiated the development of this Plan. The group consists of representatives from various local jurisdictions (i.e., cities, towns, and counties), state and federal resource and regulatory agencies, concerned and involved private citizens, and other stakeholders in the watershed. This group was formed primarily at the initiative of the Dry Creek Conservancy, a non-profit organization that has been active in the watershed since 1996.

1.3.1 Meetings

At present, the Dry Creek Watershed Council meets on a monthly basis (1st Wednesday of each month) at the Roseville Corporation Yard, 2005 Hilltop Circle, Roseville, California. Attendance at these voluntary meetings has been highly variable over the last three years, ranging from small groups of 5 or 6 individuals to larger groups of 18-20. Interested private citizens, agency or local planning jurisdiction personnel, and consultants working on various projects/contracts with participating agencies and/or local jurisdictions have been consistently attending these meetings.

Major issues focused on by this group tend to revolve around:

- Fisheries Management
- Riparian Habitat and Floodplain Management
- Wastewater and Stormwater Management
- Public Education and Involvement

1.3.2 Goals and Objectives

While the list presented above represents a relatively comprehensive catalog of concerns, there are notable omissions. For example, during the initial formative period the group developed and adopted (December 1, 1999) “Comprehensive Resource Management Plan Objectives.” These objectives were revised (and readopted) on March 6, 2002 (Appendix 1.1). In defining the overall goals and objectives, both human and natural resources were included as important components for consideration. Both versions explicitly identify concerns regarding recreational facilities and water supply facilities, yet these items receive little attention during regular meetings. Consequently, there are several issues identified as concerns that are not necessarily considered high priority.

The overall goals of this Plan, identified by the working group, are:

1. To balance the changes resulting from past present and anticipated economic development activities with the Coordinated Resource Management Plan’s Working Group interest in establishing a sustainable, natural, and healthy aquatic and terrestrial environment within the Dry Creek watershed.

2. To achieve the balance described in Goal 1 within the Dry Creek watershed after an acceptable baseline environmental condition has been identified by the plan and satisfactorily achieved by the plan's implementation.

To meet the overall goals, the working group identified four major objectives:

1. Develop a plan that integrates three key and interrelated attributes of the Dry Creek watershed: water quality, floodplain management, and habitat restoration.
2. Accommodate existing recreational facilities and promote the establishment of compatible, new, passive and active recreational facilities and activities within the Dry Creek watershed.
3. Protect water supply facilities that rely upon the Dry Creek watershed.
4. Promote and facilitate public education consistent with Objectives 1, 2, and 3.

Specific tasks intended to achieve these objectives are identified in Section 5.0.

Stakeholder interests that are represented at the meetings, in the light of agency requirements, tend to drive the focus of CRMP groups. Third party and public review of this Plan is thus necessary to assure that pertinent issues are addressed and appropriate prioritization applied.

1.4 Memorandum of Understanding

Many of the participating agencies have become signatories to the "Memorandum of Understanding Regarding the Development of Dry Creek Coordinated Resource Management Planning Initiative" (MoU) with the Dry Creek Conservancy (Appendix 1.2), thus committing them as active participants in the coordinated planning effort. A list of the signatories to date is provided as Appendix 1.3.

1.4.1 Signatories to the MoU and Regular Monthly Meeting Participants

Some of these regular participants represent signatories to the Memorandum of Understanding supporting this planning initiative, including:

- Adelante High School
- California Conservation Corps
- California Department of Fish and Game
- City of Roseville
- Dry Creek Conservancy
- Placer County Board of Supervisors (Planning Department representatives)
- Placer County Flood Control District
- Sacramento County Staff

In order to remain true to the adopted goals and objectives, it is necessary to encourage participation outside of the regular attendees. The nature of this Plan consists of interacting and overlapping interests. In order to be successful, "buy-in" by the majority of stakeholders is necessary. It is not sufficient to prepare this Plan based primarily on the input from the consistent meeting participants. Consequently, two other groups have been targeted from which to solicit additional input, as discussed below.

1.4.2 Signatories to the MoU Not Routinely Represented at the Monthly Meetings

Several signatories to the MoU are not routinely represented at the monthly meetings; however, their input is considered valuable to the planning process. These agencies include:

- California Native Plant Society, Sacramento Valley Chapter
- Central Valley Regional Water Quality Control Board
- Granite Bay Flycasters
- Placer County Department of Environmental Health
- Placer County Fish and Game Commission
- Rio Linda-Elverta Recreation and Park District
- Roseville Joint Union High School District
- Sierra College
- Sacramento Urban Creeks Council
- Sacramento Valley Open Space Conservancy
- U.S. Fish and Wildlife Service

1.4.3 Non-Signatory Interest Groups

There is another sector of the public that may not, to date, have had adequate opportunity to participate in the planning process. These include clubs, activist groups, and even agencies with specific and particular interests. These may include:

- Flood-Effected Residents
- Agricultural Interests
- Recreational Users
- Off-Road Vehicle (ORV) Users
- Sportfishermen
- Equestrians
- Bicyclists
- Locomotors
- Paddlers and Swimmers
- Rural Residents
- Conservation Organizations
- Agencies (non signatory)

The strategy identified for including these types of groups is to seek out key individuals involved in such groups and secure invitations to present our interests at their regular group meetings. There have already been several active outreach efforts undertaken by the Dry Creek Conservancy. The Dry Creek Conservancy attended local community advisory group meetings during the summer and fall of 2002. They gave a slide presentation that explains watershed issues and planning concepts and distributed watershed maps with a one-page summary of the Proposition 204 project. The groups attended were:

- Placer Municipal Advisory Councils:
    - Horseshoe Bar
    - Newcastle/Ophir
    - West Placer
    - Granite Bay
- Roseville Neighborhood Associations:
    - Folsom Road
    - Enwood Association
- Sacramento County:
    - Sacramento Area Flood Control Agency-North Area Roundtable
    - Rio Linda/Elverta CPAC

Residents reacted very positively to the slides presentation. They were very interested in the ideas and had questions. Many were knowledgeable about watershed issues and expressed a variety of concerns and suggestions including:

- Trails
- Support in their communities
- Making walking safer
- Preventing trespassers
- Flooding
- Cleaning ditches
- Increasing with new development
- Erosion threatening roads
- Allergies caused by cottonwood trees
- Providing information to newcomers about creek side landowner stewardship

1.5 Plan Review Process

The Draft Plan was distributed to all MoU signatory members and non-signatory interest groups listed above by November 15, 2003. Additional copies were be made available upon request by individuals and organizations not already identified, and the entire document was made available on the Placer County Planning website.

Comments were solicited for period of 30 days following Draft Plan distribution. Monthly council meetings were also structured to include solicitation of oral comments. Following the end of the comment period (December 15, 2003), the DCWC and their

representatives reviewed comments and incorporated suggestions into this planning document.

A public workshop was conducted by ECORP and Placer County Planning Department representatives on December 15, 2003, in Roseville, to present the Plan to local stakeholders. Comments solicited during this workshop were also incorporated into the Plan document. Prior to finalizing the Plan, follow-up and contact calls of Plan recipients were completed to solicit input from major stakeholders and agency personnel.

2.0 EXISTING ENVIRONMENT (DESCRIPTION OF THE WATERSHED)

Resource planning, prioritization, and management are based on evaluation of current conditions in light of target goal(s). Historical context is important in defining the processes creating current conditions and illuminating potential specific target goals or inherent difficulties in meeting those goals. The following section describes the existing conditions for the Dry Creek Watershed, and associated information gaps. It is preceded by a description of the prehistorical and historical context. Detailed technical data are included in the associated appendices.

2.1 Prehistorical and Historical Context

2.1.1 Prehistory

The earliest evidence of the prehistoric inhabitants of the region surrounding the Dry Creek area comes from a single, deeply buried site in the bank of Arcade Creek, north of Sacramento, containing grinding tools and large, stemmed projectile points. The points and grinding implements suggest an occupation date of some time between 6000 and 3000 B.C. (Wallace, 1978). However, diagnostic artifacts recovered from the Dry Creek area in the 1960's research are typically of the Central California Late Horizon (Palumbo, 1966). It was not until after about 3500 B.C., in the Late Archaic Period, that people began to move into the San Joaquin and Sacramento valleys in any significant numbers (Chartkoff and Chartkoff, 1984). This earliest permanent settlement of the Delta region of the Sacramento River is called the Windmiller Tradition, and is known primarily from burial sites, containing relatively elaborate grave goods, in or near the floodplain (Chartkoff and Chartkoff, 1984; Ragir, 1972; Wallace, 1978). The Windmiller Tradition reflects the amplification of cultural trends begun in the Middle Archaic, as seen in the proliferation of finished artifacts such as projectile points, shell beads and pendants, and highly polished charm stones. Stone mortars and pestles, milling stones, bone tools such as fishhooks, awls, and pins are also present. It is probable that these people subsisted on deer and other game, salmon, and hard seeds. They also were apparently the first Californians to discover the process for leaching the tannins out of acorns, thus making them edible by humans (Chartkoff and Chartkoff, 1984). Based on linguistic evidence, it has been suggested that the Windmiller culture was ancestral to several historic tribes in the Central Valley, including the Penutian speaking Nisenan (Chartkoff and Chartkoff, 1984; Elsasser, 1978). The Windmiller Tradition lasted until about 1000 B.C. (Chartkoff and Chartkoff, 1984).

Around 1000 B.C., subsistence strategies in the Delta region became noticeably more "focal," with a clear increase in the reliance on acorns and salmon (Chartkoff and Chartkoff, 1984; Elsasser, 1978). Culturally, this has been dubbed the Cosumnes Tradition (1700 B.C. to A.D. 500), and appears to be an outgrowth of the Windmiller Tradition (Ragir, 1972). These people continued to occupy knolls or similar high spots above the floodplain of the Sacramento River and the terraces of tributaries, such as the

Cosumnes and American rivers, flowing out of the foothills of the Sierra Nevadas to the east. Populations increased, and villages became more numerous than before, with more milling tools, and specialized equipment for hunting and fishing. Trade appears to have increased, with burials containing larger amounts of seashell and obsidian. Burial styles also became more varied with the increased trade. Projectile points found embedded in the bones of excavated skeletons suggest that warfare was on the rise, possibly as a result of increased competition over available resources and trade (Beardsley, 1954; Lillard *et al.*, 1939; Ragir, 1972).

The next, and final, discrete prehistoric culture is the Hotchkiss Tradition (A.D. 500 to 1769) that persisted until the arrival of European settlers in central California (Beardsley, 1954; Ragir, 1972). During this period, use of acorns and salmon reached its peak, with hunting of deer. Diet was supplemented with the addition of waterfowl, hard seeds, and other resources. Large sedentary villages along the lower Sacramento and San Joaquin rivers, and their tributaries and delta were common. The size and density of these settlements suggests a further increase in population from Cosumnes times. Trade goods were plentiful, and burials exhibit a marked stratification of society, with wide differences in the amount and variety of grave goods. Cremation of the dead appears, along with the burial styles of the previous period (Chartkoff and Chartkoff, 1984; Ragi,r 1972). While ornamental or ritual artifacts, such as large, fragile projectile points and trimmed bird bone increase during this period, milling tools are rare or absent. Shell beads continue in large numbers, and there are numerous utilitarian artifacts of bones such as awls, needles, and barbed harpoon points. Polished charm stones are more rare, but ground stone pipes became more abundant. In addition, fired and unfired clay objects begin to appear (Chartkoff and Chartkoff, 1984).

2.1.2 Ethnography

Ethnographically, the Penutian speaking Nisenan in the southwestern portion of the territory occupied the Dry Creek watershed area. The territory extended from above the junction of the Feather and Sacramento rivers on the north, to a few miles south of the American River in the south. The Sacramento River bounded the territory on the west, and in the east, it extended close to Lake Tahoe. As a language, Nisenan (meaning “from among us” or “of our side”) has three main dialects – Northern Hill, Southern Hill, and Valley Nisenan, with three or four sub dialects (Kroeber, 1976; Placer County, 1992; Shiple,y 1978). The Valley Nisenan lived primarily in large villages with populations of several hundred each, along the Sacramento River. Between there and the foothills, the grassy plains were largely unsettled, used mainly as a foraging ground by both valley and hill groups (Placer County, 1992). Individual and extended families “owned” hunting and gathering grounds, and trespassing was discouraged (Kroeber 1976; Wilson and Towne, 1978; 1982).

Politically, the Nisenan were divided into “tribelets,” made up a primary village and a series of outlying hamlets, presided over by a more-or-less hereditary chief (Kroeber, 1976; Wilson and Towne, 1978; 1982). Villages typically included family dwellings – conical houses covered with bark slabs - acorn granaries, a sweathouse, and a dance house, owned by the chief. The chief had no authority on his or her own (females could become chief, if no competent male relative could be found). Authority came from the

support of the shaman and the villagers, but with this the word of the chief became virtually the law. The principal village in the watershed area was probably Pichiku, located halfway between Auburn and Sacramento (Wilson and Towne, 1978). It is debatable whether this village is the identified site CA-PLA-86. This village may only be near Roseville and not in it, since specific location information was not gathered in the earlier ethnographic record. (Palumbo, 1966)

Subsistence activities centered around gathering acorns (tan oak and black oak were preferred), seeds, and other plant resources, the hunting of animals such as deer and rabbits, and fishing. Large predators such as mountain lions and wildcats were hunted for their skins, as well as their meat, and bears were hunted ceremonially. Although acorns were the staple of the Nisenan diet, they also harvested roots like wild onion and "Indian potato," which was eaten raw, steamed, baked, or dried and processed into flour cakes to be stored for winter use (Wilson and Towne, 1978). Wild garlic was used as soap/shampoo, and wild carrots were used medicinally (Littlejohn, 1928). Seeds from grasses were parched, steamed dried, or ground; and made into a mush. Berries, too, were collected, as were other native fruits and nuts. Game was prepared by roasting, baking, or drying. It has been reported that the owners of several ranches along Pleasant Grove Creek gave the Nisenan access to gather acorns, tubers, and grasshoppers in the late summer and fall. In addition, salt was obtained from a spring near Rocklin (Wilson and Towne, 1978; 1982).

Hunting of deer often took the form of communal drives, involving several villages, with killing done by the best marksmen from each village. Snares, deadfalls, and decoys were used, too. Fish were caught by a variety of methods including use of hooks, harpoons, nets, weirs, traps, poisoning, and the hands (Wilson and Towne, 1978; 1982).

Trade was important with goods traveling from the coast and valleys up into the Sierra Nevada, and vice versa. Items like shell beads, salmon, salt, and grey pine nuts went up, and things such as bows and arrows, deerskins, and sugar pine nuts came down. In addition, obsidian was traded in from the north (Wilson and Towne, 1978; 1982).

The Spanish moved into the Central Valley around 1769, and by 1776, the Miwok territory bordering the Nisenan on the south had been explored by José Canizares. In 1808, Gabriel Moraga crossed Nisenan territory, and in 1813, a major battle was fought between the Miwok and the Spaniards near the mouth of the Cosumnes River. Though the Nisenan appear to have escaped being removed to missions by the Spanish, they were not spared the ravages of European-spread disease. In 1833, an epidemic – probably malaria – raged through the Sacramento Valley, killing an estimated 75% of the native population. When John Sutter erected his fort at the future site of Sacramento, he had no problem getting the few Nisenan survivors to settle nearby. The discovery of gold in 1848, near the Nisenan village of Colluma (also Coloma), drew thousands of miners into the area, and led to widespread killing and the virtual destruction of traditional Nisenan culture. By the Great Depression, no Nisenan remained who could remember the days before the arrival of the Whites (Wilson and Towne, 1978; 1982).

2.1.3 History

Although the Spanish had made forays into the Central Valley since about 1769, it was not until 1808 that Capitan Gabriel Moraga explored, and named, the Sacramento area (Lawson, 2001). Other than fighting with the Indians, as in 1813, when Luis A. Arguello fought a major battle with the Miwok near the mouth of the American River, the Spanish took little interest in the area (Wilson and Towne, 1978). In 1827, American trapper Jedidiah Smith traveled up the Sacramento River and into the San Joaquin Valley to meet other trappers of his company he had left encamped there, but no permanent settlements were established at that time (Peak & Associates, 1997).

Then, in August of 1839, a European immigrant, John A. Sutter, arrived at the confluence of the American and Sacramento rivers, armed with expectations of a land grant from the Mexican government and dreams of an agricultural empire. He and his party erected a fort, originally called New Helvetia. It later came to be known as Sutter's Fort. In 1841, Sutter received his land grant - some 97 square miles – and proceeded to set up fisheries, a flourmill, and a lumber mill. The fort attracted other businesses, and after gold was discovered in a flume at Sutter's lumber mill near Coloma, a store established on the Sacramento River waterfront by Samuel Brannan soon became the heart of the new settlement of Sacramento. Sutter's son John, Jr. laid out the town itself, in 1849. By 1850, the population of Sacramento had grown to about 9000 (History of Old Sacramento, 2001; Lawson, 2001).

During the gold rush, numerous claims were worked along the American River. The project area became a shipping and supply center for the local foothills. Relative to the American River, the watershed was not as heavily impacted by the gold rush, since streams in the area did not run through large, high-yielding gold-bearing geologic deposits. However, Linda Creek did lie within the Folsom Mining District, historically owned and operated by the Natomas Mining Company. And, Secret Ravine, and Strap Ravine experienced significant historical placer mining. The area around what is today Roseville played more of a support role for the mining activities taking place in the nearby foothills. Agriculture (ranching and farming) was historically the primary activity in the area.

California was admitted to the Union on September 9, 1850, and Placer County was organized the following year. Roseville slowly grew through the 1860's. Southern Pacific railroad moved its switching yard to Roseville in 1908 making it the most populous city in the county at that time. During the latter half of the 1900s, the area grew rapidly.

Until the early 1920's, Placer County industry was dominated by agriculture and the world's largest ice manufacturing plant located in Roseville. By the 1930's, the railroad industry in Roseville was also a major employer. During the Great Depression, several public works projects were initiated to provide jobs for the unemployed population. These projects included construction of infrastructure such as storm sewers, and street and sidewalk paving in the City of Roseville. Growth and construction in the Roseville region continued during World War II and following; the City of Rocklin moved from a railroad town basis to a major operator of granite quarries. The Town of Loomis became a packing center for the regional fruit growing industry.

During the 1950's, the highway precursor to Interstate 80 was constructed, roughly paralleling the alignment of U.S. 40 and the Old Lincoln Highway. This linkage provided a corridor into Placer County for expanded growth from Sacramento County and surrounding areas.

In the 1980's, Hewlet-Packard moved from the San Francisco Bay Area to Roseville, which spurred the interest of other expanding companies to relocate in Placer County. This development and industry relocation brought with it the subsequent increased demand for more local housing and services. Additionally, growth in the City of Sacramento region spilled over into Placer County. This expanded development created growth pressures on non-residential land, as residential and commercial land is built out. Recent growth and expansion continues to this day.

2.2 Physical Environment

The approximately 101-square mile Dry Creek watershed extends from the lower western foothills of the Sierra Nevada, near the town of Newcastle (Placer County) southwest and downstream into Sacramento County to Steelhead Creek (a.k.a., the Natomas East Main Drain). Most (approximately 84%) of the watershed is within Placer County and the rest is within Sacramento County (approximately 16%). Elevations range from approximately 1200 feet above mean sea level (msl) down to approximately 30 feet above msl. Figure 2.1 is a composite of relatively recent (i.e., 2002) aerial photography showing current conditions throughout the watershed, and delineation of the subwatersheds of its major tributaries.

In general terms, the middle portion of the watershed has been subject to extreme development pressure by relatively recent growth, primarily within the cities of Roseville and Rocklin. The upper and lower portions of the watershed are already subject to the same intense pressure, and are anticipated to experience similar growth in the coming years. Such development generally has been perceived to have exacerbated normal historical flooding conditions lower in the watershed, particularly in Sacramento County, by contributing greater and faster flood flows during storm events. In addition, water quality concerns have arisen, due to the perceived increase in sedimentation and potential contamination from non-point sources.

2.2.1 Land Use/Land Cover

Historically, gold mining was prevalent within the Dry Creek watershed, greatly altering local hydrology and geomorphology (see Section 2.2.4.5). In the City of Rocklin area, granite mining was a major industry. However, most of these resources have been tapped, and most mines are not currently in operation. Figure 2.2 shows the locations of mining activity within the Dry Creek watershed. The status of many of these mines is listed as "unknown"; however, they are not likely to be currently active.

Figure 2.1. Dry Creek Subwatershed Map (Robert)

Figure 2.2. Mining Activity Map (Robert)

Figures 2.3 and 2.4 show the Dry Creek Watershed land use/land cover distribution during the 1980's and Current (2003) conditions, repsectively. Area coverage by land use/cover designation, calculated from the GIS land use/land cover data in Figures 2.3 and 2.4, is summarized in Table 2.1. It is likely that more recent and rapid development within the region will continue to alter land use/cover distribution.

Table 2.1. Land Use/Land Cover 1980's and Most Recent Compilation.

Land Use/Cover	1980's	Current	Difference*
	% total	*% total*	
Mixed Forest Land	14.9	24.1	+9.2
Cropland/Pasture	56.0	3.8	-52.2
Mixed Rangeland/Grassland	4.9	16.4	+11.5
Wetlands	ND	0.5	ND
Orchards Vineyards, Nurseries, Groves, Onramentals	4.7	0.8	-3.9
Mixed Urban/Built Up	8.5	37.7	+29.2
Residential	10.7	16.0	+5.3
Disturbed	0.2	0.2	0
Water/Lacustrine	0.1	0.5	ND

*Difference = Current -1980
**1980's classification likely different from 2003 compilation
ND = Not Determined

Industrial and commercial areas are concentrated along Interstate 80, the parallel railroad system, and major arterial roadways (e.g., Douglas Boulevard, Granite Drive, and Sierra College Boulevard). Location of industrial and commercial areas near major transportation routes is common, and serves to locate these intensive land uses close to important infrastructure.

As expected, the majority of urban lands are located within the municipalities (Roseville, Rocklin, and Loomis). The unincorporated areas of the watershed are primarily rural (agriculture, rangeland, other) and residential; although, development is changing their character as they are becoming urbanized (e.g., Granite Bay and Antelope).

Since the 1980s, the primary land use within the watershed has shifted from agricultural to residential/urban (see Table 2.1). It also appears that there has also been a shift from agriculture to rangeland/grassland and mixed forest. However, because different land use/land cover classifications and different levesl of resolution in the GIS data sets were used to create these two maps, differences should be considered approximate.

Figure 2.3. 1980’s Land Use/Land Cover Map (Robert)

Figure 2.4 Current Land Use/Land Cover Map (Robert)

The shift from agriculture to urban/residential will continue, based on full-build out of the relevant development plans. As the land use/land cover base changes, associated water resource use and distribution will be impacted. Additionally, development often changes local and regional surface hydrology parameters. Past and future land use change from rural to urban lands generally results in more impervious surfaces, higher runoff potential (total and peak flows, timing and volume), and greater modifications of local water supplies (e.g., trans-watershed transfers, groundwater use or storage, surface water withdrawals). However, if this shift is from irrigated agricultural-type uses to urban uses, reductions in irrigation water and fertilizer use can also change the regional water quality (potential for reduced agricultural chemicals in drainage and runoff) and water demands (balancing the increased residential/urban use).

Currently, the upper areas of the watershed are largely undeveloped. As growth pressures increase, this is likely to change. Development of upper watershed areas will need to be managed, so as to not impact downstream hydrology and water resources. Consequently, land use planning in the upper subwatersheds will need to incorporate mechanisms and land use practices to prevent downstream degradation.

2.2.2 Geology

The Dry Creek watershed includes geologic formations from the Sierra Nevada Geologic Province and the Central Valley Geologic Province. The Sierra Nevada portion of the watershed contains three geologic formations (Wagner et al. 1987, in Jones & Stokes 1994).

- The Penryn/Rocklin pluton comprises most of the upper Dry Creek watershed. The formation is a late Mesozoic-era, basement intrusive igneous formation of dioritic rock.

- The Copper Hill Volcanics (middle Mesozoic era) is located in a very small area of the watershed, and is comprised of an extrusive igneous basement formation of pyroclastics and pillow lava that has metamorphosed into schist by the intrusion of the Penryn/Rocklin pluton.

- The Mehrten Formation, an andesitic mudflow of the Miocene-Pliocene epoch, is found in the western edge of the Sierra foothills in the central portion of the Dry Creek watershed, the area along Clover Valley Creek, the northwestern watershed boundary, and scattered throughout the Penryn/Rocklin pluton area in isolated remnants. This formation resulted from volcanic eruptions in the Sierra Nevada that flowed westward to the edge of the present Central Valley.

The Central Valley segment of the watershed contains five geologic formations (Wagner *et al.* 1987, Helley and Harwood 1985 in Jones & Stokes 1994):

- The Laguna Formation is located in the central area of the watershed. The formation is established as remnant terraces and is an alluvial deposition, characterized by a high proportion of gravel of the Pliocene epoch, which resulted from erosion of the Sierra Nevada.

- The Turlock Lake Formation comprises most of the watershed from the central portion to the west side. It is an alluvial deposit that has been generally consolidated into sandstone and siltstone and is from the early Pleistocene epoch. The formation is believed to be the result of Sierra Nevada glaciation.

- The Riverbank Formation is found chiefly at the west or downstream end of the watershed. The alluvial deposition, of the middle to late Pleistocene epoch, is generally unconsolidated and is also the result of Sierra Nevada glaciation.

- The Modesto Formation, found as isolated terraces along the downstream portion of Dry Creek, is a late Pleistocene-epoch, unconsolidated, alluvial deposition related to the most recent major glaciation.

Holocene (recent) alluvium composed of material ranging from gravel to clay has been deposited along Dry Creek and its tributaries throughout the watershed. The deposition becomes wider from the upper to lower watershed areas.

A recent geologic map also shows the central watershed area containing a ninth geologic formation (the Ione Formation) (Rodgers 1980, Tugel 1993 in Jones & Stokes 1994). However, recent soil mapping conducted at a greater level of detail shows the same areas as the Laguna Formation. The soil surveys will be accepted as more accurate, in the absence of field verification.

2.2.2.1 Regional Seismicity

No faults are known to exist in the Dry Creek watershed. The Willows fault, near the western boundary of the watershed, was determined inactive since the start of the Pleistocene period. The Bear Mountain Fault Zone lies approximately 2 miles east of the northeast watershed boundary. This fault zone has been determined by the California Department of Mines and Geology to be not active in the Holocene period, but is still regarded as potentially active. Significant ground shaking in the Dry Creek area may occur from potentially active regional earthquake faults, such as in the Foothills and Melones Fault zones; however, earthquakes occurring on more well known California faults, such as the San Andreas, Hayward, and Calaveras faults would not be expected to cause significant ground shaking in the Dry Creek area. The Holocene alluvium found along the creek channels in the Dry Creek watershed, with water tables shallower than 30 feet, may be subject to a liquefaction hazard (Crawford, Multari & Starr *et al*. 1992 *in* Jones & Stokes 1994).

2.2.2.2 Slope Stability

Active landslides have not been formally identified in the Dry Creek watershed. However, potential landslide areas may be present since the region has not been formally assessed by a landslide professional. Some locations within the watershed appear to exhibit 'slide' or 'torrent' type mass earth movement that may create localized hazard conditions. The Mehrten Formation may be susceptible to landslides if certain factors exist, such as the presence of unconsolidated earth, steep slopes, saturated soils, lack of stabilizing vegetation, nearby active erosion, or ground shaking (Crawford,

Multari & Starr et al.1992 in Jones & Stokes 1994). Additionally, development of steep slopes at higher elevations may impact slope stability if erosion control and stabiliazation measures are not implemented.

2.2.2.3 Paleontological Resources

Within the Dry Creek watershed, only the Mehrten Formation has been determined to contain fossils of vertebrates. The Laguna, Turlock, or Riverbank Formations (alluvial terrace formations) may contain fossils, but that has not been determined (Crawford, Multari & Starr *et al*. 1992 *in* Jones & Stokes 1994).

2.2.3 Soils

Soils within the dry creek watershed are variable, depending upon landscape position and underlying geology (Figure 2.5). Most soils are formed from either granitic or volcanic parent material, and often include a clay pan, hard pan, or other consolidated layer that impedes water permeability. Shallow soils and rock outcrops are fairly common at higher elevations.

2.2.3.1 Soil Associations with Local Geologic Formations

There are four soil types on the Penryn/Rocklin pluton: the Andregg, Caperton, Sierra, and Shenandoah. The most prevalent type is the Andregg soil series, a coarse, sandy, loam-textured soil 24 to 40 inches deep to decomposed granodiorite. The Caperton series has a shallower depth, 14 to 20 inches to decomposed granodiorite. The Sierra series has a greater depth, 40 to 60 or more inches to decomposed granodiorite and has a subsoil horizon of clay accumulation and a clay loam texture. The Shenandoah series has a limited distribution on old stream terraces in the Penryn/Rocklin pluton region. It has a well-developed subsoil of clay, a depth of 32 to 40 inches to decomposed granodiorite, and hydric soil characteristics.

A small area of the Copper Hills Volcanics contain two soil series: the Auburn and Sobrante. The Auburn series is a rocky silt loam, 12 to 28 inches deep to schist bedrock. The Sobrante series is 22 to 40 inches to schist bedrock, with a moderate subsoil clay accumulation with a loam to clay-loam texture.

The two main soil series for the Mehrten Formation are the Exchequer and Inks series. The Exchequer series is a very rocky loam, 8 to 20 inches thick over hard andesitic lahar bedrock. The Inks series is a very rocky loam with a very rocky clay loam subsoil and is 12 to 20 inches deep over hard andesitic lahar bedrock. The Alamo variety is an unusual soil type, found in isolated basins and floodplains along Antelope and Clover Valley Creeks at the base of volcanic ridges. It is a black alluvial clay over unrelated dark grayish brown sandy clay alluvium, underlain by volcanic bedrock with a depth of 36 to 60 inches.

Figure 2.5. Soils Map (Robert)

The Laguna Formation contains three significant soil series: the Redding, Corning, and Red Bluff series. The Redding series is a gravelly loam over a claypan subsoil, over a duripan. The average depth to the claypan is 14 inches. Depth to the duripan ranges from 20 to 34 inches. The Corning series is a gravelly loam over a claypan subsoil, with no duripan. Depth to the claypan is approximately 12 to 22 inches. The Red Bluff series is similar to the Corning series.

The Turlock Formation has one primary soil type, the Fiddyment series. The Fiddyment series is a loam with a subsoil of clay and a clay loam texture over a duripan. Depth to the duripan is 20 to 37 inches. The Kaseberg series is less extensive and is a loam 10 to 20 inches deep over a duripan, with no clay subsoil.

The Riverbank Formation has several soil types, some with a claypan over a duripan, and others with a claypan alone. The San Joaquin series is a sandy or silt loam with a subsoil clay loam or claypan over a duripan. The depth to the duripan is 20 to 40 inches. The Madera series is very analogous. The Cometa series is a sandy loam over a claypan, with no duripan. The depth to the duripan is 10 to 22 inches. The Bruella series is similar to the Cometa series, but the subsoil is clay loam and the depth is greater than 60 inches.

Three soil series define the Modesto Formation: the identical Ramona and Orangevale series characterize the early Modesto alluvium or higher terrace, and the Liveoak series characterizes the late Modesto alluvium or lower terrace. The Ramona and Orangevale series consist of a sandy loam over a sandy clay loam subsoil, with a depth of 48 to more than 80 inches. The Liveoak series is a very deep, sandy to sandy-clay loam alluvium with little soil development other than moderate organic matter accumulation in the surface horizon.

The Holocene or recent alluvium along the Dry Creek watershed stream channels also contains mining tailings mostly from historical dredge, and hydraulic mining operations that are composed chiefly of gravels, cobbles, and stones. The tailings are located along most of the stream channels throughout the Penryn/Rocklin pluton area (Jones & Stokes 1994).

2.2.3.2 Soil Survey

Tables 2.2 and 2.3 summarize some properties of the soils found within the Dry Creek watershed for Placer and Sacramento Counties, respectively. Because there are slight differences in mapping unit classifications, soils within the two counties are treated separately.

Andregg coarse sandy loams, 2-30% slopes, composes the greatest proportion (44%) of soils within the Placer County portion of the Dry Creek watershed. Primary limitations of these soils are the shallow depths to bedrock, steep slopes, and high erosion potential. Establishment and maintenance of a permanent cover is considered essential to minimize erosion potential.

Table 2.2. Soils Description, Placer County

Table 2.2. Soils Description, Placer County (Continued)

Table 2.2. Soils Description, Placer County (Continued)

Table 2.2. Soils Description, Placer County (Continued)

Table 2.2. Soils Description, Placer County (Continued)

Table 2.3. Soils Description, Sacramento County

Table 2.3. Soils Description, Sacramento County (Continued)

Table 2.3. Soils Description, Sacramento County (Continued)

Table 2.3. Soils Description, Sacramento County (Continued)

Other major soils in the Placer County portion of this watershed are the Cometa (14%) with Caperton, Exchequer, Inks, Sierra, and frequently flooded Xerofluvents each comprising at least 3% of the area soils. For Cometa soils, low permeability, presence of a clay pan or hardpan, low soil strength, and shrink-swell potential are the main constraints associated with these soils.

Xerofluvents, cut and fill, and placer areas, together, make up approximately 9% of the area in Placer County. Cut and fill areas are used primarily for highways and urban areas. These soils are well drained, but are composed of mechanically removed and mixed soil material. Placer area Xerofluvents were formed in areas historically placer mined, and adjacent to streams. These soils are stoney, cobbly, and gravelly material, and are prone to flooding.

In Sacramento County, 50% of the soils are Fiddyment (fine sandy loam, loam) with Urban lands-Xerarants-Fiddyment complex making up 18%. Presence of a clay pan and/or hardpan, low available water holding capacity, low soil strength, low permeability, and steep slopes in some areas are major land use constraints associated with these soils. Urban lands-Xerarents-Fiddyment complex soils are similar to Fiddyment soils; however, these soils include impervious developed areas and landscapes that have been shaped for urban uses.

Liveoak and Sailboat soils are each approximately 10% of the soils in the Sacramento County portion of the Dry Creek watershed. Liveoak, clay loam, occasionally flooded soils are very deep and well drained. Liveoak soils are formed on narrow, high flood plains in alluvium derived from granitic sources. Flood hazard and easy formation of a tillage pan are major limitations of these soils. Sailboat silt loam drained, and drained, occasionally flooded, are very deep, somewhat poorly drained soils found on narrow low floodplains. The Sailboat are formed from alluvium from mixed-rock. In these soils, levees and groundwater overdraft have changed the normal drainage. Where there is occasional flooding, channeling and deposition is common along stream banks.

Andregg and San Joaquin fine sandy loam are each also present in more than 3% of the area. Andregg soils are limited by erosion hazard in steeper areas and depth to bedrock, while San Joaquin soils are limited by shallow depth to a claypan/hardpan, low permeability, low water holding capacity, low soil strength, shrink-swell capacity, and low soil strength.

2.2.4 Water Resources

The Dry Creek watershed is composed of mixed urban, suburban, rural, and open space land. Drainages are composed of numerous intermittent streams and four perennial tributaries to the Dry Creek mainstem (see Figure 2.1). It is located within U.S. Geological Survey Hydrologic Unit Code (USGS HUC) 18020111 (Lower American River). A USGS gage station on Dry Creek is located at the Vernon Street Bridge in Roseville (i.e., gage #11447293), with a period of record beginning in 1996. The City of Roseville also maintains a stage gage at Vernon Street as part of the City's ALERT system network.

The seven main tributaries in this watershed are Antelope Creek, Secret Ravine, Miners Ravine, Strap Ravine, Linda Creek, Cirby Creek, and mainstem Lower Dry Creek. In addition, there are two lesser tributaries, Clover Valley Creek and Sierra Creek. Subwatersheds for each of these drainages are shown on Figure 2.1.

For the purposes of watershed characterization and description, the subwatersheds for the major tributaries, Secret Ravine and Miners Ravine, have been divided into "Upper" and "Lower" components. The area within the combined Secret Ravine subwatershed comprises approximately 22% of the area within the total Dry Creek watershed. The area within the combined Miners Ravine subwatershed comprises approximately 20%. Data regarding Clover Valley Creek is scarce, and it is therefore reported and discussed in combination with Antelope Creek. Together, this unit comprises approximately 14% of the total Dry Creek watershed area. Similarly, the Sierra Creek subwatershed has been grouped together with the Lower Dry Creek subwatershed. Thus, the subwatershed consisting of Upper and Lower Dry Creek, along with Sierra Creek, represents approximately 24% of the total area contained within the Dry Creek watershed. Table 2.4 list the major subwatershed functional units in descending order by size.

Table 2.4. Tributary Subwatersheds in the Dry Creek Watershed

Subwatershed	**Area**	Area	**Portion of Dry Creek Watershed**
	Acres	*Sq. miles*	
Dry Creek/Sierra Creek unit	**15603**	**24.38**	**24.1%**
Dry Creek, Upper	*9583*	*14.97*	*14.8%*
Dry Creek, Lower	*3922*	*6.13*	*6.1%*
Sierra Creek	*2098*	*3.28*	*3.2%*
Secret Ravine	**14260**	**22.28**	**22.0%**
Secret Ravine Creek, Upper	*7934*	*12.40*	*12.3%*
Secret Ravine Creek, Lower	*6326*	*9.88*	*9.7%*
Miners Ravine	**12880**	**20.13**	**19.9%**
Miners Ravine Creek, Upper	*6384*	*9.98*	*9.9%*
Miners Ravine Creek, Lower	*6496*	*10.15*	*10.0%*
Antelope/Clover Valley Unit	**9491**	**14.83**	**14.7%**
Clover Valley Creek	*2332*	*3.64*	*3.6%*
Antelope Creek	*7159*	*11.19*	*11.1%*
Linda Creek	**7798**	**12.18**	**12.0%**
Strap Ravine	**3093**	**4.83**	**4.8%**
Cirby Creek	**1584**	**2.48**	**2.4%**

This area relationship is represented in Figure 2.6, below.

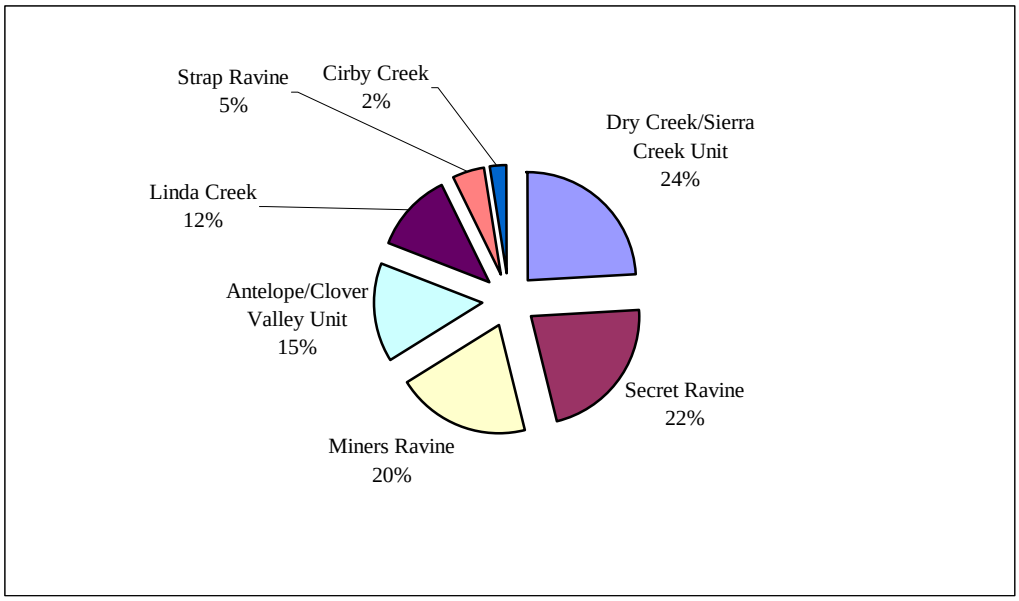


Figure 2.6. Proportion of Dry Creek Watershed area Drained by Tributary Stream Systems.

The City of Roseville is located approximately equidistant from the upstream and downstream ends of the Dry Creek Watershed. Secret Ravine, Miners Ravine, Antelope Creek, Linda Creek, Strap Ravine, and Cirby Creek, which combine to drain over 75% of the land area within the watershed, converge within its City limits. Topography also tends to flatten out in the area around Roseville.

Based upon Census 2000 block data, approximately 66% of the watershed area was "urbanized" by 2000. While various land use plans will govern overall long term development (types and areas) within the watershed, it is not possible to predict precisely where this new development will take place in the watershed over the next few years (although property transfers and development permits would allow for short-term predictions of development and potential development). Given the relatively intense development pressure in the region, and its orientation with respect to Interstate-80, dramatic growth within the watershed is all but guaranteed.

The Placer County Water Agency (PCWA) and the City of Roseville are the major water resources managing agencies within the Dry Creek watershed. The PCWA serves the municipalities of Auburn, Lincoln, Loomis, Newcastle, Penryn, Rocklin, and unincorporated western Placer County. Currently, the PCWA serves western Placer County and delivers approximately 110,000 acre-feet (ac-ft) of water from Yuba-Bear River Watershed and the American River Watershed (Toy, 2004). Approximately 10 ac-ft is delivered through the Auburn pump station on the American River, which has a maximum capacity of 13 ac-ft (Toy, 2004). The PCWA generally delivers less than about 20,000 ac-ft to the City of Roseville and 10,000 to 11,000 ac-ft to the San Juan Water District (contract maximum is 25,000 ac-ft). Additionally, the City of Roseville has a

32,000 ac-ft contract with the Federal Central Valley Project (CVP), with options for another 30,000 ac-ft. Consequently, water supplies from outside of the Dry Creek watershed are augmenting Dry Creek water resources; and, may dominate surface water flow, especially during the dry season.

2.2.4.1 Climate

The climate in this region is considered a Mediterranean climate with a warm, dry season during April through October; and a wet, mild season from November through March. Mean monthly temperatures range from about 0.7 ^{o}C (January minimum) to 36.2 ^{o}C (July maximum) (33.3 and 97.2 ^{o}F, respectively) (Western Regional Climate Data Center, 2003). Annual precipitation is approximately 20 to 25 inches per year, with peak rainfalls occurring in December through February. Summer stream flows are generally composed of flow from springs and urban runoff, such as irrigation drainage and effluent from wastewater treatment systems.

Changing climate conditions, for example, the potential increase in CO_2 that may lead to global warming, could significantly change the regional hydrology. Some studies have indicated that doubling of CO2 could effect temperature change differently in various portions of the state and is likely to occur in the next 50 to 100 years if current trends continute (Stephens, 2002). Climate models estimate that the higher temperatures resulting from doubling of may warm the Sierra mountain ranges resulting in reduced snow pack and higher winter surface water flow (more flooding potential), lower spring/summer flow (less snow pack storage), and higher overall precipitation. These effects would greatly impact water storage and conveyance systems, water needs and use, and regional biological resources that have adapted to a different hydrology. However, other studies have indicated that apparent global warming recently experience may instead be due to a different phenomenan (i.e., solar cycles) and that most recent trends may actually be pointing to a reduction in global temperatures (Sherwood and Idso, 2003). Consequently, it is important to understand the potential impacts of global climate change on the Dry Creek system, and to monitor changes and adapt management strategies accordingly.

2.2.4.2 Groundwater

The Dry Creek watershed lies above the Sacramento Valley groundwater basin, North American subbasin (groundwater basin number 5-21.64, Department of Water Resources, 1998). This basin is composed primarily of Continental Rocks and Deposits Pliocene to Holocene, with some deposits of Continental Rocks and Deposits Eocene and River Deposits Holocene. Depth to groundwater is approximately 161 ft (upper watershed) to 13 ft (lower watershed) below ground surface (U.S. Geological Survey 2001). The aquifer thickness saturated with freshwater is approximately 500 to 1500 ft (U.S. Geological Survey 1995).

Groundwater resources are primarily limited to the lower half of the watershed; little or no groundwater flows into or out of the basin from the Sierra Nevada bedrock. Under natural (predevelopment) conditions, this aquifer was recharged by seepage from

snowmelt- and rainfall- fed streams and channels running from the mountains into the valley area. Most of the recharge occurred at the valley margins and groundwater discharged into surface water bodies at the lower valley altitudes (U.S. Geological Survey 1995, 2001). The Dry Creek watershed is within the predevelopment recharge zone.

From the 1860's to the 1960's, groundwater hydraulic head dropped 40 to 80 feet within the lower confined aquifer in this area. By 1975, however, levels were back to near pre-development conditions due to increased use of surface water resources (U.S. Geological Survey 1995).

Depths to domestic wells within this region are approximated 50 to 1,750 ft (mean 665) and municipal/irrigation wells are approximately 77-1,025 ft (mean 396). Yields range from 742 to 2,500 gallons per minute (Californias Groundwater Bulletin 118, 2003) and withdrawals are approximately 1 acre-ft per acre per year (U.S. Geological Survey, 1995).

Most of this basin has good water quality; however, localized portions may have marginal water quality due to natural variability in the aquifer and/or potential contamination from spills (U.S. Geological Survey, 2001). There are three major groundwater types within this region: magnesium calcium bicarbonate or calcium magnesium bicarbonate; magnesium sodium bicarbonate or sodium magnesium bicarbonate; and sodium calcium bicarbonate or calcium sodium bicarbonate (Californias Groundwater Bulletin 118, 2003). These groundwater types may have elevated levels of total dissolved solids (TDS), chlorided, sodium, bicarbonate, boron, flouride, nitrate, iron, manganese, and arsenic in some locations. In the Dry Creek watershed, the groundwater is likely to be free from these elevated constituent levels, and no saline return flow of irrigation water is expected (U.S. Geological Survey, 1995). Median specific conductivity is about 390 μS/cm (min = 159, max = 2270) (U.S. Geological Survey, 2001).

There are a few large areas of groundwater contamination due to land use activity. The closest area to the Dry Creek watershed is a plume associated with the United Pacific Roseville Rail Yard. Smaller areas of groundwater contamination are also dispersed throughout the basin.

2.2.4.3 Surface Water

Large sections from some references were combined and incorporated with information from other references to produce this summary. Details, such as watershed area, stream length, and drainage densities were calculated using ArcView 8.1 GIS.

The headwaters of three major Dry Creek tributaries, Antelope Creek, Secret Ravine, and Miners Ravine, begin in the foothills of the Sierra Nevada mountain range at 900 to 1200 feet above mean sea level. Secret Ravine converges with Miners Ravine just upstream from Eureka Road in Roseville, CA. Antelope Creek enters Dry Creek just south of Atlantic Boulevard, also in Roseville. Linda Creek and Strap Ravine are lower gradient streams that begin near Granite Bay at a mean sea level elevation of 300 to 500 feet. Linda Creek is tributary to Cirby Creek. Cirby Creek then flows into Dry Creek just

downstream of Royer Park in Roseville. The mainstem Dry Creek begins at the confluence of Secret Ravine and Miners Ravine and flows down to about 30 feet above mean sea level into Steelhead Creek (a.k.a., the Natomas East Main Drainage Canal) in Sacramento County.

Within this watershed are numerous canals, aqueducts, siphons, reservoirs, ponds, dams, pipelines, and other natural and non-natural water features that significantly influence local hydrology. Many are depicted on the composites of the U.S. Geological Survey 7.5 minute quadrangles provided as Appendix 2.1. There is little readily-available information about these features, or about water use/withdrawals and their resulting impact on the local/regional hydrology.

The upper reaches of the watershed are relatively steep in comparison to the lower reaches (below Roseville). Soils within portions of this watershed are formed on top of granitic bedrock and volcanic rock, resulting in high runoff potential due to their shallow nature. Rapid development has also changed surface permeability through increased impervious area, reduction in native riparian habitat and overall riparian vegetation. The Dry Creek Watershed Flood Control Plan was prepared in 1992 to address flooding issues, primarily along the mainstem of Dry Creek.

Historically, livestock traffic compaction and off-road recreational vehicle activities have contributed to bank destruction. In many areas, channels have been deepened, straightened, and/or re-located to accommodate roads, to create agricultural land, for sewage treatment ponds, to convey flows, and for other developments. This channelization and reconfiguration has resulted in reduced area for overbank flow and reduced channel meandering. Whether by erosive processes, historical placer mining (hydraulic mining of the adjacent river valleys), or channel reconfiguration, these deepened channels have lowered the shallow groundwater table, particularly in the upper tributary reaches. Additionally, pool-riffle-run diversity has been lost and replaced by these more uniform stream corridors. Each of the major tributary systems is described below.

2.2.4.3.1 Antelope Creek

Antelope Creek is a perennial creek draining the northeast portion of the Dry Creek watershed. The mainstem is approximately 9.5 miles long and the watershed area is 21.4 square miles. Little information has been gathered on this watershed. From U.S. Geological Survey (USGS) topographs, the Antelope Creek system is composed of approximately 12.4 miles of intermittent tributaries in addition to a major tributary, Clover Valley Creek (7.1 miles long; watershed area of 10.2 square miles). The drainage density (ratio of stream length to watershed area) is 1.6. Higher drainage densities generally denote more rapid responses to storm events. The Aitken Reservoir is located within the Antelope Creek subwatershed.

The Placer County Flood Control and Water Conservation District (Placer County Flood Control District, 1992) modeled peak flows at full build-out as 1,426 cfs and 3,486 cfs for the the 10-yr and 100-yr storm events, respectively.

2.2.4.3.2 Secret Ravine

Secret Ravine is one of the more widely studied tributaries in the Dry Creek watershed. Secret Ravine is a 7.8-mile long perennial stream that flows in a narrow valley underlain by recent alluvial deposits. Contributing subwatershed area is approximately 22.3 square miles. The upper reaches of Secret Ravine are all intermittent drainageways (12.7 miles) and the lower reaches are intermittent (8.1 miles) and perennial (6.3 miles). The drainage density of Secret Ravine is 1.2.

Above the 220-ft elevation, Secret Ravine is incised in the granitic bedrock and the riparian corridor is correspondingly narrow. In the lower watershed, the bedrock is composed of volcanic cap rock. Soils in the watershed uplands are very shallow or very impermeable; consequently, surface and subsurface runoff are rapid. The Central Valley alluvial soils are coarse-grained and highly permeable decomposed granite, resulting from products of Placer mining and sluicing and runoff from quarry spills. Patches of seasonal wetland are also present in the Central Valley alluvial floor.

The main channel is typically 6 to 8 feet deep (sometimes over 12-feet deep), with a flat bottom, rectangular in shape, and with a median width of 12 feet (range of 10 to 25 feet). The channel bed is stable; but, meandering is very minimal and riffle-run-pool habitat is not diverse. Nonetheless, anadromous fish, including fall run Chinook salmon and steelhead, have been found in Secret Ravine.

Dry weather flows are primarily due to urban inputs, such as lawn irrigation and excess drainage, sewage effluent, unknown amounts of tailwater delivered by the Placer County Water Agency's irrigation releases, and other releases such as small amounts of freshwater seeps. During dry weather, in the upper reaches these augmentations are more significant in terms of flow proportion compared to lower reaches. Fields (1999) estimated that dry weather flows were double to triple the normal amount resulting from these urban inputs. One freshwater seep was noted just south of Interstate 80 highway crossing, about 500 feet beyond the end of China Garden Road.

Rapid development within the watershed has increased the impervious fraction and, consequently, the peak flows. This change in hydrology significantly impacts channel hydraulics; therefore, channel capacities are not sufficient to convey flow for more than the 5-year storm event in the upper reaches. Larger discharges and faster flows create flood hazards, undermine structures, and contribute to bank/channel instability and erosion.

Typical flows in Secret Ravine were measured, or estimated, for two studies. The Secret Ravine Existing Conditions Report (Dry Creek Conservancy, 2001) indicated that flows could be as low as 0.5 cubic feet per second (cfs) and 2-3 cfs during early fall. Li and Fields (1999) estimated that February flows were approximately 25 cfs in the lower reaches and 5-10 cfs in the upper reaches. The Placer County Flood Control and Water Conservation District (Placer County Flood Control District, 1992) modeled peak flows for flood events at Sierra College Blvd and determined that 10-year peak flows would approximate 1,729 cfs and 100-year peak flows would be approximately 3,814 cfs at full build-out.

2.2.4.3.3 Miners Ravine

Miners Ravine is a perennial tributary that has been studied and assessed for a number of different purposes; habitat, geomorphology, and flood studies, to name a few. The main channel is approximately 15.2 miles long. It is entrenched within an alluvial valley floor, and serves to drain approximately 20.1 square miles of mixed-use land. The upper reaches of Miners Ravine are composed of intermittent drainages (8.0 miles) and the lower reach are primarily intermittent (12.1 miles) with some perennial first-order reaches (2.9 miles) and some second-order reaches (0.6 miles). The calculated drainage density for this subwatershed is 1.1.

The surrounding uplands are characterized by gently rolling hills separated by broad flat valleys. The channel position within the alluvial valley floor of the lower reaches is not fixed and shifts or meanders across the floodplain due to eroded soils, banks, and re-deposited sediments. This is consistent with the slope gradient, which is approximately 2.4% in the upper 7.2 miles and 0.58% in the lower 8 miles. Stream gradients less than 2% generally result in meandering streams that tend to 'wander' back and forth across the flood plain over time.

Entrenchment (incising channel) over time is likely due to historical filling of the alluvial valleys with re-deposited Placer and quarry mining spoils of sand-sized granitic material, and possibly channelization and realignment for subsequent agricultural use and urban development. The valley floor is a flat floodplain that varies from 100 to 300 feet in width. However, the stream channel itself is only 12 to 30 feet wide and 4 to 12 feet deep. Water flows do not have the energy to erode bedrock rapidly, so Miners Ravine stays small. Apart from the main channel, the watershed drainage is composed of small, intermittent tributaries that carry only low flows. These intermittent tributaries can be expected to flood every 5 years on an average.

A survey of Miners Ravine determined that several watershed characteristics have impacted local hydrology. Fences and other structures within or immediately adjacent to the watercourse trap floating debris during high flows, thereby, creating flow obstructions and flooding problems. Inadequate culvert sizing at bridge crossings also contributes to obstructed flow. Trash and debris deposited on the floodplain next to Miners Ravine provide more material for trapping and backing up flows during flood events where flows over top the banks and carry debris laden water into the inadequate culverts or blocked fences. New developments often increase the watershed impervious fraction and storm drains from developments contribute flows in excess of "natural" flows. Livestock grazing compacts riparian soils, destroys riparian vegetation, and tramples unstable stream banks. All these factors have worked to contribute to impacts on Miners Ravine hydraulic and hydrologic functions.

Flow through Miners Ravine is flashy, due to the shallow depth to bedrock, limited soil permeability, and lmited water holding capacity. Additionally, the natural channel is small relative to the floodplain area; therefore, flooding occurs fairly often. Problem areas for flooding are: upstream of Sierra College Boulevard, near Joe Rodgers Road, and at the bridges of Leibinger Lane, Carolinda Drive, and Itchy Acres Road. Urbanization has led to reduced floodplain storage and inadequate channel capacity at road crossings.

Summer flow is often less than 1 cfs, whereas flood flows have been estimated at as high as 8,428 cfs at the confluence with Dry Creek and Antelope Creek per the 1992 Dry Creek Watershed Flood Control Plan (Placer County Flood Control District, 1992) during the winter wet weather season (October through April). Summer flows are generally composed of spring flows and components of urban runoff: ponds, landscape water, and historically, sewage flows. For the Miners Ravine Enhancement and Restoration Plan (Swanson 1992), flood flows were modeled using HEC-1 analysis. During this analysis, 2-year flood flows were modeled at the Itchy Acres Road and determined to be 643 cfs, which was close to their 650 cfs 5-year return analysis. Miners Ravine at Sierra College Boulevard 2-year flows were approximately 801 cfs, 10-year flood flows were approximately 1,837 cfs, and 100-year flows were 4,465 cfs at full build-out (Placer County Flood Control District, 1992). In many places along the system, 5-year flood flow capacities were often exceeded due to minimal channel capacity. The Placer County Stormwater Management Plan recommended creek improvements to protect homes in the Miners Ravine floodplain (Placer County Flood Control District, 1992).

The geomorphic classification of this stream would likely be a Rosgen Type F stream, due to land use impacts and stream incising. However, based on topography and channel shape, without the land use impacts, Miners Ravine would likely have been considered a Rosgen Type C stream. Regardless of impacts or degradation, Miners Ravine is still known to support anadromous fish, including fall run Chinook salmon and steelhead.

Design objectives recommended in the Miners Ravine Enhancement and Restoration Plan (Swanson 1992) are:

- Reduce hydrologic impact of new development to that of existing conditions
- Trap urban runoff pollutants
- Conserve existing drainage ways that support native riparian vegetation and habitat
- Use opportunities to enhance and expand natural riparian habitat and attributes in new or reconstructed channels and urban stormwater retention and detention facilities
- Design drainage facilities in a manner that is consistent with adjacent uses
- Design systems that require minimal maintenance and that mimic natural systems to greatest extent possible.

In addition to streams and creeks, Miners Ravine includes other water features such as Oak Lake, Cottonwood Lake, Pine Lake, Laurel Lake, Mamouth Reservoir, another unnamed reservoir, and more than approximately 20 small, unnamed ponds

2.2.4.3.4 Strap Ravine

Strap Ravine is a perennial waterway that is approximately 3.6 miles long and drains an area of approximately 4.8 square miles. Strap Ravine is a tributary to Linda Creek with a drainage density of 0.8. The Placer County Flood Control District (1992) modeled flow from Strap Ravine and calculated 1,050 cfs for the 100-year flood event and 194 cfs for

the 2-year flood event at full build-out conditions at its confluence with Linda Creek. A gage at McLarren Drive is operated by the City of Roseville.

There are 4 unnamed ponds located on the USGS topograph for this subwatershed. Overall slope gradient is approximately 0.48%, which is similar to the lower reaches of Miners Ravine. Dredge tailings are indicated on the USGS topograph, both within and adjacent to the stream bed, indicating historical mining has likely affected stream channel configuration, hydraulics, and overland hydrology.

2.2.4.3.5 Linda Creek

Linda Creek is a perennial stream, approximately 10.8 miles long. The subwatershed drainage area is 12.2 square miles and there are 7.3 miles of intermittent drainageways and 11.2 miles of perennial, first-order streams. The resulting drainage density is 1.5. Overall stream gradient is approximately 0.68%. A flood alert river stage gage (Station ID LOR) is located at Oak Ridge Road, at an elevation of 150 feet above mean sea level. Other waterbodies within this subwatershed are Swan Lake, an unnamed reservoir, and approximately 10 unnamed ponds/lakes. Modeled flow for this subwatershed was 4,464 cfs for the 100-year flood event and 1,136 cfs for the 2-year flood event at full build-out at the Cirby Creek confluence (Placer County Flood Control District, 1992).

2.2.4.3.6 Cirby Creek

Cirby Creek is a perennial stream approximately 2.7 miles long with a watershed area of approximately 3.4 square miles. The drainage density is about 0.8. Linda Creek comprises the upstream subwatershed and Cirby Creek outflows directly into Dry Creek. The Cirby Creek watershed is almost entirely within the urbanized area of the City of Roseville. Modeled flow for this subwatershed was 4,126 cfs for the 100-year flood event and 1,367 cfs for the 2-year flood event at full build-out at its confluence with Dry Creek (Placer County Flood Control District, 1992).

2.2.4.3.7 Dry Creek (Mainstem)

Dry Creek is a second-order perennial stream, approximately 17.6 miles long. In the lower reaches, it bifurcates around Cherry Island and reconverges prior to discharge into Steelhead Creek (a.k.a., the Natomas East Main Drain). This mainstem drainage system is composed of 1.3 miles of intermittent drainage, 20.3 miles of first-order perennial, and 21.6 miles of second-order perennial streams. The immediate watershed area is 24.4 square miles and the drainage density is 1.8. From the confluence of Miners Ravine and Secret Ravine, Dry Creek is somewhat straightened until Watt Avenue, after which it returns to more natural channel configurations. Nine other unnamed ponds/lakes are present within this subwatershed.

A USGS gage is located at the Vernon Street Bridge (USGS #11447293: Dry Creek at Vernon Street Bridge). A river stage flood alert gage (California Data Exchange Center, Station ID VRS) was used in the past to monitor flows. The minimum annual peak flow was 131 cfs, measured in 1977. Flood stage at this location is 127 feet above mean sea level and the peak of record was 132.2 ft in 1995. The estimated maximum flow at this elevation was 15,000 cfs. The maximum flow measured with the USGS gage, for the

period of record (1996 through current), was 7,950 cfs (24.39 feet gage height) in 1996. Table 2.5 provides the mean monthly flow, measured by the USGS gage, at the Vernon Street Bridge. Only a few values were recorded in 1996 followed by a gap in the data until 1999. As of the time of writing this document, 2002 through 2003 data was not yet finalized.

Table 2.5. Mean Monthly Flows at the Vernon Street Bridge (U.S. Geological Survey Data)

	Monthly Mean Flow (cubic feet/second)											
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1999										22.6	32.8	26.7
2000	272	591	173	84.7	56.9	24.3	17.1	16.0	29.8	54.2	27.7	27.5
2001	88.2	164	108	112	33.2	19.6	12.2	12.6	23.3	NA	NA	NA
Mean	***180***	***378***	***141***	***98.3***	***45.0***	***22.0***	***14.7***	***14.3***	***26.6***	***38.4***	***30.3***	***27.1***

The average watershed runoff is 16,400 acre-feet, with about 95 percent of this runoff occurring between December and May. The rest of the time (about 2/3's of the time) flow is less than 50 cfs (cubic feet per second). Summer flows are low and comprised primarily of ground-water seepage, residential, industrial waste water, and flow from the Dry Creek Roseville Wastewater Treatment Plant in Roseville.

2.2.4.3.8 Other Surface Water Resources

A major facility discharging into the Dry Creek system is the Roseville Wastewater Treatment Plant (Roseville WWTP) (NPDES #CA0079502), which is a municipal sewage treatment facility operated by the City of Roseville. This plant serves Roseville, Granite Bay, Rocklin, Loomis, and the Sunset Industrial Area. The design capacity is 18 million gallons per day (MGD). Treated effluent outfalls into the mainstem of Dry Creek. Table 2.6 reports mean monthly treated effluent discharge rates from the Dry Creek Wastewater Treatment Plant for 1998 through 2002. During three of the five years, there was no discharge during December.

Table 2.6. Mean Monthly Treated Effluent Discharge from the Dry Creek Wastewater Treatment Plant, 1998 through 2002.

Month	Discharge (Million Gallons/Day)
January	15.7
February	17.9
March	15.2
April	13.6
May	12.4
June	10.9
July	11.1
August	11.7
September	12.5
October	13.6
November	14.4
December	13.6

Table 2.7 reports mean annual discharge from 1990 through 2002.

Table 2.7. Mean Annual Treated Effluent Discharge from the Dry Creek Wastewater Treatment Plant, 1990 through 2002.

Year	Discharge (Million Gallons/Day)
1990	8.59
1991	8.64
1992	10.67
1993	12.48
1994	10.8
1995	14.72
1996	12.76
1997	12.99
1998	13.61
1999	12.99
2000	14.89
2001	13.38

Discharges from the Roseville/Dry Creek Wastewater Treatment Plant have minimal impacts during the wet weather months; however, they can compose a high proportion of dry weather flows (greater than 50% of total flow at the Vernon Street Bridge). As development continues to expand within this region, treated effluent discharges will likely increase. A new regional wastewater treatment plant is being built outside of the Dry Creek watershed by the City of Roseville. It is estimated that approximately 15,000

Roseville/Dry Creek Wastewater Treatment Plant customers will be transferred to the new facility.

At the Town of Loomis, the Placer County Sewer Maintenance District #3 (NPDES CA0079367) facility is a minor discharger of municipal wastewater, with a design flow rate of 0.75 MGD. This facility outfalls into Miners Ravine. During the wet weather season, the proportion of stream flow attributed to effluent is 2 to 3% of total flow. During dry weather conditions, the effluent contributions are less than 10% of total flow. Currently, this facility is operating at less than 20% of design capacity. At design capacity, effluent would dominate flow (approximately 50% of total flow) in the upper reaches of Miners Ravine during the dry season.

Sources and management of on-site and very small wastewater treatment facilities are unknown. On-site system treatment would likely be impeded by shallow soils and depth to bedrock, or highly impermeable soils. Other potential wastewater dischargers in the Dry Creek Watershed, identified from review of USGS topographs, are reported in Table 2.8.

Table 2.8. Other Potential Minor Dischargers of Sewage Effluent in the Dry Creek Watershed

Subwatershed	Description of Potential Dischargers
Antelope Creek	One sewage disposal pond just north of the Highway 65 road crossing.
Secret Ravine	Two sewage disposal ponds: one near Interstate 80 and the other north of Gilardi Road.
Miners Ravine	One sewage disposal pond north of the Granite Bay golf course and one sewage disposal area near the Dick Cook road crossing.
Linda Creek	Two sewage disposal areas north of Baldwin Reservoir.
	One treatment plant, approximately 1 cfs discharge during summer.
Dry Creek	One sewage disposal pond near Rio Linda Central Park. One sewage disposal area near midtown park.
Throughout	Septic Systems – not likely to be significant as most residents and developments are on a sewer system

2.2.4.4 Flood Storage and Conveyance

Dry Creek has an extensive record of flooding and flood damage to areas within the lower portion of its watershed. Flooding occurred in this vicinity in 1986, 1995, and 1997. Flooding generally occurs from October through April, due to slowly impermeable soils

that become saturated during winter rain events followed by high intensity storm systems.

In September, 1990, the Placer County Flood Control District Stormwater Management Manual (Placer County, 1994a) was prepared to assist planners and developers in assessing current flood conditions and development impacts. This manual called for development of several watershed Flood Control Plans. The Dry Creek Flood Control Plan was finalized in April 1992 (Placer County Flood Control District, 1992). This document includes the recommended plan for regional and local flood control within the watershed, floodplain delineations, peak flows for subunits, changes due to development, and other pertinent information based on HEC-1 (hydrology) and HEC-2 (hydraulic) models of the watershed. Regional on-channel detention (dams) recommendations have not been implemented due to conflicting stakeholder issues; however, the PCFCD is currently implementing off-channel regional detention facilities, as well as regional floodplain restoration projects.

2.2.4.4.1 Structural Improvements Recommended by Dry Creek Flood Control Plan

Generally, regional, on-channel detention basins were considered the most viable solution for flood control. Other potential mitigation measured included replacement of under-designed bridges and culverts, and channel improvements (including levees and floodwalls) for channels with insufficient capacity to pass the 100-year storm. The Dry Creek Watershed Flood Control Plan identifies locations of insufficient capacity and inadequate bridges and culverts targeted for improvements.

2.2.4.4.2 Non-Structural Improvements Recommended by Dry Creek Flood Control Plan

- Local or On-Site Stormwater Detention

  On-site stormwater detention has been required through the development permitting process and the National Pollutant Discharge Elimination System (NPDES) Phase II Stormwater Management Plans. Most cities in Placer County, as well as the county itself, have developed their Phase II plans.

- Floodplain Management – building and modification restrictions within the floodplain

  Placer County and local municipalities have passed floodplain encroachment and/or grading ordinances restricting development within the floodplain. Development plans are reviewed for conformance to these restrictions. Additionally, the Dry Creek Parkway Plan has been developed to govern land use and development along the riparian corridor portion of Dry Creek in Sacramento County.

- Flood Warning System (ALERT system)

This system is already installed and in use. The City of Roseville and Sacramento County own and maintains an ALERT system for the Dry Creek watershed. The ALERT system is a radio telemetered system jointly coordinated by the National Weather Service and the California Department of Water Resources. Remote stations located within the watershed are linked to communicate with base stations. These remote locations contain water level sensors and/or precipitation gages. Table 2.9 lists the gages and level sensors for the Dry Creek watershed.

In addition to the Dry Creek Flood Control Plan, the FEMA 100-year floodplain mapping and analysis has been completed (Figure 2.7). Recent FEMA sponsored floodplain re-mapping efforts were completed in 1998 along Miners Ravine and are on-going for portions of Linda Creek.

2.2.4.4.3 Other Flood Control Improvements

The following projects are actively being pursued, but have not yet been approved or constructed:

- Conceptual level studies of three alternative regional detention sites on Miners Ravine, Linda Creek, and Strap Ravine. These studies assessed the suitability of providing regional detention to reduce flood potential downstream.
- Miners Ravine Off-Channel Detention Basin Facility on approximately 26 acres of undeveloped land owned by Placer County Flood Control and Water Conservations District – approved and funded; project is now underway. This facility will allow for storage of flood flows making adjacent, abandoned treatment ponds.
- Secret Ravine Floodplain Restoration at Sierra College Blvd, consistent with the Final Feasibility Study - approved and funded; an active project site (see Placer County Flood Control District, 2003).
- City of Roseville NPDES Phase II Stormwater Management Plan – (non-structural). The NPDES Phase II Stormwater Management Plans include recommended post-construction BMPs for both flood detention and water quality.
- City of Rocklin NPDES Phase II Stormwater Management Plan – (non-structural). The NPDES Phase II Stormwater Management Plans include recommended post-construction BMPs for both flood detention and water quality.
- Placer County NPDES Phase II Stormwater Management Plan – (non-structural). The NPDES Phase II Stormwater Management Plans include recommended post-construction BMPs for both flood detention and water quality.
- Lower Dry Creek Renovation of Hayer dam – removal of non-engineered levees. The Hayer dam is a non-engineered structure that creates ponded/flooding conditions upstream and presents a barrier to fish passage. Mitigation of this structure is being examined by the Sacramento Area Flood Control Agency

Table 2.9. ALERT Precipitation and Water Level Gages

Number	Name	Ownership
	ALERT Precipitation Gages	
220	Folsom Reservoir	National Weather Service
275	Navion Dr. (Arcade Creek)	Sacramento County
276	Orangevale	Sacramento County
278	Rio Linda	Sacramento County
279	Chicago Ave. (Arcade Creek)	Sacramento County
286	Van Maren	Sacramento County
291	Sunrise Blvd. (Arcade Creek)	Sacramento County
295	American River College	Sacramento County
299	Linda Creek at Indian Creek Dr.	
1601	Diamond Oaks Golf Course	Roseville
1602	Roseville Fire Station #2	Roseville
1604	Target	Roseville
1608	Miners Ravine at Barton Rd.	Roseville
1612	Del Oro High School, Loomis	Roseville
1613	Strap Ravine at McLaren Drive	Roseville
1614	Pine View School, Newcastle	Roseville
1616	Caperton Reservoir	Roseville
1617	Endora Lift Station	Roseville
1618	Sierra College	Roseville
1620	Cirby Creek at Tina Way	Rosevile
1622	Antelope Creek	Roseville
1624	Loomis Observatory	Roseville
1628	Linda Creek at Champion Oaks Dr,	Roseville
1631	Dry Creek at Saugstad Park	Roseville
1632	Dry Creek at Royer Park	Roseville
1645	Lincoln Airport	National Weather Service
1659	Elkhorn Blvd.	Sacramento County
6024	WWTP Booth Road	Roseville
6032	Roseville Water Treatment Plant	Roseville
6303	Auburn Dam	National Weather Service
	ALERT Water Level Sensors	
1603	Dry Creek at Vernon Street	Roseville
1605	Linda Creek at Oak Ridge	Roseville
1607	Cirby Creek at Loretto Drive	Roseville
1611	Strap Ravine at McLaren Drive	Roseville
1619	Secret Ravine at China Garden Road	Roseville
1573	Antelope Creek at Sierra College Blvd	Roseville
1623	Cirby Creek at Tina Way	Roseville
1626	Linda Creek at Champion Oaks	Roseville
1630	Dry Creek at Royer Park	Roseville
297	Linda Creek at Indian Creek Drive	Sacramento County
1583	Antelope Creek at Antelope Creek Road	Roseville
1590	Linda Creek at Woodlake Bike Bridge	Roseville
1609	Miners Ravine at Moss Lake	Roseville
1627	Dry Creek at Saugsted Park	Roseville
1635	Cirby Creek at Sierra Gardens Drive	Roseville

Figure 2.7. FEMA 100 Year Flood Zone Map (Robert)

- Invasive Weed Control, Lower Dry Creek – approximately 100 acres along lower Dry Creek. Invasive weeds slow water flow, which can result in greater flooding potential upstream. Removal of weeds should clear the chanels and allow flood water conveyance.
- Removal of Residential Structures and Acquisition of Easements on approximately 200 acres, Lower Dry Creek.
- Restoration of Dry Creek channel and floodplain on public lands in Sacramento County, downstream of Elkhorn Boulevard.

Several flood control projects were initiated during the early 1990's. These include:

- Sacramento Area Flood Control Agency Flood Control Improvement Plan for the lower section of Dry Creek in Sacramento County.
- Roseville Channel Improvements – Linda Creek and Cirby Creek as it passes through Roseville.
- Rocklin Redevelopment – redevelopment of Rocklin and associated rerouting of drainage from central Rocklin to Antelope Creek at a location upstream of the current discharge site and replacement of Sunset Boulevard bridge.
- Loomis Improvements Program – inventory of stream crossings that need to be replaced due to increased traffic or inadequate flow passage capacity.
- Structural elevation projects within Placer County and the City of Roseville under Federal Hazard Mitigation Grant Assistance Program – 57 structures.

The current status of many of these projects is unknown.

2.2.4.5 Geomorphology and Sedimentation

Stream channels are dynamic systems that respond to changes in water flow, sediment supply, and base level, through adjustments in channel width, channel depth, sinuosity, and profile, to minimize energy expended and to achieve a balance of forces. When these forces are in balance, a channel will maintain a static equilibrium where channel slope, geometry, and substrate conditions are fairly constant through time. Perturbations, such as those caused by flooding, landslides, bank instability, tectonic uplift, or changes in land use, result in adjustments in the channel toward a new equilibrium condition. Since perturbations are common, especially in a rapidly urbanizing watershed, the time necessary for the channel to react to a perturbation and reach a new equilibrium is greater than the time period between perturbations, resulting in a channel condition that is constantly changing. This type of channel is said to be in a state of dynamic equilibrium.

Stream channels do not always act as a single unit to a given perturbation. A landslide may only significantly alter sediment supply conditions to a small portion of stream, with no affects upstream and attenuated affects downstream. Changes in water flow, sediment supply, and bed conditions longitudinally along a stream channel play an important role in channel function and how they react to a given type of perturbation. In

general, steep channels and hillsides in the upper watershed (termed the zone of erosion or depletion) are subject to net erosion as flow is too swift to allow for significant storage of sediment. The middle portion of a watershed, termed the “zone of transportation”, is where the stream flows within a sloping, alluvium-filled valley and temporarily stores sediment such that the sediment load coming into a reach is equal to that going out. The lower watershed area where the stream meets its "base” level (such as a delta or the ocean) is a zone of net deposition.

A stream valley has features that are important to understand and recognize in a geomorphic analysis. Figure 2.8 shows a cross-section of an idealized valley. The channel is shown in three stages: the low flow channel often carries well over 90% of the flows that occur over time and contains much of the aquatic habitat important for fish. The low flow channel owes much of it character to the “bankfull channel”, which is the channel sized to the dominant or channel forming flow. The geomorphic floodplain is the low flat area adjacent to the bankfull channel that is subject to frequent flooding and fine sediment deposition. The flood channel carries the larger flows, generally no less than a 5-year event. The flood channel includes older geomorphic floodplain surfaces termed “terraces”, and is ultimately bounded by the surrounding hillslopes. Terraces may form as a result of channel incision or entrenchment into the valley floor, which may occur in response to climatic change, tectonic uplift, progressive erosion, or a short term filling by a large flood event.

Stream channel size is most influenced by small to intermediate-sized floods, which are those that occur fairly often, about once every 1.5 to 3 years on average. This “channel forming” or “bankfull” flow is hydraulically correlated to features in and near the channel, especially in the development of “geomorphic floodplain” surfaces, predominant scour lines and in some climates, growth and occurrence of particular species of vegetation. The “bankfull” features or indicators are a common denominator among stream channels. The channel’s geometry (width and mean depth) and pattern as measured in the field will generally correlate well with drainage area in a given geographic region sharing similar climate and geology. The power of analyzing channel geomorphology and channel forming flow lies in the understanding of existing and potential stable channel forms and associated processes.

Rosgen (1994) developed a channel classification system of stable channel forms found in nature and measured at channel forming flow, based upon channel slope, geometry, entrenchment and pattern, as viewed from above. Although application of this system for development of restoration plans is controversial, it is useful for an assessment of current and potential stable channel forms.

Figure 2.8 Idealized Valley Floor Cross-Section Showing Typical Geomorphologic Features

Aquatic and riparian habitat quality of a stream system is directly related to the geomorphic, hydrologic, and hydraulic processes acting on it. The width of the channel, variability of the flood plain, sediment supply and sorting mechanisms, and hydrologic setting all act to define the type of riparian species that can grow and reproduce, the abundance and species richness of aquatic macroinvertebrates, and the fish species assemblage present in the reach of interest. Conversely, the abundance, distribution, and age structure of the riparian vegetation community can have a profound impact on local channel morphology (e.g. – meander pattern, pool and riffle formation, etc) and sediment supply and sorting characteristics. The presence of large woody material or geologic controls (e.g. – bedrock outcrops, boulders, etc) dictates pool development, the quality of riffle habitat, and gravel/sand sorting occurring at the tail of pools. Stream banks that are stabilized by mature riparian vegetation provide escape cover for fish by allowing the formation of undercut banks that do not increase the risk of bank failure.

2.2.4.5.1 Geomorphic History of the Dry Creek Watershed

Land use changes in the Dry Creek Watershed over the past 150 years have been extreme and have had many significant direct and indirect impacts on channel morphology. The following is a summary:

Placer Mining

In the 1840s and 1850s alluvial deposits throughout the Dry Creek watershed were dug and sluiced for gold. The operations involved diversion of flow from the stream into trenches of alluvium from which gold was sorted by sluicing and gravity. These operations probably destroyed the original natural channel and floodplains and released large volumes of nutrient-poor sand, which was deposited on productive native alluvial soils. Today, many of the primary stream channels within the Dry Creek Watershed, including Secret Ravine and Miners Ravine, have incised through these deposits leaving a deeper channel and arid, less productive soils on the alluvial valley floor. Dense new stands of riparian vegetation have colonized areas along streams where the old alluvial soils have been exposed after the placer deposits were stripped away by recent floods.

Quarry Development

Large, hard rock quarries were developed to provide granite building blocks for San Francisco and other developing areas in the late 1800s and early 1900s. The operations disturbed the ground and native soils and generated spoils. The spoils were likely routed by storm flows to the primary stream channels within the Dry Creek Watershed, thereby increasing suspended and bedload.

Agricultural Development

Agricultural development followed the Gold Rush Era and included reclamation of wetlands for cultivation and diversion of stream flow for irrigation. Specific histories for each channel in the Dry Creek Watershed would be difficult to reconstruct. However, unnaturally straight segments of channel and abundant evidence of cattle grazing strongly suggests that these uses occurred and impacted the watershed. The impacts would include denudation of channel banks, loss of channel shade and cover, and an

increase in suspended sediments and nutrients. Many water courses have been converted into ponds which disrupt flow and sediment transport. Many watershed areas are still being grazed.

Urbanization

Dramatic levels of urbanization have occurred since the 1950s, particularly in the Roseville and Rocklin areas. Many roads traverse the stream valleys modifying floodplain areas and channels where bridges and culverts have been installed for crossings. Streams have been channelized to fit floodplain developments and riparian vegetation has been removed mechanically or by use of herbicides leading to bank instability and erosion. Levees have been constructed confining streams to narrow corridors.

Impact on Stream Functions

These land use impacts that have occurred over the last 150 years have had a dramatic affect on the form and function of stream channels throughout the Dry Creek Watershed, which in turn have impacted riparian and aquatic communities. Much of the focus of these impacts have been in the middle and lower reaches of the watershed (transitional reaches), with much attention paid to Secret Ravine, Miners Ravine, and the mainstem of Dry Creek due to their importance in sustaining salmonid populations and riparian habitats.

Prior to significant land use impacts, the middle and lower reaches of the primary streams within the Dry Creek Watershed have existed in a state of static equilibrium between sediment supply, storage, and transport. The result was an active channel that meandered back and forth across a wide floodplain that consisted of an alternating series of vegetated stable point bars. These stable bars would become inundated during high flows, allowing the water to spread across the floodplain, causing fine sediment to settle out and adding additional nutrients to riparian communities.

During the receding limb of high flow events, sediment starved water (due to deposition on the floodplain) would pour off the floodplain and concentrate in the main channel, scouring out deep pools and cleaning cobble dominated riffles, leaving high quality salmonid spawning gravels in the tail sections of the pools. These scour events would produce a longitudinal series of pools and riffles. Pools would occur on the outside of bends with stable point bars on the inside of bends. Between pools, cobble dominated riffles would occur in the straight sections and act as grade control, limiting excessive downcutting during peak flow events and allowing deep scour pools to develop on either side of the riffle. Due to the presence of riparian vegetation on the edge of the bankfull channel, dense root systems would allow bars to persist and banks to be undercut, increasing the habitat value of the system for salmonids.

During the hydraulic mining period, a large amount of sand-sized decomposed granite was introduced into the primary channel from inactive terraces. The introduction of large amounts of material overwhelmed the system and induced a period of channel aggradation. Channel aggradation results from the inability of the stream to carry the introduced sediment load. As the channel becomes overwhelmed by high sediment

loads, it fills up with sediment along its entire length, burying existing channel and floodplain features, such as stable bars, pools, and riffles, smothering riparian vegetation, and causing water to flow across the floodplain, even during low to moderate flow events.

Following the period of hydraulic mining, sediment loads to the channel were reduced and the stream began to adjust to a condition of decreased sediment supply. This consisted of incision of a new channel through the hydraulic mining deposits and establishment of a meandering pattern with a high flow floodplain. Essentially, the channel was attempting to reestablish the static equilibrium that existed prior to the perturbation (e.g., in the absence of hydraulic mining).

The process of recovery and return to the static equilibrium that existed prior to hydraulic mining is extremely slow. Sediment supply is still excessive within the active channel due to re-incision of hydraulic mining deposits through undercutting of unstable and unconsolidated bank deposits. The reactivated bank deposits are composed primarily of sand that form unstable alternating bars. These sand bars do not support stable riparian vegetation because they are mobile and transient during peak flow events. In addition, channel incision into extensive hydraulic mining deposits (6-12 feet in some places) has resulted in reduced access of flows to floodplain surfaces during 2- to 10-year recurrence interval floods. Loss of floodplain access can result in higher velocities and shear stresses that can reduce the ability of the bars to support vegetation and reducing the overall sinuosity of the channel.

In addition to historic impacts to the channel from hydraulic mining, many of the streams within the Dry Creek Watershed have been moved, narrowed, or straightened to make room for roads or residential development. This has accelerated the process of downcutting, resulting in increased bank erosion as the channel attempts to restore the meander pattern and reduce channel slope.

2.2.4.5.2 Existing Geomorphic Conditions

Given past and current impacts to stream channels within the Dry Creek Watershed, much attention has focused on their recovery. Recovery is focused on restoration of the form or channel morphology in an attempt to restore natural geomorphic function to the channel. By restoring function, the hope is that the processes which build and maintain aquatic and streamside habitat will also be restored.

To restore natural geomorphic function to the streams of the Dry Creek Watershed, research has focused on identifying conditions or locations in the watershed that could be considered reference sites for restoration parameters. As mentioned previously, through bank erosion, impacted streams that lack significant streamside urban developing are attempting to meander and form stable point bars through erosion of adjacent terraces. In some areas, inset bankfull channels and floodplains have developed that can act as reference sites for future engineering-based restoration design projects.

The primary variables required to guide the engineering design for the channel and floodplain restoration work in the Dry Creek Watershed are bankfull width, depth and

channel entrenchment. Bankfull width and depth define the geometry at which the channel forming flows occur, typically at the 1.5 to 2.33-year recurrence interval or the mean annual flood (Rosgen, 1994; Leopold et al., 1964). At flows above bankfull, water accesses the floodplain. Entrenchment is defined as the ratio between flood-prone width and bankfull width. Each of these variables, along with channel slope, defines the channel type based on the Rosgen Classification (Rosgen, 1994).

Historically, many of the channels in the lower and middle reaches of the Dry Creek Watershed were likely to be 'C' type channels. A 'C' channel is characterized by low channel slope (< 2%), an entrenchment ratio greater than 2.2 (this parameter is counterintuitive; high entrenchment values mean the floodplain is wide, relative to the bankfull channel), moderate sinuosity, and a non-uniform cross-section. In the upper portions of the watershed, where the channel is steeper and there are more bedrock exposures, the channels were historically 'B' type channels, characterized by channel slopes from 2-4%, entrenchment ratios from 1.4 to 2.2, and low sinuosity.

Due to the sequence of land use impacts where the channels were filled with sediment delivered from mining activities, agriculture, and the early stages of urbanization, and subsequently cut down when the sediment supply decreased and impervious surfaces increased peak storm flow, many of the channels in the lower and middle reaches of the watershed were converted to 'F' type channels, characterized by channel slopes less than 2%, entrenchment ratios from 1.4 to 2.2, and low to moderate sinuosity. Channels that were historically 'B' channels have been converted to 'G' type channels, characterized by channel slopes from 2-4%, entrenchment ratios from 1-1.4 and low sinuosity.

2.2.4.5.3 Channel Morphology Restoration Objectives

To obtain these parameters for a variety of restoration projects throughout the watershed, geomorphologists and restoration specialist typically develop regional relationships between channel parameters and drainage area, referred to as regional hydraulic geometry curves. These curves are developed regionally due to changes in rainfall and runoff patterns across landscapes.

Appropriate hydraulic geometry parameters for the Dry Creek Watershed were determined by developing a regional curve relating hydraulic geometry variables such as width, depth, and gradient, to drainage area. The regional hydraulic geometry curves were generated by visiting sites throughout the Dry Creek watershed and conducting bankfull surveys (Dunne and Leopold, 1976). Six sites were selected representing a range of drainage area including two sites on Miners Ravine, two sites on Secret Ravine, and two sites on the mainstem of Dry Creek. The surveys included measuring a longitudinal profile and cross-sections along 200 to 450 feet of channel within the selected areas. Bankfull indicators were identified at each cross-section and surveyed using an auto-level and measuring tape. A summary of the results are shown in Figure 2.9.

Figure 2.9. Average Bankfull Depth and Width (feet) As a Function of Drainage Area (square miles) From Field Data Collected by the Dry Creek Watershed in the Central Valley of California.

In terms of restoration, reducing channel entrenchment and allowing flow to access a vegetated floodplain would improve channel form and function and move the Rosgen classification of the channel from an 'F' or 'G' toward a 'C' or 'B' type channel, which is more characteristic of pre-hydraulic mining and urban condition. The following measures have been proposed to accelerate the transition to a more functional channel and valley form:

- Excavate existing high terraces to improve floodplain access and reduce shear stress on the channel and banks,
- Stabilize existing alternating bars by building up to the bankfull elevation and planting native riparian vegetation,
- Modify geometry of riffles to improve hydraulics that will in turn encourage pool development. This may include placing cobble and gravel material in riffles to stabilize them while providing spawning habitat for salmonids and substrate for macroinvertebrates, and
- Place large roughness elements and woody material in strategic locations to improve pool development and protect the toe of eroding banks.

2.2.4.5.4 Sedimentation

Sedimentation and erosion within a watershed are a function of watershed hydrology, hydraulics, climate, vegetation, and soils or surface/channel-bed particle structure. Altering either one of these factors can affect the erosion and sedimentation processes.

Hydrology will determine how much water will run into a stream system, how fast it will get there, and what path it will take. These are important conditions for both determining in-stream flows (e.g., flooding potentials) and sediment transport. Unless surfaces are dry and devoid of vegetation or cover, sediment transport will be governed by water flow. Saturated soils, shallow depth to impeding layer, high precipitation amount and intensity, low or no vegetation, steep slopes, and impervious surfaces will all increase surface runoff.

Climate is an uncontrollable factor; however, it must not be ignored in any assessment of hydrology or sediment transport. Precipitation amount, frequency, and duration are all important components of the hydrology and hydraulic functions. These will change between regions and with seasons. Temperature and atmospheric variables can also affect how much, where, and when water will flow; but these are not expected to be significant factors in the Dry Creek watershed, except for high temperature effects on dry season evaporation losses.

Vegetation affects the hydrologic budget, provides protection of soil surfaces from compaction (and hence, contributes to favorable infiltration and reduced erosion) and raindrop impact, and helps stabilize soils by strengthening structure through root action, reduced compaction, and surface sealing. Removal of riparian vegetation often contributes to increased bank instability, higher runoff and erosion rates, and more sediment deposition within the stream corridor.

Sedimentation is affected by both the amount of sediment transported into the stream (erosion) and the amount of sediment transported within the stream (Total Suspended Solids, scouring, and bedload). Highly erosive soils and high amounts of runoff will increase the total sediment load into the stream (erosion). Highly unstable bank soils and high energy/high flow waters within the stream will increase the scour, and bedload and suspended sediment transported within the stream. In either of these cases, features that slow the water down will result in fractions of sediment dropping out of the water column and depositing on the surface. Features that increase the stability of the sediment fractions (e.g., vegetation, increased bank stability features, armored creek bottom) will reduce the amount of deposited sediment or channel bank material from becoming suspended and available for deposition further down stream.

Hydraulics describes the energy and forces acting within the water column and the effects of flow on the channel, banks, any structures, and movement of sediment. Flow velocity/flow rate, fluid properties (e.g., sediment load), channel sinuosity, channel/bank roughness, bank configuration, flow constrictions, and other physical features will all affect the system hydraulics. Hydraulic analysis will, in turn, help describe where sediment will be eroded/scoured, where it will be deposited, and what kind of effects features such as constrictions might have on the whole process.

In streams with large amounts of existing or inflowing sediments, high stream flows that flush the sediment downstream are generally advantageous. However, high suspended sediment loads and high-energy water (fast flowing water) can also contribute to scour of banks and channel bottoms. Consequently, it is better to have a variable system to create areas of high and lower flows in order to keep streams moving unwanted sediment downstream, yet mitigating high flows to minimize bank and channel erosion.

Dry Creek Watershed

Few studies have been conducted in the Dry Creek watershed pertaining to erosion and sediment transport, except for preliminary geomorphological characterizations, conducted as part of the identification of fish habitat in Secret and Miners Ravines (introduced below).

Soils and particle sizes/structure in the Dry Creek watershed are governed by the bedrock geology (parent material) and historical land use practices. Bedrock geology in this watershed is primarily granitic rock in the upper reaches, and volcanic cap in the lower reaches. Soils developed on the granitic rock are sandy and highly permeable, but have very shallow depths to bedrock. Soils developed on the volcanic cap are deeper, but often contain a clay pan and are highly impermeable. Consequently, soils derived from both types of material are erosive, and will have high runoff rates when precipitation is high.

Based on the histories of Secret and Miners ravines, it is likely that many areas within the entire Dry Creek watershed were historically Placer mined, or otherwise mined/quarried for gold or other materials. In the upper reaches, this mining process resulted in release of fine sand sized particles of granitic rock mine tailings into the stream systems and their immediate subwatershed. Following the mining activities, riparian vegetation was removed for agricultural or development purposes. Development can further exacerbate

sediment transport by increasing impervious surfaces, thereby increase runoff rates and peak flows.

Hydrology in the Dry Creek watershed is variable. Generally, the hydrology is characterized as a “flashy” system; where the system responds suddenly to precipitation or other water inputs. Very high flow rates are possible during the wet weather season.

Miners Ravine

The upper reaches of Miners Ravine are not considered sediment-impacted. The channel substrate consists of primarily bedrock material, and the gradient is steep enough to flush eroded sediment downstream. However, livestock grazing results in trampled stream banks and stirred up sediments that increase erosion. Additionally, removal of riparian vegetation contributes to bank instability and erosion.

Secret Ravine

A 1999 survey by Li and Fields noted that much of the Secret Ravine channel bed consisted of deposited sand material composed primarily of decomposed granitic sand. The source of this material was considered to be from the Gold Rush mining that released large amounts of fine sediment into the watershed in just a few years. This release of sediment was coupled with irrigated orchards replacing native oak woodlands, creating more highly erodible soil conditions on the uplands, compared to the historically vegetated communities. In recent years, rapid development, livestock streamside impacts, off-road vehicle traffic, and the use of the channel as a horse trail has contributed to increased imperviousness that has led to higher peak flows, which enhance bank erosion and instability (Fields 1999).

While the source of sedimentation is sand from the historical disturbance associated with quarries and Placer mining, it is also an unfavorable channel morphology that does contribute to riffle and pool flushing that perpetuates this problem. There is an excessive supply of sediment, and channel hydraulics cannot distribute it appropriately. Consequently, excess sand has buried spawning riffles and may negatively affect fry emergence. It has degraded rearing habitat for aquatic invertebrates and salmon and steelhead. The sand buries riffles, reduces gradients, and blocks access to gravel or buried cobbles and interstitial spaces. The sand is also suspected to contribute to unhealthy warming of the stream by slowing water flow (travel time) and making the stream shallower. Despite the sediment-degraded system, Secret Ravine still produces fall-run Chinook salmon and steelhead, despite urban encroachment and other human influenced impacts.

Dry Creek Channel

Sedimentation in Dry Creek ravine has contributed to inadequate channel capacity by infilling. Heavy sediment accumulation downstream of bridge constrictions has exacerbated bank erosion by splitting the stream to go around deposited sediment.

2.2.4.6 Water Quality

Water quality impairment or non-impairment is determined based on whether or not the water body supports its designated beneficial use by attainment of the uses' water quality standards and criteria. Availab.e water quality information for this watershed has been minimal until year 2000, when the Central Valley Regional Water Control Quality Board (CVRWQCB) and Dry Creek Conservancy (DCC) initiated water quality monitoring programs at several locations within the watershed. Historical data is limited to a few samples and analyses from 1951 through 1961, which will be discussed under the "STORET" section, below. Additional in-stream water quality data is associated with the Roseville/Dry Creek Wastewater Treatment Plant (Roseville WWTP) and the Placer County Treatment Plant No. 3 (Placer WWTP) National Pollutant Discharge Elimination System (NPDES) permit monitoring. Collected water quality data has only been formally assessed by the CVRWQCB for the Dry Creek mainstem, Linda Creek, and Antelope Creek.

Based on stream flow and Roseville WWTP discharge, the main stem of Dry Creek below the Roseville WWTP is an effluent dominated system. Consequently, Roseville WWTP discharge characteristics will likely dominate downstream water quality.

Antelope Creek is designated by the Regional Water Quality Control Board as Calwater Watershed 509.630 (U.S. EPA, 2003b). It was assessed in 1998 for water quality. No beneficial uses, causes of impairment, sources of impairment, or TMDLs (Total Maximum Daily Loads) were listed for this creek (Information Center for the Environment, 1998).

Dry Creek and Linda Creek were also evaluated for water quality and support of beneficial uses. Table 2.10 summarized the assessments (305(b) report) for both creeks. The Clean Water Act, Section 305(b) requires that states, territories, and jurisdictions assess their water quality biennially and report these findings to the U.S. Environmental Protection Agency for inclusion in the National Water Quality Report to Congress. Dry Creek and Linda Creek are both identified by the CVRWQCB as Calwater Watershed 51921000 (Information Center for the Environment, 1998). Both were assessed in 2000 for water quality conditions and use attainment, as noted in the table below (U.S. EPA, 2003b). No TMDLs are listed for either of these water bodies.

Table 2.10. Assessed Water Quality Condition of Dry Creek and Linda Creek

	Dry Creek CAR519210002000021610532 6_0			Linda Creek CAR51921000200008152156_0		
State Designated Use	**Use Support**	**Threatened**	**% Impaired**	**Use Support**	**Threatened**	**% Impaired**
AGRICULTURAL SUPPLY	Partial	No	100	Not Assessed	No	0
AGRICULTURE	Partial	No	100	Not Assessed	No	0
FISH SPAWNING	Partial	No	100	Partial	No	100
FISH MIGRATION	Partial	No	100	Partial	No	100
AQUATIC LIFE SUPPORT	Partial	No	100	Partial	No	100
MUNICIPAL AND DOMESTIC	Partial	No	100	Partial	No	100
DRINKING WATER SUPPLY	Partial	No	100	Partial	No	100
NON-CONTACT RECREATION	Partial	No	100	Partial	No	100
WATER CONTACT RECREATION	Partial	No	100	Partial	No	100
WILDLIFE HABITAT	Partial	No	100	Partial	No	100
FISH CONSUMPTION	Partial	No	100	Not Assessed	No	0
COLD FRESHWATER HABITAT	Partial	No	100	Partial	No	100
WARM FRESHWATER HABITAT	Partial	No	100	Partial	No	100
SWIMMABLE	Partial	No	100	Partial	No	100
SECONDARY CONTACT RECREATION	Partial	No	100	Partial	No	100
HYDROELECTRIC POWER GENERATION	Partial	No	100	Not Assessed	No	0
INDUSTRIAL SERVICE SUPPLY	Not Assessed	No	0	Not Assessed	No	0
Water Impairments	Unknown Toxicity - Slight Pesticides - Slight Priority Organics - Slight			No Impairments Reported		
Potential Sources of Impairments	Source Unknown - Slight			No Sources Reported		

SOURCE: U.S. Environmental Protection Agency, 2002

Water quality is evaluated based on both numeric and narrative water quality standards. Narrative standards are difficult to evaluate unless numeric criteria have been developed for that standard, based on the beneficial use needing protection. Numeric water quality criteria and standards are available in the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan) (California Regional Water Quality Control Board Central Valley Region, 1998) and State of California "Numerical Limits" spreadsheet (State Water Resources Control Board, 2003). Not all narrative standards have numeric criteria (e.g., several pesticides, nutrients, oil and grease, others). Nutrient

criteria for aquatic life support and overall aquatic ecological health have not yet been developed specifically for this region.

Without specific numeric nutrient criteria, application of the U.S. EPA recommended nutrient criteria is practicable for assessing nutrient levels in the streams and creeks of this watershed. Approximately one-half of the watershed lies within U.S. EPA Aggregate Ecoregion I (lower/western watershed) and the other half in Ecoregion III (upper/eastern watershed). Aggregate ecoregions for nutrients were an aggregation of level III ecoregions, with similar characteristics expected to affect nutrient levels:

> *"The US EPA used available data from waterbodies in each ecoregion to determine a best estimate of minimally impacted conditions and developed criteria for causal and response variables from seasonal and annual median values." (*U.S. EPA, 2003c)

U.S. EPA nutrient criteria include value for total nitrogen, total phosphorous, turbidity, and chlorophyll a.

Within the Dry Creek watershed, several water quality studies have been initiated by both the Central Valley Regional Water Quality Control Board (CVRWQCB), Dry Creek Conservancy (DCC), and cooperating agencies/individuals. These studies include measurements of chemical constituents and bioassessment. Chemical and physical measurements are indicators of environmental constraints within aquatic ecosystems, and are important in identifying potential areas of impairment, sources of impairment, and human risk potential. Bioassessments, on the other hand, evaluate local biological communities and organism survival. These measures are direct indicators of impairment for aquatic life support. However, their response is often an integration of various constraints and identification of specific causes/sources of impairment is more difficult. Combining programs and data that evaluate both types of analysis is ideal in determining overall ecosystem health and constraints.

Sites within the watershed that have been or currently are being monitored for water quality parameters are shown on Figure 2.10. Summaries of the studies are discussed in the following sections.

Figure 2.10 Water Quality Sample Locations Map (Robert)

2.2.4.6.1 Chemical and Physical Indicators

Conventional Parameters:

Conventional parameters are basic measurements that describe general water quality conditions and are fairly easy to measure/monitor.

- Dissolved oxygen (DO) is an important parameter for support of aquatic organisms, which use DO for metabolic process as land-based organisms use gaseous oxygen.
- Temperature is a parameter that affects all metabolic and chemical processes. Not only is temperature important for maintaining aquatic life support, growth, and reproduction; but, temperature also affects how quickly aquatic chemical reactions occur and the amount of oxygen dissolved in water when at saturation (i.e., higher temperature lead to lower DO).
- Turbidity can be related to the amount of suspended sediment, although the relationship between turbidity and suspended sediment must be determined for each stream system. Regardless, certain species of aquatic life need clear water (low turbidity) in order to survive (e.g., prey hunting fish). Other species need less clear water in order to escape and hide. Additionally, higher turbidity waters often also heat up faster.
- Conductivity is often used as a measure of water salinity (the amount of mineral in water). Higher conductivities are associated with higher salinity. This is also often used as a surrogate for obtaining a general indication of the amount of some nutrients in the waterbody.
- Ammonia is a nutrient that at high pH and temperature will exist in the form of unionized ammonia. Unionized ammonia is highly toxic to aquatic life. In the NPDES monitoring programs, ammonia levels were negligible and are therefore not considered in this document. For surface water quality monitoring, results for ammonia are included.

Nutrients

Nutrients in aquatic systems assist in aquatic plant (e.g., algae) growth. Addition of excessive nutrients, or more often, the addition of a limiting nutrient (nutrient necessary for growth, but in short supply) can lead to a flourish of aquatic plant growth and changes in cycling of other chemicals and eutrophication of the water system. While some aquatic plants are necessary for ecosystem functions, excessive nutrients unbalance the ecosystem and can contribute to reduced dissolved oxygen, clogging of waterways with vegetation, and, in some case, toxic effects.

- Nitrate (and nitrite) are dissolved formes of nitrogen, readily available for plant growth. High levels of nitrate indicate potential nutrient problems. However, because aquatic plants like algae can “fix” their own nitrogen (use atmospheric nitrogen for growth), nitrate is often not a concern until values are very high.
- Phosphorous is often a limiting nutrient in aquatic systems. Even small additions can create a flourish of plant growth. Non-flowing systems (e.g., ponds and lakes) are more sensitive to phosphorous additions. On the other hand, wetlands

can use much phosphorous and remain healthy; this is the reason constructed wetlands can be used for water quality treatment.

- Ammonia is also a nutrient, but as mentioned in the previous paragraph, the primary concern with ammonia is its unionized form, which is toxic to some aquatic life.

Heavy Metals

Heavy metals are often toxic to all life forms in excessive amounts. Only a few studies have measured heavy metals concentrations in the Dry Creek Watershed. Primary sources in this area are likely from historical mining operations. Historical deposition of metal-laden sediment can, if present, still possibly contribute to metal toxicity problems of sediment dwelling organisms or water column dwelling organisms as metals are dissolved into the water. Other sources may include transport from impervious surfaces in the watershed and spills.

Pesticides and Other Organic Chemicals

Pesticides in aquatic systems are toxic when in high concentrations. In flowing systems, such as streams, pesticides and other organic chemicals usually are transported in stormwater runoff or drainage and are quickly flushed out of the system. There is the possibility that some historically used pesticides may still be present in the area sediment and soils, and these may be slowly be released into aquatic systems.

Toxicity Testing

Toxicity testing measures the response (mortality, growth, reproduction) of aquatic organisms to samples of water or sediment. If the media proves toxic (high mortaliy, stunted growth, or inability to reproduce), samples are reprocessed with various chemical additives and modificaitons to try and determine the likely cause of toxicity. This type of testing is a direct measure of aquatic life impairment, but determination of the source can be difficult and the procedure is expensive.

Benthic Macro Invertebrate (BMI) Rapid Bioassessment

Benthic dwelling aquatic invertebrates (BMIs) integrate the potential constraints of the localized environment. In this manner, BMI assessment provides a spatially specific (localized) measurement, integrated over time. Thus, unlike toxicity testing, BMI assessment will not necessarily show impairment for an episodic event, such as a storm. However, it will show impairment if the episodic event is of a large magnitude (e.g., sediment release) or has a semi-permanent to permanent effect on the localized ecosystem.

2.2.4.6.2 Wastewater Treatment Plant National Pollutant Discharge Elimination System (NPDES) Permit Monitoring Studies

Wastewater treatment plants (WWTPs) are generally required to monitor the water quality of their discharge and receiving water body to comply with the terms of their National Pollutant Discharge Elimination System (NPDES) permits. Two WWTP are

located within the Dry Creek Watershed. The Roseville WWTP is located on Dry Creek, downstream of Roseville, California and has a design capacity of 18 MGD (million gallons per day). The Placer WWTP is located on Miners Ravine, near Dick Cook Road, and has a design capacity of 0.75 MGD.

Placer Waste Water Treatment Plant

A summary of data from the Placer WWTP is provided in, "Review of NPDES reports (Jan 2001 - Sep 2002) of Placer County Treatment Plant No. 3" (Baker, 2003). Discharges were less than design capacity, averaging 0.106 MGD, with a maximum of 0.137 MGD during the period assessed. Figure 2.11 shows the relationship between Placer WWTP discharge and receiving water body (Miners Ravine) flow. Even during low flow periods, discharge never exceeds 10 percent of Miners Ravine flows at this location. Consequently, Miners Ravine is not an effluent dominated water body and Placer WWTP Constituents of Concern (COCs) are not likely to have a great impact on Miners Ravine unless present in excessively high values.

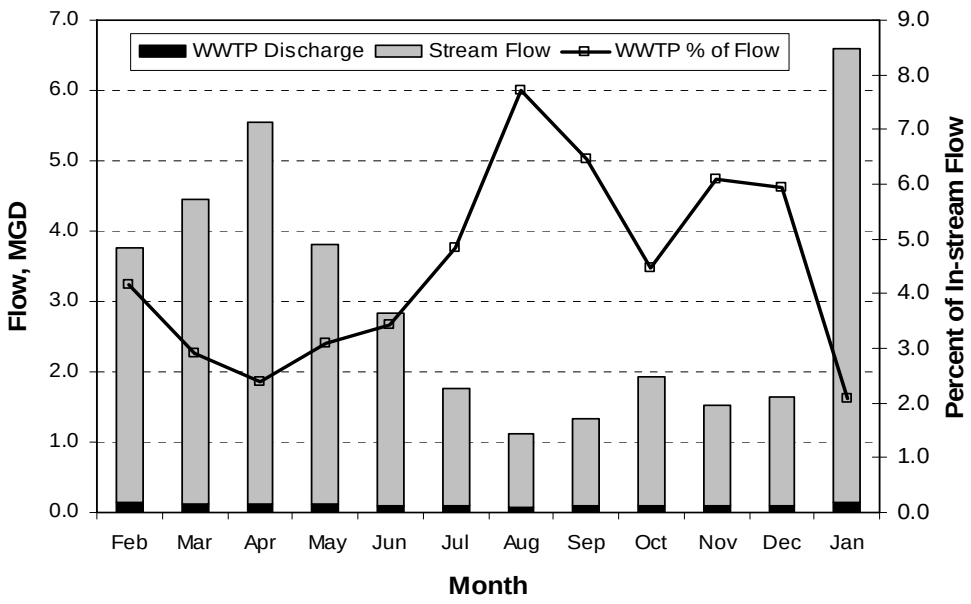


Figure 2.11. Placer Waste Water Treatment Plant Discharge and Miners Ravine Flow Relationship

In 2001, mean monthly dissolved oxygen (DO) values in Miners Ravine upstream and downstream of the Placer WWTP outfall were within water quality standards for both cold (COLD) and warm (WARM) water fish support designated beneficial uses (Basin Plan: California Regional Water Quality Control Board Central Valley Region, 1998). However, in 2002, DO values fell below WARM standards (5.0 mg/L minimum) during June through August; and below COLD water standards (7.0 mg/L minimum) from May through September, upstream of the outfall, and May through August, downstream of the outfall. Seasonal means at each location are in Table 2.11.

Table 2.11. Mean Seasonal Dissolved Oxygen In Miners Ravine Above and Below the Placer Waste Water Treatment Plant Outfall.

Position Relative to Outfall	Hot Season (May – Oct)		Cold Season (Nov-Apr)	
	2001	2002	2001	2002*
	mg/L	*mg/L*	*mg/L*	*mg/L*
Upstream	8.5	5.0	10.9	8.5
Downstream	8.4	5.4	10.8	9.7

*missing Nov and Dec

No temperature requirements are specified in either the Basin Plan or in the State of California "Numerical Limits" spreadsheet (State Water Resources Control Board, 2003), except that WARM or COLD designated waters cannot have their temperatures raised by more than 2.78^{o}C above ambient conditions. The Sacramento River does have listed temperature standards that can serve as a basis for evaluating Dry Creek tributaries. These standards are based primarily on COLD and WARM water fish support. Generally, temperatures near the WWTP exceeded water quality standards all months during 2002 and March through October during 2001. As reported in Table 2.12, no differences between temperatures upstream and downstream of the Placer WWTP outfall were noted.

Table 2.12. Mean Seasonal Temperature In Miners Ravine Above and Below the Placer Waste Water Treatment Plant Outfall.

Position Relative to Outfall	Hot Season (May – Oct)		Cold Season (Nov-Apr)	
	2001	2002	2001	2002*
	^{o}C	^{o}C	^{o}C	^{o}C
Upstream	20.4	20.30	11.7	9.6
Downstream	20.5	18.0	11.7	12.2

*missing Nov and Dec

All turbidity measurements exceeded U.S. EPA-recommended values for streams in U.S. EPA Aggregate Ecoregion III of 2.34 Nephelometric Turbidity Units (NTUs). As reported in Table 2.13, no differences between sites upstream or downstream of the Placer WWTP outfall were noted.

Table 2.13. Mean Seasonal Turbidity In Miners Ravine Above and Below the Placer Waste Water Treatment Plant Outfall.

Position Relative to Outfall	Hot Season (May – Oct)		Cold Season (Nov-Apr)	
	2001	**2002**	**2001**	**2002***
	NTU	*NTU*	*NTU*	*NTU*
Upstream	3.9	5.5	6.9	6.6
Downstream	3.7	5.4	6.9	3.4

*missing Nov and Dec

Conductivity is a measure of water salinity. All values in Miners Ravine were within standards (State Water Resources Control Board, 2003). Conductivity in Miners Ravine downstream of the Placer WWTP outfall appeared slightly higher than upstream from January through April. As reported in Table 2.14, between May and December, downstream conductivity was approximately 50% higher than upstream values; and, from July through October, values were approximately twice as high downstream compared to upstream.

Table 2.14. Mean Seasonal Conductivity In Miners Ravine Above and Below the Placer Waste Water Treatment Plant Outfall.

Position Relative to Outfall	Hot Season (May – Oct)		Cold Season (Nov-Apr)	
	2001	**2002**	**2001**	**2002***
	µS/cm	*µS/cm*	*µS/cm*	*µS/cm*
Upstream	74.8	85.4	150	189
Downstream	139	145	177	200

*missing Nov and Dec

Miners Ravine mean monthly pH was within water quality standards (6.0 to 8.5) for all months. Table 2.15 shows the mean seasonal pH for Miners Ravine at this location.

Table 2.15. Mean Seasonal pH In Miners Ravine Above and Below the Placer Waste Water Treatment Plant Outfall.

Position Relative to Outfall	Hot Season (May – Oct)		Cold Season (Nov-Apr)	
	2001	2002	2001	2002*
	SU	*SU*	*SU*	*SU*
Upstream	7.2	7.3	7.7	7.8
Downstream	7.3	7.2	7.7	7.7

*missing Nov and Dec

Fecal coliforms counts were generally lower in Miners Ravine downstream of the Placer WWTP outfall compared to upstream. Water quality standards are based on a geometric mean of at least five samples in one month or exceedence of a maximum value for any single sample. Upstream of the Placer WWTP outfall, five of six samples exceeded the geometric mean standard (200 counts/100 mL), and three of these also exceed the maximum allowable for any one sample (400 counts/100 mL).

Similar DO, pH, temperature, and turbidity between upstream and downstream sites indicate minimal impacts of the Placer WWTP on Miners Ravine water quality. This is expected, due to high dilution (minimal proportion of Miners Ravine flow) of the Placer WWTP discharge. The higher conductivity downstream of the Placer WWTP outfall, compared to upstream, is likely indicative of very high conductivity in the wastewater effluent, common for wastewater effluent. Treatment of wastewater to eliminate pathogens results in low counts for most wastewater effluent. Additionally, any residual chlorine or other sterilizing agent may have remained in the effluent and killed these organisms in the stream.

Overall, water quality in Miners Ravine at this site experiences:

- Dissolved Oxygen impairment during the summer
- Temperature impairment most of the year

The effect of the Placer WWTP on Miners Ravine is limited to:

- Higher Conductivity, but within standards
- Lower turbidity, but still exceeding criteria

Roseville Waste Water Treatment Plant

Water quality data for the Roseville WWTP discharge and Dry Creek flow are summarized below. Discharge is generally less than design capacity (18 MGD), averaging 13.8 MGD from 1999 through 2002. However, during the period of record (1991 through 2002), there was a maximum weekly mean of 26.5 MGD, in January of 1997. During the period of analysis (1999 through 2002), there was a maximum monthly

mean of 20.1 MGD, in January of 2000. Figure 2.12 shows the relationship between Roseville WWTP discharge and the receiving water body (Dry Creek) flow from 1999 through 2002. Even during high flow periods, discharge is never less than 15 percent of Dry Creek flow, and provides up to 55% of dry season flow within the lower portion of Dry Creek. Consequently, Dry Creek is an effluent-dominated water body and Roseville WWTP Constituents of Concern (CoCs) are likely to have a great impact on Dry Creek water quality unless present in very low values.

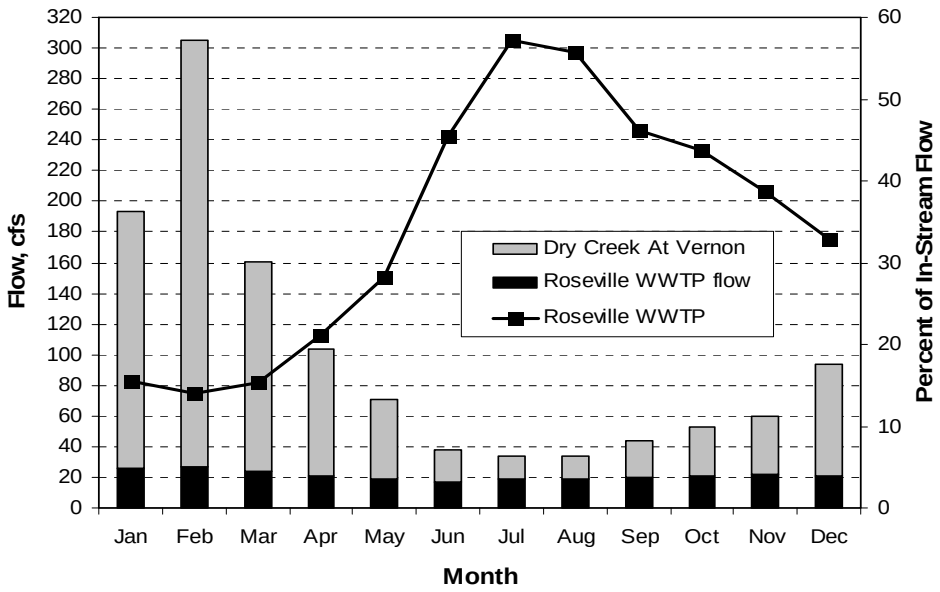
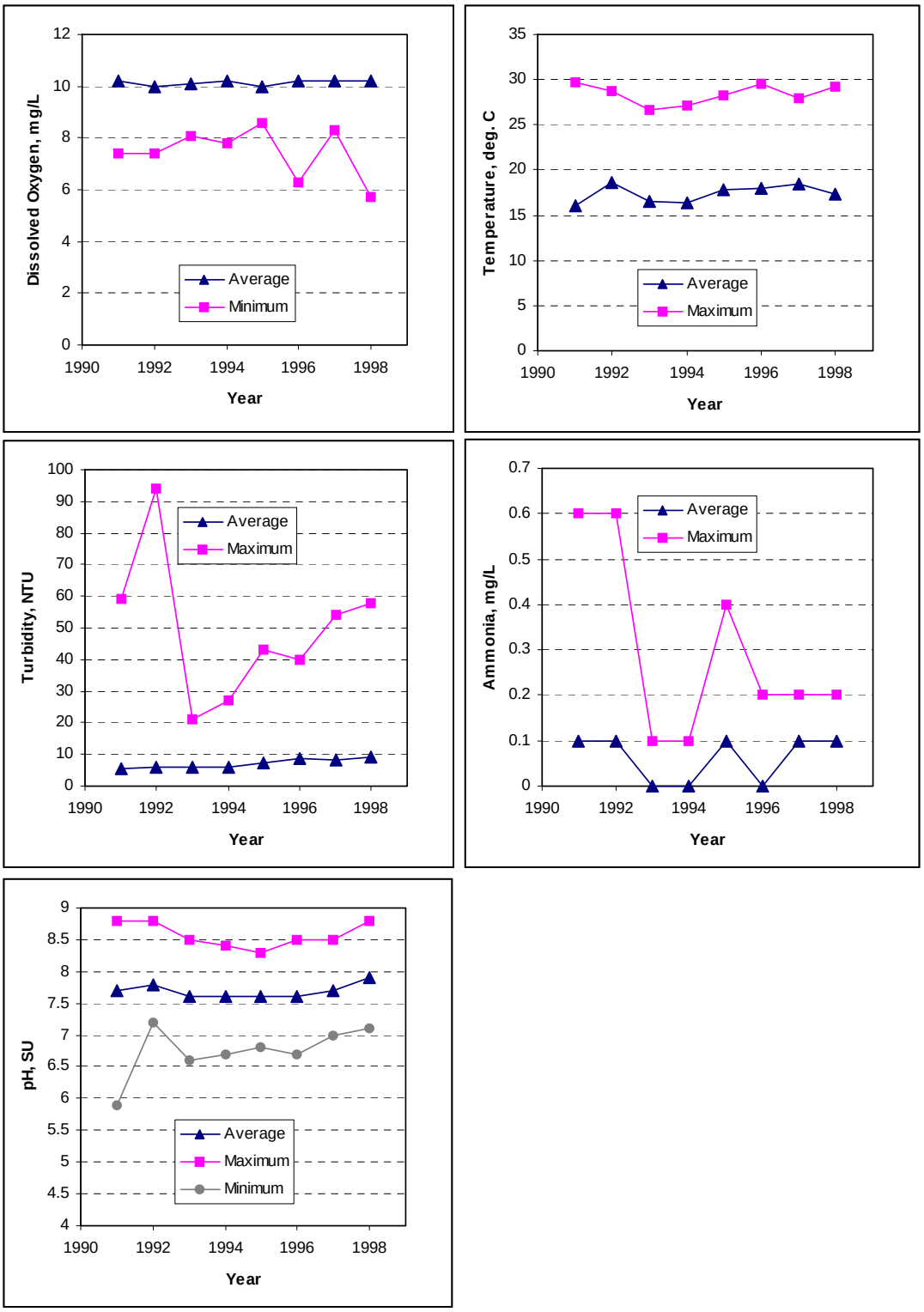


Figure 2.12. Roseville Waste Water Treament Plant Discharge and Miners Ravine Flow Relationship

Improvements to the WWTP were made prior to 1998; consequently, pre-1998 data cannot be used for assessing impacts of the current WWTP on downstream water quality. However, measurements of ambient conditions upstream of the Roseville WWTP, from 1991 through 1998, included in the NPDES permit data, is available for long-term trends analysis of DO, pH, turbidity, conductivity, ammonia, and temperature. Figure 2.13 shows the annual ambient water quality data (except for conductivity), upstream of the Roseville WWTP, from 1991 through 1998.



Fgure 2.13. Ambient Dry Creek Water Quality Measured Upstream of the Roseville Waste Water Treatment Plant

In general, it appears that there may be an increasing trend in turbidity and possibly also pH, over time. Statistical trends analysis using 1998 through 2003 data would be necessary to determine if these increases are real. In-stream minimum DO and pH are generally above the water quality minimum; but, pH maximum exceeds the water quality standard 3 out of 8 years. Mean turbidity consistently exceeds the U.S. EPA-recommended value of 4.25 Nephelometric Turbidity Units (NTUs) for streams in U.S. EPA Aggregate Ecoregion I. Temperatures averages are high for cold water fisheries support and maximums are very high for cold water fisheries support and high for warm water fisheries support. Ammonia concentrations are generally below detection limit (0.1 mg/L) and maximum values may be due to episodic events.

Effects of the Roseville WWTP on in-stream water quality can be evaluated by comparing parameter values in the stream above the WWTP outfall and below the outfall. Parameter values above the outfall provide information about the ambient conditions. Values below the outfall reflect WWTP contributions to the system. The following section shows the impacts of the Roseville WWTP on measured parameters from June 1998 through June 2003.

Seasonal DO averages for Dry Creek (Table 2.16) are slightly lower, on average, at the site below the Roseville WWTP. Minimum values are higher. Additionally, the lower values do not cause in-stream concentrations to fall below water quality standards.

Table 2.16. Seasonal Dissolved Oxygen In Dry Creek Above and Below the Roseville Waste Water Treatment Plant Outfall.

Position Relative to Outfall	Hot Season (May – Oct)		Cold Season (Nov-Apr)	
	Mean	**Min**	**Mean**	**Min**
	mg/L	*mg/L*	*mg/L*	*mg/L*
Upstream	9.1	5.5	11.6	8.3
Downstream	8.4	6.0	10.3	8.2
Mean Difference	*-0.7*	*+0.5*	*-1.3*	*-0.1*

No temperature requirements are specified in either the Basin Plan (California Regional Water Quality Control Board Central Valley Region, 1998) or in the State of California "Numerical Limits" spreadsheet (State Water Resources Control Board, 2003, except that WARM or COLD designated waters cannot have their temperatures raised by more than 2.78^{o}C above ambient conditions. The Sacramento River does have listed temperature standards that can serve as a basis for evaluating Dry Creek tributaries. These standards are based primarily on COLD and WARM water fish support.

Temperature effects are presented in Table 2.17. Generally, ambient temperatures (above the WWTP) exceeded water quality standards during June through September. Temperatures were warmer, on average downstream of the outfall. From October through December, the WWTP discharge increased in-stream temperatures above the water quality standard (increase of 2.78 ^{o}C above ambient). During the summer, however, WWTP discharge often slightly reduced in-stream temperatures.

Table 2.17. Mean Seasonal Temperature In Dry Creek Above and Below the Roseville Waste Water Treatment Plant Outfall.

Position Relative to Outfall	Hot Season (May – Oct)		Cold Season (Nov-Apr)	
	Mean	**Max**	**Mean**	**Max**
	°C	*°C*	*°C*	*°C*
Upstream	22.8	31.0	11.8	21.0
Downstream	23.5	28.0	15.5	22.1
Mean Difference	*0.71*	*6.8*	*3.5*	*9.6*
Outfall	24.3	27.6	19.1	23.8

November through May ambient turbidity measures often exceeded the U.S. EPA-recommended value of 4.25 Nephelometric Turbidity Units (NTUs) for streams in U.S. EPA Aggregate Ecoregion I. Turbidity below the Roseville WWTP outfall was generally lower than ambient conditions (Table 2.18). Consequently, California Water Quality Standards were not exceeded (no increase greater than 1-2 NTU).

Table 2.18. Mean Seasonal Turbidity In Dry Creek Above and Below the Roseville Waste Water Treatment Plant Outfall.

Position Relative to Outfall	Hot Season (May – Oct)		Cold Season (Nov-Apr)	
	Mean	**Max**	**Mean**	**Max**
	NTU	*NTU*	*NTU*	*NTU*
Upstream	4.23	15.0	11.9	90
Downstream	2.78	12.0	8.1	82
Mean Difference	-1.45	|1.45|	-3.5	|21.0|

Conductivity is a measure of water salinity. All values in Dry Creek were within standards (State Water Resources Control Board, 2003) (Table 2.19). Conductivity in Dry Creek downstream of the Roseville WWTP outfall was generally twice as high as ambient conditions throughout the year.

Table 2.19. Mean Seasonal Conductivity In Dry Creek Above and Below the Roseville Waste Water Treatment Plant Outfall.

Position Relative to Outfall	Hot Season (May – Oct)		Cold Season (Nov-Apr)	
	Mean	**Max**	**Mean**	**Max**
	µS/cm	*µS/cm*	*µS/cm*	*µS/cm*
Upstream	173	230	204	260
Downstream	434	660	391	550
Mean Difference	608	820	571	790

Dry Creek ambient pH was within water quality standards (6.0 to 8.5) during the Hot Season (Table 2.20) except for July 2001 and May 2002. During the Cold Season, maximum pH was generally exceeded during December, March, and April. Roseville WWTP discharge reduced in-stream pH resulting in water quality standard compliance in Dry Creek downstream of the outfall.

Table 2.20. Seasonal pH In Dry Creek Above and Below the Roseville Waste Water Treatment Plant Outfall.

Position Relative to Outfall	Hot Season (May – Oct)			Cold Season (Nov-Apr)		
	Mean	**Min**	**Max**	**Mean**	**Min**	**Max**
	SU	*SU*	*SU*	*SU*	*SU*	*SU*
Upstream	7.9	7.2	9.0	7.9	7.3	9.1
Downstream	7.2	6.9	7.6	7.2	6.8	7.7

The only nutrient parameter measured for the Roseville outfall and in-stream impacts was Ammonia. Values for ammonia were low and met water quality standards, except for a few instances where discharge concentrations exceed 10 mg/L.

Ambient conditions in Dry Creek upstream of the Roseville WWTP outfall exceed standards for DO, temperature, turbidity, and pH for some months. The effect of Roseville discharge into Dry Creek did not contribute to water quality impairment, based on water quality standards. However, the large increase in Conductivity and lower DO could still adversely effect the aquatic ecology. Additionally, nutrient parameters were not measured. Evaluation of Central Valley Regional Water Quality Control Board and Dry Creek Conservancy monitoring program data suggests that high concentrations of nitrogen and phosphorous at the lower Dry Creek sampling station could be due to inputs from the Roseville WWTP.

Overall, water quality in Dry Creek at this site experiences:

- Dissolved Oxygen impairment for COLD water fish support during the summer
- Temperature impairment June through September

- Turbidity impairment November though May
- pH impairment December, March, and April
- No Conductivity impairment

The effect of the Roseville WWTP on Dry Creek was limited to:

- Higher Conductivity - but within standards
- Lower turbidity - bought into compliance with standards
- Lower Dissolved Oxygen – but no impairment
- Higher temperature – exceeded standards
- Lower pH – brought into compliance with standards
- Unknown nutrient contributions

2.2.4.6.3 Historic Storage and Retrieval Water Quality Database (STORET) Historical Data

Historic STORET data is included in Appendix 2.2. Six stations were monitored from 1951 through 1961. Table 2.21 lists the stations, locations, and general sample data available.

Table 2.21. Historic STORET Data

Site	Site ID	Location	Elevation	Parameters	Dates
			ft above msl		
Dry Creek (Linda Creek) @ Cook Riolo Rd.	16166094	38.73694 121.3361	90	Conventional parameters, Dissolved salts, nitrate, Dissolved Cr, Cl, Bo	2/54; 7/54; 9/54; 12/59
Dry Creek @ Auburn Blvd, Roseville	16166099	38.73389 121.2897	105	Conventional parameters, Dissolved salts, nitrate, Dissolved Cl, Bo	2/58; 6/58; 9/58
Dry Creek @ 4th St. (Rio Linda)	16166086	38.66861 121.4558	35	T, pH, Cond., Oils and Grease, Dissolved Chlorides, Tot. Phenolics	2/54; 7/54; 9/54; 3/55; 6/55
Dry Creek @ Elverta Rd	16166088	38.71444 121.4025	70	T, pH, SpCond., Oils and Grease, Dissolved Chlorides, Tot. Phenolics	2/54; 7/54; 9/54
Linda Creek @ Sunrise	16166103	38.73417 121.2708	140	Dissolved heavy metals	6/61
Linda Creek (Dry Creek) near Roseville	16166067	38.73444 121.3014	110	Conventional parameters, dissolved salts, dissolved heavy metals	4/51; 5/51; 7/51; 8/51; 10/51; 1/52; 2/54; 7/54; 9/54; 3/55; 10/57; 6/58; 9/58; 6/61

STORET data were qualitatively compared with Central Valley Regional Water Quality Control Board and Dry Creek Conservancy data at similar locations. This provides a snapshot view of potential changes in water quality that have occurred over the past twenty or more years.

2.2.4.6.4 Central Valley Regional Water Quality Control Board Studies

The water quality team of the Central Valley Regional Water Quality Control Board (CVRWQCB) conducted 15 monthly sampling events at eight locations in the Dry Creek watershed during fall, 2000 through winter, 2002. Study sites are listed in Table 2.22 and shown on Figure 2.10.

Table 2.22. Sampling Locations for Central Valley Regional Water Quality Control Board Studies

Site No.	Stream Name	Location	Description
DC1	Dry Creek	DC at Elkhorn Blvd.	Downstream of Roseville WWTP, lower watershed
DC2	Dry Creek	DC at Cook Riolo	Downstream of Roseville WWTP, lower watershed
DC3	Dry Creek	DC at Atkinson	Upstream of Roseville WWTP, downstream of railroad
DC4	Antelope Creek	AC at Sunset	Lower watershed
DC5	Antelope Creek	AC at Sierra College Blvd.	Upper watershed
DC6	Secret Ravine	SR at Loomis Park	Upper watershed
DC10	Linda Creek	LC at Champion Oaks	Tributary, urban impacts
DC11	Miners Ravine	MR at Auburn Folsom Road	Downstream of SMD 3

Sites were sampled for *in-situ* DO, turbidity, conductivity, temperature, and pH. Grab samples were analyzed for hardness, alkalinity, and ammonia. Statistical analyses have not yet been performed to identify trends and relationships. Consequently, only a brief discussion of data is provided here. Graphs of all data are included in the Appendix 2.3.

DO met all WARM water fish support standards (DO $\geq$ 5.0 mg/L) throughout the sampling period. COLD water fish support standards (DO $\geq$ 7.0 mg/L) were generally met, except for 6/26/2001 through 8/23/2001 at Dry Creek locations, and 6 of 14 samples in Miners Ravine at Auburn Folsom Road. DO was generally high during winter months, probably due to the higher solubility of oxygen in colder waters.

Dry Creek temperatures are generally lower at the Atkinson site (above the Roseville WWTP), compared to Cook Riolo and Elkhorn Blvd sites (downstream of the outfall). This is consistent with data measured by the Roseville WWTP: lower temperatures in-stream above the outfall. No temperature standards are listed for this watershed; however, this watershed is a tributary to the American River, which is tributary to the Sacramento River. Using Sacramento River standards as a measure of potential impairment, during summer months, June through August, in-stream temperatures may impair water quality for aquatic life support (temperature >21.1 ^{o}C). During winter months, temperatures remain below 12.8 ^{o}C. Secret Ravine at Loomis Park tended to

show less temperature variation between summer and winter, and Dry Creek sites and Antelope Creek at Sunset (lower watershed) had the greatest variation. In general, though, temperatures were similar among sites.

Turbidity ranged from < 0.5 NTU to 47.7 NTU during the monitoring study. Turbidity measurements show a strong response to winter wet weather. Generally, higher turbidities were measured at all sites during the winter season compared to summer. The highest turbidity (12.7 to 47.7 NTU) was measured at all locations during the 2/13/2001 sampling event. The U.S. Geological Survey (USGS) gage on Dry Creek at the Vernon Street Bridge recorded the yearly peak flow on 2/11/2001. Turbidity criteria (U.S. EPA, 2003c) for these sites are 2.38 (upper watersheds) to 4.25 NTU (lower watershed). However, turbidity criteria do not necessarily apply to storm flows. Antelope Creek at Traylor Park, Secret Ravine, and Miners Ravine sites exceeded turbidity criteria (2.38 NTU) in 8 to 11 samples out of 12 total (67 – 92% non-compliance). Linda Creek exceeded turbidity criteria (4.25 NTU) during 9 of 12 sampling events (75% non-compliance). The remainder of sites were 67% in compliance with criteria, except for the furthest site downstream on Dry Creek (at Elkhorn Boulevard), which was 45% in compliance with criteria.

Conductivity was within water quality standards during all sampling events. Generally, the two sites on Dry Creek below the Roseville WWTP and the Linda Creek site had the highest conductivities (345 µS, 327 µS, and 289 µS, respectively), averaging approximately 100 µS higher than the other sites. High conductivity at the Dry Creek sites is expected, based on the high Roseville WWTP outfall conductivities and proportion of in-stream flow. Linda Creek drains an urbanized area, consequently, conductivity could be a function of runoff, lawn care, and other practices associated with urbanization. Conductivities at the other sites ranged from 145 to 185 µS.

Comparison of historical (STORET) conductivity at similar sites (Dry Creek at Elkhorn and Cook Riolo, and Linda Creek) indicates that conductivity was historically generally lower at the Linda Creek and Elkhorn sites, but slightly higher at the Cook Riolo site. Historic data are minimal; consequently, slight differences are not likely to be significant.

All sites met pH standards (6.0 to 8.5) for all sample events except for Dry Creek at Atkinson and Cook Riolo on 2/13/2001, and Antelope Creek at Sunset on 7/11/2001. In all cases, pH exceed 8.5; but, they did not exceed 9.0. Average pH at all sites was approximately 7.5. Historical pH (STORET data) was similar to study pH at approximately co-located sites.

Unionized ammonia is toxic to aquatic life. This parameter can be calculated from ammonia concentrations, pH, and temperature. At all sites and all sampling events, except for one, ammonia was low: less than or equal to 0.2 mg/L. The Miners Ravine site had an ammonia concentration of 0.5 mg/L on 9/28/2001. This value does not exceed the aquatic toxicity level when converted to unionized ammonia; however, it does exceed the US EPA recommended nutrient criteria of 0.38 mg/L Total Nitrogen. The highest ammonia concentration were on Miners Ravine and at the Elkhorn Dry Creek site. These high concentrations could be due to nutrient loads from the upstream wastewater treatment facilities.

2.2.4.6.5 Dry Creek Conservancy Studies

The Dry Creek Conservancy Monitoring Group (DCCMG), a volunteer citizens monitoring group, was created in April, 1996, primarily for conducting rapid bioassessment monitoring. The rapid bioassessment includes collection and identification of benthic macroinvertebrates and habitat assessment. A 319(h) grant was obtained that allowed for citizen training and equipment purchasing. Additional funding from Proposition 204 and Cal-Fed grants allowed for improved monitoring, creation of an over all water quality sampling program Quality Assurance Project Plan (QAPP), purchase of additional water quality monitoring equipment, and contracting with professional services for taxonomic identification of benthic macroinvertebrates (BMIs) and outside analytical laboratory services.

The following water quality monitoring objectives were established by the Dry Creek Conservancy Monitoring Group:

- To initiate understanding and documentation of the relationship between water quantity/hydrologic functions and water quality, watershed management, and land use.
- To initiate and sustain a continuing process for collecting data for the purpose of assessing and modeling watershed conditions over decades.
- To initiate the education of residents about the watershed processes in the entire Dry Creek watershed, and to strengthen their connection to the ideal of a healthy watershed.
- To make data available to decision makers and the public to foster improved watershed stewardship.

Details of the monitoring program are included under a separate cover entitled “Dry Creek Conservancy Water Quality Monitoring and Quality Assurance Project Plan (QAPP)”. In addition to the project QAPP, a Water Quality Monitoring Handbook was developed to assure consistent DCCMG monitoring practices. Monitoring locations were selected to reflect watershed conditions such as:

- Land use
- Vegetation: plant community types, tree inventory, individual plant species or invasive plant species
- Human activities: transportation, developed areas, agricultural areas, community services, recreation areas, abandoned facilities
- Geophysical features: soils and geomorphological processes, geology and topography, climate/weather/air quality
- Hydrology

Additional factors were evaluated to select sites in order to maximize use of existing information, allow for comparability with previous and concurrent studies, to identify impacts of specific potential sources, and to allow for a safe sampling environment. Specifically, consideration was given to:

- Is there an existing flow gauging station?

- Is there or has there historically been a major land use (agriculture, municipal, industrial, mining, recreational, etc.) that may affect water quality in the area?
- Is the area included in the designated Critical Habitat for listed species?
- Are there sampling access constraints?
- Is there a potential water quality impairment?
- Is there previous water quality data that could be used?

Ten sampling locations were initially established (Table 2.23). The DCCMG coordinated sample sites with the CVRWQB Effluent Dominated Water body program in 2000 and 2001. Following 2001, the DCCMG restructured sites to provide comprehensive coverage. These locations are depicted on Figure 2.10.

Table 2.23. Dry Creek Conservancy Study Sampling Locations in Dry Creek Watershed

Location	DCC Site No.	Justification	Prameters Measured	
			Physical/ Chemical	Biological
Traylor Ranch/ Antelope Creek at King Road Bridge	1	Rural background setting. Upstream of Rocklin. No previous data. CVRWQCB to monitor intermediate sites at Sunset and Sierra College Blvd.	Yes	Yes
Miners Ravine above Cottonwood dam	2	Upper end of stream. Above dam No previous data. CVRWQCB to monitor intermediate sites above and below Placer County treatment plant. . Data available from Placer County wastewater treatment plant.	Yes	Yes
Miners Ravine at Dick Cook Rd	2Alt	Just downstream of the WWTP	Yes	
Linda Creek at Barton Road	3	Upstream of Roseville. No previous data. CVRWQCB to monitor downstream in Roseville.	Yes	Yes
Linda Creek at Country Court	3Alt		Yes	
Clover Valley Creek prior to golf course	4	Tributary to Antelope Creek, mostly rural, a large development is planned. No previous data.	Yes	Yes
Secret Ravine at Sierra College/above Rocklin Rd	5	Intermediate point: CVRWQCB will monitor above at Loomis Basin Park. . Below several small headwater tributaries. Above several large drainages from urbanized Rocklin. Large amount of benthic macroinvertebrate data available.	Yes	Yes
Secret Ravine at Miners Ravine	6	Lower end of stream. Previous data available. Downstream end of Roseville Preserve. Large development being built upstream.	Yes	Yes
Miners Ravine at Secret Ravine	7	Lower end of stream. Previous years data available. Downstream end of Roseville Preserve. Large development being built upstream. CVRWQCB to monitor upstream of these features at Sierra College Blvd.	Yes	Yes
Antelope Creek at Atlantic	8	Downstream of Rocklin and decommissioned landfill. Near confluence with Dry Creek. Several years of benthic macroinvertebrate data available	Yes	Yes
Dry Creek at Royer Park	9	Intermediate site. CVRWQCB to monitor downstream sites above and below Roseville wastewater treatment plant and in Rio Linda. Previous years data available. Central Roseville after confluence of Antelope, Secret Ravine, and Miners Ravine. At restoration site. Above rail yard. Previous years data available.	Yes	Yes
Linda/Cirby above Dry Creek Confluence	9A		Yes	?
Dry Creek at Rio Linda Blvd	10	Lower end of Dry Creek. Data available from DWR for Steelhead Creek.	Yes	Yes

Following the first sampling event, site number 9 was moved to Cirby Creek above the confluence with Dry Creek and assigned a site number of 9alt. Similar Adjustments were made at sites 2 and 3.

In addition to personnel training and pre-program planning (e.g., preparation of the QAPP and Water Quality Monitoring Handbook), the Dry Creek monitoring program was funded to run 2 years of studies. Projects included in this program were:

- Quarterly sampling of program sites for 2 years
- Benthic macroinvertebrate sampling at co-located sites for 2 years
- First Flush sampling and analysis during the fourth quarter of each year

Other site specific studies have been initiated since the beginning of this monitoring program, often in response to local citizen concerns. The availability of equipment and trained personnel, made possible by the Proposition 204 grant, has enabled the DCCMG to serve additional water quality assessment needs within the watershed.

Additionally, a Department of Water Resources Urban Streams Restoration Program (USRP) 2001 water quality monitoring project was initiated to develop baseline data prior to a major streambank restabilization project along a section of Dry Creek from Adelante High School to the Darling Road Bridge.

Proposition 204 Monitoring Study

This 2-year study is nearing completion. Final reports and data are available from the Dry Creek Conservancy. In this section, a review of preliminary water quality data to date is provided. Comparison of DCCMG quarterly site data with CVRWQCB site data is only qualitative. Locations of sites for these two studies were similar and statistical analysis may illuminate important trends.

Parameters measured by the DCCMG were:

- Dissolved Oxygen
- Velocity
- Temperature
- Ammonia (NH4-N)
- Nitrate (NO3-N)
- Ortho-phosphate (O-PO4)
- pH
- Turbidity

It should be noted that the First Flush study did not likely capture the first flush event (beginning of the hydrograph). Comparison of sample timing with the USGS gage at Vernon street hydrograph indicates that First Flush samples were actually taken during the tail of the event. Five sites were assessed for first flush parameters prior to the 2-year monitoring program (Nov 2001) and during the fourth quarter sampling in 2002.

DO values were within WARM water fish support standards (DO $\geq$ 5.0 mg/L) throughout the entire study area (Figure 2.14). COLD water fish support DO standards (DO $\geq$ 7.0

Figure 2.14 Dissolved Oxygen

mg/L) were met for all sites and sampling events except Linda Creek at Barton Road during the third quarter of 2003, and Dry Creek at Rio Linda Blvd during the 2002 first-flush Figure 2.14. Dissolved Oxygen for Dry Creek Conservancy sampling event. Third quarter DO values are generally slightly lower than other quarters. This is like due to high temperatures resulting in lower oxygen solubility in water. Temperature does not seem to be a significant water quality issue, based on these study results. However, previous analysis of Placer WWTP in-stream data, indicates that DO may be an issue at localized portions of this watershed. Additionally, CVRWQCB monitoring program data, which is taken at a higher frequency than DCCMG data (monthly instead of quarterly), indicates that Miners Ravine at Auburn Folsom Road may be slightly impaired for COLD water fish support.

Temperature data are depicted in Figure 2.15. No temperature requirements are specified in either the Basin Plan (California Regional Water Quality Control Board Central Valley Region, 1998) or in the State of California "Numerical Limits" spreadsheet (State Water Resources Control Board, 2003, except that WARM or COLD designated waters cannot have their temperatures raised by more than 2.78^{o}C above ambient conditions. The Sacramento River does have listed temperature standards that can serve as a basis for evaluating Dry Creek tributaries. These standards are based primarily on COLD and WARM water fish support.

Temperatures were generally within Sacramento River water quality standards except for third quarter samples. In 2002, four sites exceed standards ($\leq$ 21.1 ^{o}C): Miners Ravine above Cottonwood Dam (24.7), Clover Valley Creek (21.3), Linda Creek at Barton Rd (21.7), and Dry Creek at Rio Linda Blvd. (23.0). There is a possibility that Dry Creek at Rio Linda Blvd. also exceeded the fish support standards. Impacts cannot result in a temperature increase greater than 2.78 ^{o}C; however, there was no temperature measurement taken above the Roseville WWTP, so natural ambient conditions are unknown. In 2003, all sites except Secret Ravine at Miners Ravine exceeded the standard (approximate average of 22.5).

Second quarter turbidities often exceeded the U.S. EPA-recommended values of of 4.25 NTU for streams in U.S. EPA Aggregate Ecoregion I or 2.34 NTU for Ecoregion III of (Figure 2.16) (U.S. EPA, 2003c). California Water Quality Standards could not be assessed as 'natural' ambient conditions are unknown. First flush turbidity was very high (29.5 to 125 NTU); however, California does not apply the turbidity standards to storm flows. Regardless, episodic high turbidity, often associated with high sediment load, can have still have a negative impact on the aquatic ecosystem.

DCCMG measured turbidity was similar to the CVRWQCB study, except for Antelope Creek sites. DCCMG measured slightly higher turbidity at Antelope Creek sites compared to the CVRWQCB.

Conductivity data is represented in Figure 2.17. Conducivity meets water quality standards at all sites and for all sample events. The majority of measured values are less than 150 µS/cm and are comparable to CVRWQCB measurements for the similar sites. These values are also within the range of local groundwater conductivity.

Figure 2.15. Temperature for Dry Creek Conservancy

Figure 2.16. Turbidity for Dry Creek Conservancy

Figure 2.17. Conductivity for Dry Creek Conservancy

Conductivity showed a similar trend with location during this study compared to the CVRWQCB study. Linda Creek above the confluence with Dry Creek had relatively higher Conductivity compared to all other sites except for Dry Creek at Rio Linda Blvd.. The high Conductivity near the outlet of Dry Creek could be due to the Roseville WWTP discharge, which has very high Conductivity and comprises over 45% of the stream flow during the summer (third quarter sampling event).

In-stream pH readings were within water quality standards (6.0 to 8.5) at all sites and for all sampling events (Figure 2.18). Slightly higher values were noted for lower watershed sites, Dry Creek at Rio Linda Blvd. and Linda Creek above the Dry Creek confluence, which is consistent with the CVRWQCB study. Antelope Creek at Atlantic Street pH, however, was slightly lower than pH at the CVRWQCB upper Antelope Creek site. Miners Ravine at Secret Ravine also had lower pH than the CVRWQCB Miners Ravine site. These differences are not necessarily significant and they do not indicate any potential impairment.

An important difference between this program and other monitoring programs is the inclusion of nutrient analysis (NO_3-N and O-PO_4). Since no nutrient standards are available for aquatic life support, U.S. EPA-nutrient criteria guidance values will be used for analysis (Table 2.24). Although these criteria are based on total values for nitrogen and phosphorous, if these fractions exceed the criteria, then the criteria has not been met.

Table 2.24. U.S. Environmental Protection Agency Nutrient Criteria

Nutrient	Aggregate Ecoregion	
	I	III
	mg/L	*mg/L*
Total Nitrogen	0.66	0.38
Total Phosphorous	0.55	0.22

Source: U.S. EPA 2003c

Ammonia concentrations are shown in Figure 2.19. Method sensitivity was 0.01 mg/L. Ammonia was not analyzed for second quarter 2002 samples. Ammonia concentrations are low and within the unionized ammonia toxicity standards (State Water Resources Control Board, 2003). Additionally, they are below the nutrient criteria. Highest ammonia concentrations were found during the third quarter in 2003 and first flush samples.

Figure 2.18. pH for Dry Creek Conservancy

Figure 2.19. Ammonia for Dry Creek Conservancy

Nitrates are within water quality standards (10.0 mg/L drinking water MCL), and within US EPA nutrient criteria, except for First Flush samples and Dry Creek at Rio Linda Blvd. (Figure 2.20). Nitrates are readily transported in water; consequently, high nitrates during the First Flush event are likely due to stormwater runoff from urban and rural sources. No measurements were taken during the first sampling effort (second quarter 2002).

Although many measurements were missing due to exceedence of quality control/quality assurance (QA/QC) criteria, very high nitrates at the Dry Creek at the Rio Linda Blvd. site during normal sample events is indicated and is likely due to Roseville WWTP effluent. The magnitude of increase compared to upstream sites is similar to the effect of effluent conductivity at this site. Unfortunately, Roseville WWTP effluent and receiving water are not monitored for nitrates, nor are there nitrate values for Dry Creek above the WWTP or between the WWTP and Rio Linda Blvd. It is possible that some nitrates are from the agricultural fields between the WWTP and Rio Linda Blvd. However, not only is there not much contributing watershed area between these two locations for loads from other sources to likely be very high, but the lower First Flush nitrate concentration, compared to regular event samples, indicates that the source of nitrates is not likely to be agricultural (or urban) runoff.

Phosphorous is an important nutrient in aquatic ecosystems, often the limiting factor to plant growth. Figure 2.21 shows the ortho-phosphate concentrations measured during the monitoring period. No measurements were taken during the first sampling effort (second quarter, 2002). Ortho-phosphate ($O\text{-}PO_4$) concentrations are an indicator of dissolved phosphorous in the system (readily available phosphorous). Linda Creek Above the Confluence with Dry Creek and First Flush samples regularly exceeded phosphorous criteria (see Table 2.24). Of particular note are the consistently high $O\text{-}PO_4$ levels in Dry Creek at Rio Linda Blvd. Again, this is likely due to Roseville WWTP effluent impacts. However, as with nitrates, $O\text{-}PO_4$ values have not been measured upstream of the WWTP and between the WWTP and Rio Linda Blvd. Consequently, the primary source cannot be definitively identified.

First Flush Samples:

Stormwater runoff can carry high concentrations of sediment, associated pollutants, nutrients, and other Constituents of Concern (CoCs) into surface water systems. The maximum concentrations are usually washed off the land surface during the 'first flush', or within the first ½ inch of rainfall after a prolonged dry period (where CoCs build up on the land surface). Conventional constituents were discussed in the preceding sections. Several additional parameters were analyzed in First Flush samples, including pesticides and metals. A table of CoCs analyzed, along with associated standards and criteria, is included in the Appendix 2.4.

- No Organochloride Pesticides were detected.

  The analytical detection limit was not sensitive enough to detect many CoCs at the standard/criteria level.

Figure 2.20. Nitrates for Dry Creek Conservancy

Figure 2.21. Phosphates for Dry Creek Conservancy

- No Organophosphate Pesticides were detected, except Diazinon.

  Both Linda Creek at Dry Creek and Dry Creek at Steelhead Creek had diazinon levels that exceeded both acute and chronic aquatic life support criteria concentrations by over an order of magnitude. Human toxicity standards were not exceeded. The analytical detection limit was sensitive enough for all CoCs except Chlorpyrifos and Disulfoton.

- Heavy metals were detected in several samples and criteria exceedance was variable.

  Generally, methods were not very sensitive and therefore, could not detect metals at concentrations low enough to determine if criteria/standards were exceeded. Barium, Chromium, Copper, and Zinc were found in some samples during both years and Cadimium was found in samples in 2002. Table 2.25 lists the COC, site(s) with detections, and criteria evaluation.

Overall, several exceedances of criteria or standards were found within the watershed. More detailed statistical analysis is necessary to determine if any trends exist and how strong they may be. Identification of trends, and in particular, trends associated with landscape or land use, will be helpful in determining viable mitigation measures.

Fecal Coliforms

During the 2003 monitoring period, five sites were sampled for fecal coliforms analysis: Secret Ravine at Miners Ravine (#6), Miners Ravine at Secret Ravine (#7), Antelope Creek at Atlantic (#8), Cirby Creek at Dry Creek (#9) and Dry Creek at Rio Linda Blvd.. Samples were taken during the second quarter (April), third quarter (July), and first flush (Nov) monitoring events. During April, all samples were less than 200 colonies/100 mL (water quality standard, geometric mean), with Dry Creek and Cirby Creek having the highest counts (170 colonies/mL for both). During July, all counts exceeded the procedure maximum (>1600 colonies/100mL) and water quality standard maximum (400 colonies/100mL in any one sample) except for Antelope Creek, which had only 8.0 colonies/100mL. The November first flush samples all exceeded the procedure maximum and water quality standard maximum, except for Secret Ravine at Miners Ravine (#6), which measured 350 colonies/100mL. It is likely that low April counts are, in part, due to higher flows (dilution) and, potentially, a previously flushed system.

Populations contributing to high fecal loads cannot be determined without DNA analysis. However, non detailed sampling (increased frequency, more locations) could help pinpoint primary sources and effects of land use.

Table 2.25. Constituents of Concern Detected in First Flush Sampling

Table 2.25. Constituents of Concern Detected in First Flush Sampling (continued)

Other Studies

Other studies have been conducted but are not reviewed in this report.

- Garcia and Associates – Linda Creek Storm Water Quality Monitoring 2003 to 2006
- Additional DCC Studies – Linda Creek pH (2002), Barrington Hills Sediment Study (2002), DWR-USRP (2001, 2002) pre-restoration sampling for a portion of Dry Creek.

2.2.4.6.6 Bioassessment

Biological indicators are important measures of water quality, in terms of aquatic life support. A healthy environment is often characterized by the presence of sensitive species and a diverse community (although natural physical conditions can also limit these factors). The few bioassessment studies that have been conducted within the watershed seem to indicate the system is impaired for supporting aquatic life. Three studies, a Rapid Bioassessment (benthic macroinvertebrates), a sediment toxicity (H*yalella*), and aquatic toxicity study (Rainbow trout embryos and *Ceriodaphnia*) all show impaired responses. However, due to the wide variation in values, statistically significant differences are not indicated in most cases.

Rapid Bioassessment

The Rapid Bioassessment was completed for four sites in 2000, ten sites in 2001 and twelve sites in 2002. After completion of sample processing, the taxonomic data were entered into an MS Excel workbook supplied by the CDFG Water Pollution Control Laboratory to calculate the 24 biological metrics identified using the California Stream Bioassessment Procedure (CSBP) (California Department of Fish and Game, 2002) for evaluation of the benthic macroinvertebrate (BMI) community. These metrics describe the community in terms of species richness or total taxa, community diversity, counts of specific Orders/Families, and the feeding group function in the community. Increasing or decreasing values for these metrics will help illuminate whether the system is degraded/impacted or improving/degrading.

The CSBP (California Department of Fish and Game, 2002) is used to determine the general health of a stream (watershed program) and/or as a tool to estimate the damage to the BMI community in a stream/river after an incident (spill of chemical/sediment type event). When assessing the amount of damage and/or recovery of the benthic community, reference sites in similar non-impacted watersheds are selected for comparison to the test sites. The DCCMG studies are a watershed assessment; no reference sites were selected or sampled. Areas of point source impacts, which may degrade the benthic community, have not been programmatically sampled. Comparison of sites within the watershed may not be relevant due to habitat differences at the stream sampling locations (e.g., gradient or elevation differences) even though there are corresponding upstream and downstream samples.

Even though no reference sites were sampled or identified, examination of the BMI metrics for the Dry Creek watershed is useful in providing an indication of potential

impairment. Generally, impairment is indicated when comparison of metrics between sites indicate decreases or increases in a particular metric as defined by California Deparment of Fish and Game (2002):

- Taxa Richness — Decreases
- Percent Dominant Taxon — Increases
- Ephemeroptera, Plecoptera, Trichoptera (EPT) Index — Decreases
- Sensitive EPT Index — Decreases
- Shannon Diversity Index — Decreases
- Tolerance Value — Increases
- Percent Intolerant Organisms — Decreases
- Percent Tolerant Organisms — Increases
- Percent Collectors — Increases
- Percent Filterers — Increases
- Percent Shreders — Decreases

The biological metrics for the Dry Creek watershed benthic macroinvertebrate sites are reported in Table 2.26. The BMI metrics indicate a system with a benthic community composed of intermediate tolerant taxa.

An interesting note is the lack of Intolerant organisms, stonefly, and Shredder taxa, at all sites in the study. Only the Secret Ravine sites had any stonefly taxa (main Shredder taxa in this watershed) in the samples. The stonefly (Plecoptera) taxa are intolerant taxa with Tolerance Values from 0 to 2, where Tolerance Value is a weighted average of relative of individual tolerance scores. Tolerance scores range 0 (intolerant) to 10 (tolerant) based on the organisms' ability to survive in varying habitat conditions. Shredder taxa are not limited to the Plecoptera; however, no taxa in the entire Shredder guild were collected at most sites. Shredder taxa comprised less than one percent of the community at sites where they were found (Clover Valley Creek, Antelope Creek at Kings Road, Secret and Miners Ravines near their confluence, and the upstream Linda Creek site).

Linda Creek, the most downstream tributary, appears to have the highest Tolerance Value, least number of Intolerant taxa, the lowest taxa richness, and a low Shannon Diversity Index (SDI) compared to the other tributaries.

The Dry Creek sites are in an urban area and have similar metric values compared to the major tributaries. The two Dry Creek sites were not sampled during the same sampling periods; the upstream site was sampled in 2000 and 2001, and the lowest downstream site was sampled in 2002. The site at Royer Park had lower Tolerance values than most upstream sites in 2000 and 2001. Taxa richness was also within the range of the upstream sites.

Miners and Secret Ravines had similar metric values; however, Secret Ravine at Sierra College had the highest Taxa Richness and Shannon Diversity Index (SDI) values of all sites surveyed in 2001 and 2002. The lower Secret Ravine site had higher Taxa Richness and SDI values than the adjacent Miners Ravine site. The Miners Ravine site at Secret Ravine had the lowest SDI of all sites in 2001 but a higher taxa richness value than the upstream site upstream of Cottonwood Dam.

Table 2.26

The Antelope Creek downstream site had higher Taxa Richness and SDI values compared to the upstream site at Kings Road in 2001; but, they were lower than values for the upstream site in 2002. The Clover Valley Creek sites had similar metric values to those of the Antelope Creek sites.

Historically, these streams were probably intermittent in the summer and fall; however, these streams are now likely to be dominated by nuisance flows or discharge from treatment facilities during the summer and fall.

Consistent sampling of sites from year to year would improve the data set for this study and allow a better evaluation of the watershed. Upstream and downstream sites in the proximity to all water treatment facilities, water diversions and impoundments could improve this study to document any effects caused by these facilities. This study was conducted in conjunction with a study by the CVRWQCB, who sampled sites near the waste water treatment facilities. Incorporating CVRWQCB data with DCC data would improve evaluation of the watershed conditions.

Sediment Toxicity

As a component of a larger study, a sediment toxicity study in Secret Ravine was conducted by the University of California at Davis (U.C. Davis) in cooperation with the Univeristy of California at Santa Barabara (U.C. Santa Barbara) and the Dry Creek Conservancy. Funding was provided from the Coastal Ecotoxicology Program (Fong et al., 2003). In December, 2002, five sites along Secret Ravine were sampled for sediment to conduct a 10-day static renewal sediment toxicity test using *Hyalella asteca*, a sediment amphipod. The five sites sampled included:

- Confluence of Secret Ravine and Miners Ravine
- Secret Ravine at Secret Court
- Secret Ravine at Dias Lane
- Secret Ravine at King Road
- Secret Ravine at Rock Springs Road

No statistically significant differences were found due to wide variation in data and single samples at each site. However, the mortality in samples with Secret Ravine sediment was 15.1-53.7% higher than in the controls.

Sediment was analyzed for heavy metals that might indicate higher mortality rates. Total nickel concentration was less than levels known to have an adverse effect on *Hyalella*. Cadmium concentration was below detection limits. No toxicity risk information was available for either Chromium or Silver. However, Copper, Zinc, and Lead concentration all exceeded reported LC_{50} (lethal concentration killing at 50% of the organisms) value for *Hyalella*.

Recomendation

Programmatic follow-up toxicity testing is recommended to determine the extent and constituents contributing to sediment toxicity in the watershed.

Aquatic Toxicity

California Regional Water Quality Control Board

The California Central Valley Regional Water Quality Control Board conducted Rainbow trout embryo and *Ceriodaphnia* toxicity tests on water sampled from the Dry Creek at Walerga Road during a November (1997) first flush storm event and January (1998) storm event (California Regonal Water Quality Control Board Central Valley Region, 1999). These tests compare the mortality of the organism in study water compared to control water. *Ceriodaphnia* toxicity was only assessed during 1997. There was a 100% mortality with the Dry Creek water from this event. Addition of piperonyl butoxide (PBO) resulted in a significant reduction in mortality. PBO is added to the sample to reduce the effects of any organophosphate pesticides that may be in the sample. A reduction in deaths with the addition of PBO suggested that the *Ceriodaphnia* in untreated water were dying due to high levels of organophosphate pesticide. Samples were analyzed for both chlorpyrifos and diazinon. Chlorpyrifos concentrations were close to the manufacturer's 90% mortality levels (49 monograms/liter ng/L and 55 ng/L, respectively) and diazinon came close to the California Department of Fish and Game chronic aquatic life support level (36.6 ng/L and 40 ng/L, respectively). Both of these pesticides are expected to have a cumulative effect on aquatic life because of their similar nature. Dry Creek showed a significant toxicity effect on Rainbow trout embryos during the 1997 event; however, no toxic effect was noted for the 1998 event. It is likely that many toxins were flushed away by storms prior to the 1998 event, rendering Dry Creek water less toxic for that sample.

Pacific EcoRisk

As part of the NPDES permit toxicity testing for the Placer WWTP on Miners Ravine, toxicity of ambient receiving water, upstream of the WWTP, was also tested in March, 2003 (Pacific EcoRisk, 2003). Three toxicity tests were conducted: 96-hour algal growth (*Selenastrum capricornutum*), 3-brood (6-8 day) survival and reproduction test with the crustacean *Ceriodaphnia dubia*, and 7-day survival and growth with larval fathead minnows (*Pimephales promelas*). Preliminary results indicated complete mortality in receiving water wtihin 24 hours for both the 3-brood and 7-day survival tests. Further analysis indicated heavy metals, in particular, zinc, were likely causes of this toxicity.

Recomendation

Programmatic follow-up toxicity testing is recommended to determine the extent and constituents contributing to water toxicity in the watershed.

2.2.5 Biological Resources

Biological resources comprise an important component of the Dry Creek watershed ecology. Maintaining the biological integrity is a necessary aspect of managing for watershed health and functions. The following section reviews studies of biological

resources, conducted within the watershed, and provides a description and inventory of known resources as follows:

- Vegetation
- Wildlife
- Fisheries
- Special Status Species
- Non-native Invasive Plant Species

2.2.5.1 Vegetation

Vegetation refers to all the plant species in a region and the way that they are arranged (Sawyer and Keeler-Wolf 1995), and is often described by 'type'. Describing vegetation by 'type' (based on the individual species' needs as similar, and therefore, those certain assemblages of species will be found together), versus by 'community' (where some of the species are believed to have obligatory/mutualistic relationships) has been the subject of considerable argument in the past few decades. More recent studies have indicated that the composition of plant species in a given area has mostly to do with each plant species' individual requirements for moisture, temperature, and other environmental factors, and little to do with any specific dependence of one species on any other (Ornduff *et al* 2003). Additionally, the boundary lines of plant communities may vary based on methodology used, researcher bias, and other subjective factors. Therefore, the current trend is toward the use of vegetation types (Sawyer and Keeler-Wolf 1995).

Vegetation 'type' description is often the preferable method because it can describe the general look of an area, species that occur in that type, which species are dominant, and other factors. These descriptive terms provide more information as to what the dominant plants are, and they provide an image of what the whole area looks like.

Practical reasons also exist for recognizing vegetation types as a basis for discussing the plant life of the watershed. Understanding and identifying vegetation types can be used in: planning future development, identifying areas for preservation, demonstrating relationships between soils and vegetation, and others. Identifying vegetation types can also provide information on what types of animal species will be present in a given area, the health of the habitat, and the presence of non-native or invasive species.

Although vegetation type is classified by the name or names of dominant plant species, such as live oak, deergrass, or cattail, the lines for these vegetation types are not strongly defined. Transitional boundaries or gradients exist where plants from two or more vegetation types occur in the same area.

A compiled list of the plant species found in the watershed is included in Appendix 2.5. Very generally, there are three four types of vegetation present within the watershed: wetland, grasslands, woodlands, and riparian areas. All of these have been impacted significantly by humans.

2.2.5.1.1 Biotic and Abiotic Factors Influencing Vegetation

A partial list of biotic and abiotic factors that influence vegetation type include (Ornduff *et al.,* 2003):

- Soils (physical and chemical properties)
- Nutrient status
- Moisture regime/available water
- Salinity
- Topography (slope, aspect, elevation)
- Climate (wind, sunlight, temperature, precipitation)
- Fire
- Microbiological community (fungi and bacteria)
- Meso/Macrobiological community (grazers, pollinators, etc.)
- Seed dispersal strategy
- Plant competition (moisture, shade, allelopathy, parasites, mutualism, etc.)

All of these factors can be seen contributing to the types of vegetation found in the Dry Creek watershed.

2.2.5.1.2 Effects of Past and Present Land Uses on Vegetation

Grasslands have been greatly impacted by the introduction of cattle and sheep husbandry. Heavy, year round grazing began with 200 cattle at the first mission in San Diego and the number of cattle in California soon grew into the millions (Pavilk *et al.* 1991). This unmanaged grazing was favorable for the invasion and spread of annual non-native grass species. Continuous grazing of the native perennial grasses weakens them. Additionally, grazers will often preferentially forage on perennial native grasses in the summer because they remain green. Annual, non-native grasses sprout, grow, and set seed quickly, allowing them to take over the grazed perennial native grasses.

The presence of cattle also had, and in some cases is still having, several lasting impacts on oak woodlands. Oak trees were often completely cleared from grazing land because the practice was thought to increase range capacity. Grazing on young oak seedlings is believed to be one of the reasons that oak regeneration has been poor (McCreary 2001). The importation of cattle also created a large tanning industry, which harvested tan oak trees in such quantities that some botanists predicted that these species would become extinct (Pavilk *et al*. 1991).

Another event that had a large effect on the oak woodlands was the gold rush. In 1849, tens of thousands of men came to California. The clear-cutting of oaks occurred throughout the territory as the influx of settlers created large demands for energy and charcoal. Later, millions of acres of oak-covered land were cleared for farms and orchards in the Sacramento, San Joaquin, Santa Clara, Salinas, and San Gabriel valleys. Today, oak woodlands continue to be cleared for development, orchards, farming, fuel, timber, and range improvement.

Riparian areas have also been significantly altered by human activities. With development of the watershed, flood control became a high priority along the waterways.

Riparian forests were rapidly demolished as floodplains were graded and artificial levees were constructed. Within this century, more then 70% of all riparian forests in the Central Valley were cleared for orchards of stone fruits, olives, almonds, pears and a wide variety of vegetables (Pavilk *et al.* 1991).

Riparian areas can also be damaged by grazing. This is not just a localized effect, but also impacts everything downstream, including fish, wildlife, and people who use the water for recreational purposes (AgResearch, 1999). Typical problems caused by livestock grazing in riparian areas are foul-smelling and foul-tasting water with excessive weed or algal growth, sedimentation, decline in stream aquatic life, trampling or erosion of stream banks, increased run-off from banks into water, and damage to riparian vegetation (Federal Interagency Stream Restoration Working Group (FISRWG), 1998). Fecal material from these populations increases nutrient loads, and the concurrent reduction of mid- and over-story plants due to grazing decreases shade and increases water temperature. A combination of these factors can result in low dissolved oxygen and, therefore, fish support constraints (FISRWG 1998).

Most of California's wetland habitats have been altered or lost due to human impacts. California has lost nearly 99 percent of its wetlands, and 90 to 95 percent of all vernal pools are gone (U.S. EPA, 1995). Many original wetlands have been drained and converted to farmland. Activities resulting in continued wetland loss and degradation include agriculture, commercial and residential development, road construction, and resource extraction. Wetland loss in the Dry Creek watershed reflects overall state trends.

2.2.5.1.3 Benefits and Functions of Vegetation

Native vegetation is a vital part of ecological systems that provides important services, such as soil regeneration, pollination, recycling of oxygen and nutrients, food sources and cover for wildlife, and purification of air and water. Vegetation prevents land degradation by reducing the risk of erosion, salination, acidification and structural breakdown, and it is a major influence on the nutrient balance of soils, soil microfauna, and agricultural productivity. Healthy soils contribute to maintenance of good water quality and the associated native vegetation provides unique protection for native wildlife, as it is their natural habitat. Vegetation assemblages provide habitat for endemic species, a vital component of biodiversity.

Grasslands are important for nutrient cycling, carbon sequestration, watershed health, wildlife habitat, soil stabilization, and a source of biodiversity. Riparian land is usually the most fertile and productive part of the landscape, in terms of both primary production and ecosystems. It often has better quality soils than the surrounding hillsides, and because of its position lower in the landscape, often retains moisture over a longer period. Consequently, riparian land generally supports a higher diversity of plants and animals than does non-riparian land. Many native plants are found only, or primarily, in riparian areas. These areas are essential to many animals for all or part of their lifecycles because of their wide range of habitats and food types, proximity to water, microclimate and ability to provide refuge in extreme events, such as drought or fire. Riparian vegetation also regulates in-stream primary production through shading; supplies energy and nutrients (in the form of litter, fruits, terrestrial insects and other organic matter)

essential to aquatic organisms; and provides essential aquatic habitat by supplying large and small woody debris in streams.

2.2.5.1.4 General Vegetation/Habitat Types

Following are general descriptions of the vegetation/habitat types that occur in the watershed. The next section deals with the detailed classification of these types. General environmental conditions and constraints determine the vegetation type. For example, vernal pool-type vegetation only occurs on particular soils in the watershed ,and blue oak-savannah occurs where the soil is nutrient poor and water is less available. Conversely, riparian vegetation occurs in valleys, where creeks and rivers are present, providing water throughout the year.

Aquatic/Wetland Types

Intermittent/Ephemeral Drainage

Intermittent or ephemeral drainages are characterized by a defined bed and bank with a distinct high-water level. They convey flows during storm events, but, standing water generally does not persist, except in areas where deeper pools form. These types of drainages are largely unvegetated, due to the scouring effects of fast flowing water; however, hydrophytic vegetation may be prevalent at the upper edges of the drainage.

Seasonal Wetland

These are topographic depressions that follow a hydrological cycle of ponding/saturation during the winter and early spring and then a drying down phase in late spring and summer. A variety of plants and wildlife can be found within seasonal wetlands. “Drier” seasonal wetlands are dominated by low-growing grasses and annual herbs including perennial ryegrass (*Lolium perenne*), Mediterranean barley (*Hordeum marinum*), and hyssop loosestrife (*Lythrum hyssopifolium*). “Wetter” seasonal wetlands are dominated by species such as prostrate knotweed (*Polygonum arenastrum*), Baltic rush (*Juncus balticus*), annual rabbit-foot grass (*Polypogon monspeliensis*), and creeping spikerush (*Eleocharis macrostachya*).

Seasonal Wetland Swale

Seasonal wetland swales are ephemerally wet linear features where runoff accumulates from adjacent upland areas into topographic swales, and then is further directed into larger creeks and streams. The vegetative composition of the wetland swales is primarily composed of non-native wetland generalist plants but may also include native annual species such as: Italian ryegrass, Mediterranean barley, annual hairgrass (*Deschampsia danthonioides*), hyssop loosestrife (*Lythrum hyssopifolium*), and little quaking grass (*Briza minor*).

Vernal Pool

Vernal pools occur as isolated basins within the grassland community. These features are typically underlain with an impervious layer. They become saturated and inundated

during the wet season, but are dry during the summer. The vernal pool plant community is generally made up of native annual species specifically adapted to the seasonal conditions; whereas, the seasonal wetland plant community generally consists of a mixture of native and non-native plant species. Vernal pool species observed in the watershed include slender popcorn flower (*Plagiobothrys stipitatus*), dwarf woolly heads (*Psilocarphus brevissimus*), Solano downingia (*Downingia ornatissima*), bractless hedgehyssop (*Gratiola ebracteata*), and Fremont's goldfields (*Lasthenia fremontii*).

Seasonal Marsh

Seasonal marshes may be isolated basins or areas adjacent to creeks and streams that pool water during the wet season. By evaporation through the late spring and summer months, the water level drops and a fringe of wetland vegetation becomes established at the upper edges of the marsh. Depending upon depth of the feature, the deepest portions of the marsh may be unvegetated. Plants within the seasonal marsh are typical seasonal wetland and moist soil species such as creeping spikerush (*Eleocharis macrostachya*), hyssop loosestrife, smartweed (*Polygonum* spp.), rough cockle-bur (*Xanthium strumarium*), annual rabbit-foot grass, and sticktight (*Bidens frondosa*).

Perennial Marsh

Perennial marsh differs from seasonal marsh because it holds water year round. Usually there is a significant component of open water. Dominant vegetation within perennial marshes include species which require extended periods of inundation and/or saturation, such as cattails (*Typha spp.*), tule (*Scirpus* spp.) mosquito fern (*Azolla filiculoides*), spikerush (*Eleocharis macrostachya*), joint paspalum (*Paspalum distichum*), and Baltic rush (*Juncus balticus*).

Seep

Seeps are characterized by the presence of ground water which percolates to the surface. Inundation may or may not occur, but the area remains saturated for most of the year, depending upon seasonal rainfall. Seeps also provide habitat for a variety of endemic plant and animal species. Species that may be present in seeps include annual rabbit-foot grass (*Polypogon monspeliensis*), creeping spikerush (*Eleocharis macrostachya*), field mint (*Menthe arvensis*), pennyroyal (*Menthe eulogium*), and hairy willow-herb (*Polonium ciliate*). When inundated, seeps may provide habitat for aquatic invertebrates and amphibians and can be particularly important for wildlife during the summer months when other seasonal wetland habitats dry up.

Riparian Types

Riparian Woodland

The riparian woodland is composed of a canopy of mature trees, an intermediate shrub layer, and herbaceous ground-cover. This stratified community provides important elements for life cycle completion of many wildlife species and acts as important migration corridor for a variety of wildlife in addition to providing forage and cover.

Upland Types

Oak Woodland and Oak Savanah

Within the oak woodland habitat designation are two distinct communities, a) the oak savannah and b) the oak woodland. The savannah is an intermediate condition between the non-native grassland, which is a treeless plain, and the oak woodland, where the tree canopy is nearly closed.

Annual Grassland Types

The annual grassland community is composed primarily of non-native naturalized Mediterranean grasses. These include: ripgut brome (*Bromus diandrus*), soft brome (*Bromus hordeaceus*), wild oats (*Avena fatua*), ryegrass (*Lolium multiflorum*), Mediterranean barley (*Hordeum marinum*), and medusahead grass (*Taeniatherum caput-medusae*). Other herbaceous species in this community may include: bur clover (*Medicago polymorpha*), filaree (*Erodium botrys*), clover (*Trifolium* spp.), blue dicks (*Dichelostemma capitatum*), spikeweed (*Hemizonia fitchii*), and yellow-star thistle (*Centaurea solstitialis*).

Perennial Grassland Types

It is commonly believed that the California perennial grassland was dominated by purple needle grass (*Nassella pulchra*) (formerly *Stipa pulchra*). Other native California perennial grasses associated with *Nassella* may have included: blue wildrye (*Elymus glaucus*), slender wheatgrass (*Elymus triticoides*), Idaho fescue (*Festuca idahoensis*), June grass (*Koeleria micrantha*), California oniongrass (*Melica californica*), and deer grass (Munz, 1974; Lathrop and Thorne, 1985). Changes in the watershed grasslands are believed to be due to invasion by alien plant species, changes in the kinds of herbivores and their grazing patterns, cultivation of crops, and fire protection and prevention (California Rangelands Research and Information Center, 2003).

Remnants of California's native perennial grasslands are present within the watershed. However, in the highly urbanized portions of the watershed they can be difficult to find. Small stands of purple needle grass have been found growing in the Secret Ravine and Miners Ravine subwatersheds, as well as in a larger area along Linda Creek in Sacramento County. Smaller areas of other native grasses, including deer grass (*Muhlenbergia rigens*) and meadow barley *(Hordeum branchyantherum,* have been found in isolated areas within the watershed.

2.2.5.1.5 Vegetation Classification Systems

Starting in the first half of the twentieth century, botanists began to classify vegetation complexes. These efforts included the Wieslander Vegetation Type Map Survey of California, and the identification of 29 plant communities within 11 vegetation types identified by Munz and Keck (Sawyer and Keeler-Wolf, 1995). Since then, many other classification systems have been created. Each of these efforts has attempted to summarize information about vegetation for different reasons such as vegetation types as indicators of ecosystem type and health or identification of rare vegetation types for

conservation purposes. Three of these systems have been used to identify vegetation types within the Dry Creek watershed. A comparison of these types is provided in Table 2.27.

California Wildlife-Habitat Relationship System

A system intended to classify California wildlife habitats was developed in the early 1980s. The California Wildlife-Habitat Relationship System (CWHR) is intended to identify existing vegetation types important to wildlife, and to use them to provide credibility to wildlife analyses and resource management decisions (Mayer and Laudenslayer, 1988). This system also contains some non-native vegetation types, agricultural types, and developed habitats not treated in other classifications. Placer County has contracted to have the western portion of the county mapped using a modified version of CWHR (i.e., the Placer County Wildlife Habitat Relationship System, PCWHR). Those data are depicted in Figure 2.22 and Table 2.28 lists the CWHR types that do occur, or have the potential to occur, in the Dry Creek watershed.
Descriptions of these types can be found in Appendix 2.6.

California Natural Diversity Database Natural Communities of California (Holland)

In 1986, Holland prepared an in-depth assessment of California vegetation to accurately identify the majority of the state's biota and to allow for the identification and conservation of rare natural communities (Ornduff et al., 2003). This system is a more refined version of Cheatham and Haller's classification system for the University natural reserves (Sawyer and Keeler-Wolf, 1995). Holland's system correlates types briefly with their site factor, characteristic species, and distribution (Holland, 1986). The following types (Table 2.29) do occur or have the potential to occur in the Dry Creek watershed:

The full descriptions of these types can be found in Appendix 2.7.

Table 2.27. Examples of California Wildlife Habitat Relationship Vegetation Types Cross-Indexed with Holland and California Native Plant

Figure 2.22 Vegetation Map

Table 2.28. California Wildlife Habitat Relationship Vegetation and Land Cover Types Occurring in the Dry Creek Watershed.

Type	Description
Aquatic – Open Water	
WL	Lacustrine - Lakes/Reservoirs (generally greater than 1 acre in size)
WR	Riverine - Rivers and Creeks (only mapped if large enough to delineate accurately on the photographs)
Barren	
BR	Barren (Cliffs, rock outcrops)
BD	Disturbed Lands (Landfills, Graded lands-Non agricultural)
Herbaceous	
HA	Annual Grassland
HP	Pasture - Irrigated
HW	Fresh Emergent Wetland
HS	Seasonal Wetland
VP	Vernal Pool (individual vernal pool >0.5 acre in size-only mapped if not included in previous mapping and not within a complex)
VC	Vernal Pool Complex: VCh (High) vernal pool density >7% VCm (Medium) vernal pool density 4-7% VCl (Low) vernal pool density <3%
Shrub	
SC	Foothill Chaparral
Forested	
FR	Riparian
FH	Foothill Hardwood - includes where signatures are distinguishable: FHV Valley Oak Woodland FHB Blue Oak Woodland FHL Interior Live Oak
FOP	Oak-Foothill Pine
FS	Oak Woodland-Savanna (low density oak woodland/savanna mix <= 5 'large' trees per acre)
FP	Ponderosa Pine
FE	Eucalyptus
Agricultural	
AA	Alfalfa
AP	Pasture
AO	Orchards
AU	Unidentified Croplands (includes plowed, idle)
Urban	
US	Urban/Suburban (>1 unit / acre)
UR	Rural-residential (0.1 – 1.0 unit / acre; less than 70% canopy cover of large trees)
URF	Rural-residential Forested (0.1-1.0 unit/acre plus 70-90% canopy cover of large trees)
UP	Urban Parks (includes isolated city parks: playgrounds, grass fields, etc)
UG	Golf Courses
UT	Urban riparian (includes internal riparian areas such as greenbelts, most often surrounded by residential/urban development)
UF	Urban woodland (includes city parks with predominantly woodland type vegetation and windbreaks with mostly non-native trees)
UW	Urban wetland (includes vernal pools, seasonal wetlands, and emergent marshes surrounded by urban uses)

Table 2.28. California Wildlife Habitat Relationship Vegetation and Land Cover Types Occurring in the Dry Creek Watershed. (continued)

Type	Description
Small-Patch Ecosystems	
XW	Springs and Seeps
XP	Stock Ponds (less than 1 acre)
XL	Landscape and Golf Course Ponds (less than 1 acre)
Special Geologic Formations and Soils	
MR	Mehrten Formation Soils

Table 2.29. California Natural Diversity Database Natural Communities Occurring in the Dry Creek Watershed.

Element Name (Type)	Element Code
Blue Oak Woodland	71140
Buttonbush Scrub	63430
Coastal and Valley Freshwater Marsh	52410
Elderberry Savanna	63440
Great Valley Cottonwood Riparian Forest	61410
Great Valley Mixed Riparian Forest	61420
Great Valley Valley Oak Riparian Forest	61430
Great Valley Willow Scrub	63410
Interior Live Oak Chaparral	37A00
Interior Live Oak Woodland	71150
Non-native Grassland	42200
Northern Claypan Vernal Pool	44120
Northern Hardpan Vernal Pool	44110
Northern Volcanic Mudflow Vernal Pool	44132
Tamarisk Scrub	63810
Valley Needle Grassland	42110
Valley Oak Woodland	71130
Valley Wildrye Grassland	42140
White Alder Riparian Forest	61510

California Native Plant Society

The California Native Plant Society (CNPS) has developed very detailed descriptions of vegetation types, with a focus on the identification of all types present in California and an emphasis on rare habitats that may go unidentified in other classification systems (Sawyer and Keeler-Wolf, 1995). This protocol uses *A Manual of California Vegetation* (MCV) (Sawyer and Keeler-Wolf, 1995) as the basis for the vegetation types. In this system, each type is a series that is further divided into associations depending on the understory species variation within the series. It is expected that new series will be identified as vegetation is assessed in the field.

This method of identifying vegetation types was selected by ECORP to conduct an assessment of vegetation within the watershed (adjacent to the creeks). Assessment in

the field was done using the CNPS Vegetation Rapid Assessment Protocol developed by the CNPS vegetation committee (November 5, 2001). This methodology allows for a quick, yet informational, assessment that includes information on dominant tree, shrub, and herbaceous species, in addition to recording non-native species, anthropogenic impacts, and topography. Time and financial constraints only allowed a very small portion of the watershed to be assessed by ECORP, but because of the detailed information it provides, it would be a worthwhile endeavor to continue (see Appendix 2.8 for the data sheets). The following series found in the MCV may be found in the watershed (Table 2.30) and a full description of the series can be found in Appendix 2.9.

Table 2.30. Manual of California Vegetation Series Occurring, and/or Expected to Occur in the Dry Creek Watershed

Status	Description	General Habitat
Expected	arroyo willow series	Riparian
Expected	black oak series	Oak Woodland
Expected	black willow series	Riparian
Observed	blue oak series	Oak Woodland
Expected	bulrush series	Wetland
Expected	bulrush-cattail series	Wetland
Expected	buttonbush series	Riparian
Expected	California annual grassland series	Grassland
Expected	California buckeye series	Oak Woodland
Expected	California sycamore	Riparian
Expected	California walnut series	Riparian
Expected	cattail series	Wetland
Expected	coyote brush series	Oak Woodland
Expected	duckweed series	Wetland
Expected	eucalyptus series	Oak Woodland/Riparian
Expected	foothill needlegrass series	Grassland
Expected	foothill pine series	Oak Woodland
Observed	Freemont cottonwood series	Riparian
Expected	giant reed series	Riparian
Observed	interior live oak series	Oak Woodland
Expected	Mexican elderberry series	Oak Woodland/Riparian
Observed	mixed oak series	Oak Woodland
Observed	mixed willow series	Riparian
Expected	mulefat series	Oak Woodland
Expected	narrowleaf willow series	Riparian
Expected	northern claypan vernal pools	Grassland
Expected	northern hardpan vernal pools	Grassland
Expected	northern volcanic mudflow vernal pools	Grassland
Expected	pampas grass series	Riparian
Expected	pondweeds with floating weeds series	Wetland
Expected	pondweeds with submerged leaves series	Wetland
Expected	purple needlegrass series	Grassland
Expected	quillwort series	Wetland
Expected	red willow series	Riparian
Expected	sandbar willow series	Riparian
Expected	scrub oak series	Oak Woodland
Expected	sedge series	Riparian/Wetland
Expected	spikerush series	Wetland
Observed	Valley oak series	Riparian/Oak Woodland
Expected	wedgeleaf ceanothus series	Oak Woodland
Observed	white alder series	Riparian

2.2.5.2 Wildlife

The Dry Creek Watershed is composed of a variety of general vegetation/habitat types, such as wetland, riparian, oak woodland, and annual grassland. Each complex represents varying degrees of suitable habitat for a variety of wildlife within the region, including several special-status species (see section 2.2.5.4).

2.2.5.2.1 Habitat Types

Seasonal Wetlands and Vernal Pools

Typical wildlife associated with vernal pools include various aquatic invertebrates and amphibians, such as the Pacific chorus frog (*Pseudacris regilla*). On occasion, birds, including mallard (*Anas platyrhynchos*), cinnamon teal (*Anas cyanoptera*), and greater yellowlegs (*Tringa melanoleuca*), may forage and/or rest within seasonal wetlands or vernal pools. In addition to providing a unique habitat for plant species, vernal pools in the Central Valley, they provide potential habitat for a number of vernal pool invertebrate species, including two that are federally-listed: the vernal pool fairy shrimp (*Branchinecta lynchi*) and vernal pool tadpole shrimp, (*Lepidurus packardi*).

Seasonal Marsh/Perennial Marsh/Stock Ponds

Many wildlife species are likely to use these habitats throughout the year, including: great egret (*Ardea alba*), great blue heron (*A. herodias*), belted kingfisher (*Ceryle alcyon*), bullfrog (*Rana catesbeiana*), and Pacific chorus frog. Warmwater fish species, such as largemouth bass (*Micropterus salmoides*) and green sunfish (*Lepomis cyanellus*), may also be present.

Riparian Habitat

The riparian woodland is composed of a canopy of mature trees, an intermediate shrub layer, and herbaceous ground-cover. This stratified community provides important elements for life cycle completion of many wildlife species, and acts as a important migration corridor for a variety of wildlife in addition to providing forage and cover.

The riparian complexes in this region typically support a wide variety of wildlife species, including Bewick's wren (*Thryomanes bewickii*), downy woodpecker (*Picoides pubescens*), golden-crowned sparrow (*Zonotrichia atricapilla*), wood duck (*Aix sponsa*), red-shouldered hawk (*Buteo lineatus*), great horned owl (*Bubo virginianus*), and tree swallow (*Tachycineta bicolor).* Several bat species could also occur within the riparian areas. The western red bat (*Lasiurus blossevilii)* is a riparian obligate that will roost on tree bark and is less commonly found in this area. Mexican free-tailed bats (*Tadaria brasiliensis*), Yuma myotis (*Myotis yumanensis*), and big brown bats (*Eptesicus fuscus*) are common species that prefer bridges and other structures, but may also roost in tree cavities or hollow trunks.

The understory scrub community provides nesting habitat for wrentit, Bewick's wren, song sparrow, and California towhee. Resident and migratory songbirds such as hermit thrush (*Catharus guttatus*), Bewick's wren (*Thryomanes bewickii*), fox sparrow

(*Passerella iliaca*), and spotted towhee (*Pipilo maculatus*), also use the willow scrub community for foraging and nesting cover.

Other wildlife species observed within the riparian communities include: Pacific chorus frog (*Pseudacris regilla*), common garter snake (*Thamnophis sirtalis*), western gray squirrel (*Sciurus griseus*), raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and Virginia opossum (*Didelphis virginiana*), Virginia opossum mule deer (*Odocoileus hemionus*), striped skunk (*Mephitis mephitis*), beaver (*Castor canadensis*), and raccoon (*Procyon lotor*).

Oak Woodland/Savannah

The oak woodland and oak savannah provide for a number of important wildlife needs, including food, cover, shade, roosting, and breeding sites. Acorns are preferred or essential food items in the diets of acorn woodpecker (*Melanerpes formicivorus*), western scrub-jay (*Aphelocoma californica*), western gray squirrel (*Sciurus griseus*), and many other species. Insects found in association with oak foliage and bark also attract insectivorous birds such as, yellow-rumped warbler (*Dendroica coronata*) and Hutton's vireo (*Vireo huttoni*). Larger, dead, and/or decaying trees provide nesting sites for cavity-nesting birds such as American kestrel (*Falco sparverius*), western bluebird (*Sialia mexicana*), tree swallow (*Tachycineta bicolor*), and white-breasted nuthatch (*Sitta carolinensis*).

Wildlife species observed within the oak woodland community include many birds such as American kestrel, acorn woodpecker (*Melanerpes formicivorus*), yellow-billed magpie (*Pica nuttallii*), western bluebird, and oak titmouse (*Baeolophus inornatus*), California Kingsnake (*Lampropeltis getulus*), and coyote (*Canis latrans*). Other wildlife species that may be found in the oak woodland include pacific chorus frog (*Pseudacris regilla*), western fence lizard (*Sceloporus occidentalis*), sharptail snake (*Contia tenuis*), Mexican free tailed bat (*Tadaria brasiliensis*), big brown bat (*Eptesicus fusus*), pallid bat (*Antrozous pallidus*) and striped racer (*Masticophis lateralis*).

Grassland

The annual grassland habitat supports a modest diversity of wildlife species. Small mammals present include California vole (*Microtus californicus*), black-tailed jackrabbit (*Lepus californicus*), deer mouse (*Peromyscus maniculatus*), and pocket gopher (*Thomomys* spp.). These mammals represent potential foraging items for predators such as northern harrier (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*), white-tailed kite (*Elanus leucurus*), Swainsons Hawk, gopher snake (*Pituophis catenifer*), western rattlesnake (*Crotalus viridus*), and coyote (*Canis latrans*). Birds that may find the grasslands suitable for nesting include the horned lark (*Eremophila alpestris*) and western meadowlark (*Sturnella neglecta*). Other birds, which do not necessarily nest within the grasslands but may forage in this habitat, include Brewer's blackbirds (*Euphagus cyanocephalus*) and tricolored blackbird (*Agelaius tricolor*).

2.2.5.2.2 Wildlife Studies

UC Davis Study

In 1993, students from U.C. Davis (Hendersen *et al* 1993) conducted a study to "identify and quantify resident birds and mammals in the Dry Creek riparian habitat of northern Sacramento County". Their study focused on bird and mammal species.

Three Great Valley-Valley Oak Riparian Forest (Holland 1986) sites were selected within the mainstem Dry Creek riparian corridor. Site 1 was approximately 35 meter (m) downstream of the Elverta Road bridge at Cherry Island Golf Course to 270 m downstream (southwest). Site 2 was 30 m downstream of the golf cart bridge (immediately southwest of site 1) to 270 m downstream. Site 3 covered 270 linear m along the bicycle path adjacent to Rio Linda Airport. The sites were selected primarily based on accessibility.

Bird Sampling

Strip transects were 270 m long with a width equal to the vegetation corridor width. Sampling was conducted twice on two consecutive mornings at sites 1 and 2, and once at site 3. Birds were identified and counted (by sight and/or song) within the strip for three minutes at each of 10 stations along the transect. The transect path followed an established trail that paralleled the creek bank at each site. Birds identified outside of the sampling time or space, but using the riparian forest, were recorded separately.

Mammal Sampling

A small mammal trap-line was established through the riparian corridor at each site, composed of 35 stations with two Sherman live traps per station (70 traps total). Stations were approximately 5 m apart and targeted typical riparian vegetation. Traps were set at dusk and examined the following morning. Trapping was conducted twice on two consecutive nights ("trap nights") at all sites.

Three to four predator scent stations were also established at each site in order to identify mammalian carnivores by track impressions. Stations were placed throughout the corridor on bare patches of sandy soil. The soil surface was smoothed into a 2-m circumference and a partially opened cat food can was positioned in the midpoint as an attractant. Stations were activated at dusk and checked the next morning. Scent station visitors were identified by tracks imprinted within the 2-m circumference.

Results

Thirty avian species and ten mammalian species were identified in Dry Creek's riparian habitat. Some of the birds were: scrub jay, mourning dove, Anna's hummingbird, bushtit, Bewick's wren, American robin, golden-crowned sparrow, house finch, great horned owl, red-shouldered hawk, northern flicker, yellow-bellied

magpie, and Ring-necked pheasant. A portion of the mammals identified included: *Reithrodontomys megalotis* (Western harvest mouse), *Microtus californicus* (California vole), *Mus musculus* (house mouse), *Peromyscus maniculatus* (deer mouse), *Rattus rattus* (black rat), *Lutra Canadensis* (river otter), *Procyon lotor* (raccoon), and *Canis* spp., *Sciurus griseus* (Western gray squirrel), and *Lepus californicus* (blacktail jackrabbit).

Discussion

Tracks between C. *latrans* (coyote) and C. *familiaris* (domestic dog) could not be distinquished. However, the surrounding urban area and frequent encounters with dogs in the riparian zone suggest that these tracks were C. *familiaris*. The presence of *Lutra Canadensis* (river otter) is likely primarily a function of the stream's perennial flow and intact crayfish population (Hiehle, personal communication).

Dry Creek's diverse bird community reflects its habitat richness and value. The resident avifauna represents numerous feeding guilds including insectivores, granivores, piscivores, carnivores, and herbivores. Additionally, presence of red-shouldered hawk and great horned owl indicate that the Dry Creek riparian forest may function as important raptor nesting, roosting, and foraging habitat.

This inventory provides a limited avian and mammalian composition of the Dry Creek riparian habitat. Logistic constraints limited the number and size of sample sites and time restricted the number of replications. Furthermore, comprehensively assessing wildlife habitat relies partly on seasonal inventory replication. The migratory nature of many bird species, as well as seasonal movements in mammals, requires that meaningful inventories encompass breeding and non-breeding seasons. Consequently, it is suggested that subsequent biological samplingbe undertaken (especially in spring), to account for the seasonality and dynamism of natural communities, be completed. However, as of fall, 2003, no additional seasonal sampling has occurred.

ECORP Studies

ECORP biologists have been working in the Dry Creek watershed since the late 1980s, and from field observations they have compiled the following list (Table 2.31) of wildlife species observed within the watershed.

Table 2.31. Wildlife Observed

Table 2.31. Wildlife Observed (Continued)

Table 2.31. Wildlife Observed (Continued)

Table 2.31. Wildlife Observed (Continued)

2.2.5.3 Fisheries

The Dry Creek watershed supports resident native and introduced fish populations, as well as annual runs of Chinook salmon and steelhead. Historical usage of Dry Creek by anadromous salmonids prior to urbanization and development of the Natomas East Main Drainage Canal (NEMDC, a.k.a., Steelhead Creek) is largely unknown; however, since the 1960's the annual run size of the fall run Chinook salmon has experienced a ten-fold decline. Currently, anadromous species present in Dry Creek include Pacific lamprey (*Lampetra tridentata*), Central Valley fall-run Evolutionarily Significant Unit (ESU) Chinook salmon (*Oncorhynchus tshawytscha*), and Central Valley ESU steelhead (*O. mykiss*). The Central Valley ESU steelhead is federally-listed by the National Marine Fisheries Service (NMFS) under the Endangered Species Act (ESA) as threatened, and the Dry Creek watershed is designated as critical habitat for Central Valley ESU steelhead. The Central Valley ESU fall-run Chinook salmon is not federally-listed under the ESA, but is considered a candidate species for future listing. Additionally an anadromous salmonid often receives a degree of special-status protection. The Pacific lamprey is not currently federally-listed, but is receiving more attention by fisheries scientists and federal and state agencies due to dwindling populations and run sizes throughout the Central Valley.

Special-status fish species (e.g., Sacramento splittail (*Pogonichthys macrolepidotus*) and Delta smelt (*Hypomesus transpacificus*)), other than the anadromous salmonids, may occasionally be present in the lowest portion of the Dry Creek watershed, particularly in Steelhead Creek. In particular, the NEMDC likely contains suitable spawning habitat for the splittail; however, the Sacramento splittail was recently delisted as a federally-threatened specie. Anadromous salmonids, steelhead and fall-run Chinook salmon, are both seasonally present during adult upstream and juvenile downstream migration periods.

The California Department of Fish and Game (CDFG) has conducted periodic Chinook salmon spawning escapement (migration out of the watershed) surveys in Dry Creek, primarily upstream of the confluences with Secret and Miners ravines, at least as far back as 1963. The fall-run Chinook salmon escapement to the Dry Creek watershed was estimated to be just over one thousand fish in 1964, with the majority of spawning occurring in Secret and Miners Ravines. Since the late 1990's, Chinook salmon escapement to Secret Ravine alone has averaged about 160 fish per year.

The CDFG Native Anadromous Fish and Watershed Branch initiated a reconnaissance level assessment of steelhead distribution and abundance, relative to stream habitat conditions, in 1998 and 1999. At that time, steelhead escapement to the upper Dry Creek watershed was estimated to be a few hundred fish, with the most suitable spawning and rearing habitat in Secret Ravine and to a lesser extent, Miners Ravine. Juvenile salmonid emigration monitoring was also conducted by the CDFG in 1999 and 2000. Steelhead and Chinook salmon juveniles were collected during both years in screw traps located immediately below the confluence of Secret and Miners ravines.

Annual spawner surveys were conducted by the DCC between the end of October and December for the years 1997 through 2002 (Dry Creek Conservancy, personal communication). Sampling effort and number of stations increased over the survey

period. Overall, one station was located on each Dry Creek and Antelope Creek, two stations were located on Miners Ravine, and five stations on Secret Ravine. No fish were observed during surveys conducted in January and February 2002. Linda/Cirby Creek was sampled by Garcia and Associates during the 2001-2002 surveys and results were combined for each year. The highest number of salmon (live and carcasses) were found in Secret Ravine, ranging from 15 (1997) to 298 (2002) live fish and 5 (1997, 1998) to 125 (2000) carcasses. Miners Ravine had the second highest observed fish counts, ranging from 8 (1998) to 74 (2002) live fish and 0 (1998) to 18 (2001) carcasses. The other sections surveyed (Antelope and Linda/Cirby Creeks) had lower fish counts, indicating less utilization by salmon populations.

The CDFG historically planted about 100,000 juvenile Chinook salmon from the Feather River hatchery (fall-run) each spring in lower Miners Ravine during years of excess production. At present, a resident rainbow trout population is thought to be present in upper sections of Secret Ravine and other headwaters of the Dry Creek watershed.

Seven species of resident fish were collected by Vanicek (1993) in his surveys of Dry Creek. Four of these species are native, including Pacific lamprey, Sacramento pikeminnow (*Ptychocheilus grandis*), hitch (*Lavinia exilicauda*), and Sacramento sucker (*Catostomus occidentalis*). Three are introduced game species, including bluegill (*Lepomis macrochirus*), green sunfish (*L. cyanellus*), and spotted bass (*Micropterus punctulatus*). Sampling conducted for the Cirby-Linda-Dry Creek Flood Control Project (GANDA 1998) identified the presence of additional introduced species, such as brown bullhead (*Ameiurus nebulosus*), western mosquitofish (*Gambusia affinis*), and golden shiner (*Notemigonus crysoleucas*). More recent non-published surveys have indicated a broader non-native fish community, primarily downstream of the confluence of Secret and Miners ravines, including species such as the common carp (*Cyprinus carpio*), largemouth bass (*M. salmoides*), black bullhead (*Ameiurus melas*), and fathead minnow (*Pimephales promelas*). A list of non-native fish species that have been found in Dry Creek is presented as Table 2.32.

The following section describes the life history of fish present within the Dry Creek watershed. Life histories are important for developing strategies to manage or control populations effectively.

2.2.5.3.1 Life History Summaries

Native Anadromous Species

Pacific lamprey (Lampetra tridentata)

The Pacific lamprey, a parasitic anadromous species, was historically abundant in the Sacramento-San Joaquin River basin. They are still largely present throughout the basin, except where migration is blocked by dams or degraded stream conditions; however, migratory populations have declined. The Pacific lamprey remains common in the American River (up to Nimbus Dam), the Sacramento River (up to Red Bluff Dam), and in the Napa River. Adults migrate from the Pacific Ocean to natal spawning

Table 2.32. Non-Native Fish Species Present, and Effects Upon Salmon

Table 2.32. Non-Native Fish Species Present, and Effects Upon Salmon (Continued)

streams, generally from March through June, but may occur as early as January in Dry Creek, due to its low elevation and historically warm, low flow conditions by June. Similar to salmon and steelhead, spawning occurs in riffle areas in swift current, and often many nests are found in close proximity. Both sexes construct the nest in gravel and occasionally sandy substrates, in water depths usually less than 1 m. The diameter of the nest is about 40 to 60 cm (Moyle 1976). Eggs are slightly adhesive and most are washed into the crevices of the rocks on the downstream side of the nest. Hatching occurs in about 19 days at 15 ^{o}C. Often, the eggs of other native species, particularly Sacramento sucker, are observed in lamprey nests. The newly hatched ammocoetes (larval/juvenile life stage) remain for a short time in the crevices of the rocks, but eventually swim up into the current. Ammocoetes are then carried downstream to suitable areas of soft mud and sand, to coarse sand. They generally burrow tail first into the substrate, but may lie on top of the substrate, and move from one place to another. Ammocoetes are filter feeders, subsisting on algae and organic matter, and may remain in freshwater from 5 to 7 years. Metamorphosis into the predatory adult stage results in formation of a sucker disc, large eyes, and other physiological changes, such as the ability to tolerate seawater. Downstream migration begins when metamorphosis is complete and is thought to occur mostly in winter and spring during elevated flow events.

Chinook salmon (Oncorhynchus tshawytscha)

Chinook salmon are anadromous, spending three to five years at sea before returning to freshwater to spawn. Central Valley ESUs of Chinook salmon pass through the Sacramento River and Delta to reach their upstream spawning grounds. Juvenile "smolt" salmon also use the Sacramento River and Delta as a migration corridor to reach the Pacific Ocean. Smoltification is the physiological acclimation of juvenile salmon to full strength seawater that occurs after completion of the freshwater rearing phase. The Chinook salmon population in the Sacramento River and Delta is composed of four races: fall-run, late fall-run, spring-run and winter-run. Each of these spawning populations is separated based on the timing of adult upstream migration, spawning, and juvenile downstream migration. The Central Valley ESU winter-run is federally listed as endangered (58 FR 33212) and the Central Valley ESU spring-run is federally listed as threatened (64 FR 50393). Neither of these races is present in Dry Creek. However the candidate Central Valley ESU fall-run is present. Upstream spawning migration of adults and downstream migration of juvenile steelhead and Chinook salmon generally occur after October 15 and prior to June 15. Consequently, most construction activities that may potentially affect instream habitat conditions, and that are permitted by the U.S. Army Corps of Engineers and National Marine Fisheries Service (NMFS), take place between June 15 and October 15.

Fall-run Chinook salmon may enter the American River, and its tributaries (e.g., Dry Creek), from mid-September through January. Peak upstream migration generally occurs from mid-October through December, though spawning may occur from mid-October through February. Fall-run Chinook salmon exhibit “ocean type” behavior, in which adult salmon spawn immediately upon entering the spawning tributary. This strategy is in contrast to “stream type” behavior, in which the sexual products (eggs and sperm) become mature while the fish is in the stream environment (e.g., winter-run and spring-run Chinook salmon). Adults of all races of Chinook salmon die soon after spawning. The range of water temperatures for optimal survival of incubating eggs is

between 6.1 and 14.4 ^{o}C (43 and 58°F). Fall-run Chinook salmon fry are known to emerge from the American River (and from Dry Creek) spawning gravels from January through mid-April. They rear to smoltification in the American River from January through mid-July, leaving freshwater habitat within their first year of life. Data collected by CDFG in 1999 and 2000 indicate that emigration of juvenile Chinook salmon smolts in Secret Ravine largely occurs from February through June, with peak emigration occurring from March through May.

Steelhead (Oncorhynchus mykiss)

Steelhead populations in the Central Valley ESU have been listed by the National Marine Fisheries Service (NMFS) under the ESA (FR 62, No. 159) as threatened. Dry Creek is designated by NMFS as critical habitat for the Central Valley ESU steelhead. Steelhead, the anadromous form of rainbow trout, historically inhabited most tributaries to the Sacramento River, including Dry Creek. The life history of steelhead is similar to that of Chinook salmon with two major differences. First, steelhead do not necessarily die after spawning, thus maintaining their ability to return to the Pacific Ocean after spawning in freshwater. Second, juvenile steelhead may spend up to four years rearing in freshwater prior to emigrating to the ocean as smolts. Typically, juvenile steelhead emigrate as age class 1+ fish (one year in fresh water), through the Sacramento River and the Sacramento-San Joaquin Estuary, from November through May. Juvenile steelhead emigration from Dry Creek largely occurs from late March through May.

Spawning steelhead require gravel or cobble substrate (0.6 to 13 cm diameter) in which they lay their eggs. Fine sediments (e.g., silt, fine sand, and clay) may suffocate eggs by preventing the transport of dissolved oxygen from the water to the eggs. Generally, steelhead eggs require temperatures of less than 16.1^{o}C (61°F) for successful hatching. Both fry and older juveniles require instream object cover, cobble or boulders, large woody debris, undercut banks, or submerged and overhanging vegetation, for protection against predators.

Native Resident Species

Sacramento sucker (Catostomus occidentalis)

The Sacramento sucker is a species widely distributed throughout the Sacramento-San Joaquin drainage and is common to Dry Creek. The Sacramento sucker is found in a wide variety of water temperatures from cold Sierran streams to warm tributaries and sloughs in the Central Valley rangin from 15.6 to 32.2 ^{o}C (60 to 90 ^{o}F). They are most abundant in clear, cool streams and rivers, and in lakes and reservoirs at moderate elevations (200 to 600 m). Adults are most abundant in larger streams; juveniles are often most abundant in tributary streams or shallow reaches of large streams where adults have previously spawned. Suckers often congregate at the mouths of streams prior to the spawning migration, and they begin movement into spawning streams as early as late December. The trigger for spawning is thought to be sudden warming of inflowing creeks after a series of warm days. Most spawning takes place over gravel riffles between late February and early June, with peak spawning between March and

April. Preferred spawning temperatures range from 12.8 to 18.9 ^{o}C (55 to 66°F). The fertilized eggs adhere to gravel or bits of debris. Larval suckers (<14 mm) concentrate over detritus or among emergent vegetation in warm, protected stream margins. Juvenile suckers (<50 mm) remain close to the stream bottom, foraging in shallow (20-60 cm), slow-moving (<10 cm/sec) waters along stream margins.

The Sacramento sucker is one of several species of native fish species that has thrived despite sometimes dramatic changes in Central Valley watersheds. Sacramento sucker are quick to recolonize areas that previously contained unsuitable habitat during severe drought conditions, and have often done so within a year of return to normal flow.

Sacramento pikeminnow (Ptychocheilus grandis)

The Sacramento pikeminnow, like the Sacramento sucker, is found throughout the Sacramento-San Joaquin River system, and both species are most often found together and with other native fish species. They are most common in low to mid-elevation streams with deep pools and slow-moving run habitat, and with undercut banks and overhanging vegetation. They generally prefer summer water temperatures ranging from 20 to 30 ^{o}C (68 to 86°F).

Sacramento pikeminnow are a top predator and feed throughout the water column on fish near the surface or midwater and on epibenthic organisms, such as crawfish. Before the introduction of other predatory fishes such as the largemouth and spotted bass, large pikeminnows were at the top of the aquatic food chain, particularly in the lower tributaries to the Sacramento and San Joaquin rivers.

Pikeminnows are long lived and slow growing; they are well adapted to persist through periods of extended drought when reproductive success is low. This species spawns annually; however, they will not spawn in years when conditions are unfavorable. Upstream spawning migration occurs during April and May with males arriving first when water temperatures range from 15.6 to 22.7 ^{o}C (60 to 72°F). The Sacramento pikeminnow prefers to spawn over gravel riffles or shallow pool tailouts. Individuals that are resident in small to medium size streams typically move to nearby riffles to spawn; however, long migration runs (over 100 km) have been reported in larger rivers such as the Sacramento River. Juvenile pikeminnow may disperse widely in their first year of life, colonizing stream reaches that were previously unsuitable due to drought, dewatering, or other adverse conditions. Sacramento pikeminnow populations appear to be relatively stable in the Central Valley, except for localized areas where largemouth and spotted bass have become dominant.

Hitch (Lavinia exilicauda)

The hitch, a member of the minnow family, is native to the Sacramento-San Joaquin basin and is sometimes locally common in portions of Dry Creek. Hitch are found in warm, low-elevation lakes, sloughs, and slow-moving stretches of river, and in clear, low-gradient streams. They prefer cool, clear, sandy-bottomed streams, and are generally absent or found in low abundance in channelized streams with aggradation of silt and turbid water conditions. Hitch have the highest temperature tolerance among all native fishes in the Central Valley, and can tolerate acclimated temperatures up to 32.2 ^{o}C

(90°F). Spawning takes place mainly in riffles during spring rains. Hitch appear to select clean, fine to medium gravel, and water temperatures of 14.4 to 20 ^{o}C (58 to 68°F). Spawning generally occurs en masse, where the eggs and sperm are broadcast into the water column, and the fertilized eggs sink into interstitial spaces among the gravels.

Hitch are not aggressive swimmers, and their migrations can be impeded by small dams and other instream structures. Populations of this species appear to be declining throughout the Central Valley, and it has been recommended by fisheries scientists that their populations be monitored to ensure that special protective action is applied, if necessary.

Sacramento splittail (Pogonicthys macrolepidotus)

The Sacramento splittail was determined by the US Fish and Wildlife Service to be federally threatened (FR vol 64, No. 25, February 8, 1999); however, it was recently delisted (FR vol 68, No. 183, September 22, 2003). Historically, this species was abundant throughout the Central Valley, but presently is restricted to the tidal sloughs and slow-moving waters of the Delta, Suisun Bay, Napa Marsh, the lower Sacramento River and its tributaries, and lower reaches of the American and Feather rivers. Adult and juvenile splittail may occur in the lowermost portion of Dry Creek from December to July. Habitat preference data indicate an association of Sacramento splittail with shallow-water habitat and low salinity, particularly during spawning. Splittail presence in Dry Creek is currently unknown. The decline of the splittail populations throughout its range is thought to be associated with reduced Delta outflow, increased Delta diversions, and habitat degradation.

Delta smelt (Hypomesus transpacificus)

The delta smelt is a migratory, plankton-feeding fish native to San Francisco Bay and the Sacramento-San Joaquin estuary. This species is tolerant of a wide range of salinities, but is primarily found in brackish to freshwater habitats. Prior to spawning, adults congregate in brackish water downstream of the entrapment zone (an area of freshwater and sea water mixing where phytoplankton and zooplankton productivity is high), typically in San Pablo or Suisun bays. Adults migrate upstream to freshwater river channels and sloughs to spawn. Larvae are transported downstream to the area of the entrapment zone. Year class strength is generally dominated by the extent of the entrapment zone.

Historically, delta smelt were among the most abundant species in the Estuary; however, the population declined dramatically from 1983 through 1991, resulting in its federal listing as a threatened species (58 FR, 5 March 1993). Recent declines in abundance are thought to be associated with reduced Delta outflow and food supply, and from increased Delta diversions. Critical habitat for the Delta smelt occurs in the Sacramento-San Joaquin estuary upstream of the Benicia-Martinez Bridge.

Non-Native Resident Species

Green sunfish (Lepomis cyanellus)

The green sunfish is usually closely associated with aquatic plants, or other types of dense cover. Optimal water temperature for adult and juvenile sunfish has been reported to be 27.9 ^{o}C (82.8°F). If possible, green sunfish will avoid temperatures above 31 ^{o}C (87.8 °F) and below 26 ^{o}C (78.8°F). Dissolved oxygen levels are presumed to be optimal at levels greater than 5.0 ppm, and lethal levels are less than 1.5 ppm. Green sunfish abundance is positively correlated with moderate turbidities (25 to 100 Jackson Turbidity Units (JTU)).

Green sunfish usually spawn in May and June, beginning when water temperatures exceed 19.9 ^{o}C (66°F). They prefer sand and gravel as a spawning substrate. Nests are generally built at depths from 4.6 to 35 cm (0.15 to 1.15 feet). Optimal temperatures for spawning and embryo development range from 20 to 26.7 ^{o}C (68 to 80°F). The upper and lower temperature limits for spawning are 31 and 19 ^{o}C (87.8 and 66.2°F), respectively. For fry, optimal temperatures range from 18 to 26 ^{o}C (64.4 to 78.8°F). In stream environments, fry seeks areas with velocities less than 0.08 meters per second (mps) (0.26 feet per second (fps)), preferably, 0.05 mps (0.16 fps). The diet of green sunfish consists of larger invertebrates and small fish.

Redear sunfish (Lepomis microlophus)

Redear sunfish typically inhabit ponds, lakes, and river backwaters with water depths greater than 1.8 meters (m) (6 feet) and abundant aquatic vegetation. Redear sunfish spawn throughout the summer at temperatures from 22.2 to 23.9 ^{o}C (72 to 75°F). Redear sunfish will use sand, gravel, or mud to build their nest. Spawning usually occurs at depths of 1.8 to 3.0 m (6 to 10 feet). Other life history requirements are similar to those listed for green sunfish. The diet of redear sunfish consists of snails and other bottom dwelling invertebrates.

Bluegill (Lepomis macrochirus)

Bluegill live primarily in lakes, ponds, sloughs, and other quiet water habitats. They are often associated with rooted aquatic plants in which they take shelter and feed. Bluegill can live in a wide range of temperatures and dissolved oxygen levels, but optimal growth occurs at water temperatures between 22 to 32 ^{o}C (71.6 and 89.6°F) and dissolved oxygen levels from 4 to 8 ppm. Bluegill are spring spawners, with preferred spawning temperatures between 16.9 and 21.1 ^{o}C (62.5 and 70°F). The nest is built in shallow water, with spawning substrates of gravel, sand, or mud. After emerging from the nest, young bluegill typically move into shallow water with aquatic plant beds that serve as cover. As bluegill fry grow (approximately 1.3 cm in length), they move out into deeper water and feed on zooplankton near the surface. After six or seven weeks, they return to aquatic plant beds along the shoreline. Bluegill are opportunistic predators and will feed on plankton, insects, other invertebrates, and small fish.

Largemouth bass (Micropterus salmoides)

Largemouth bass live primarily in lakes and ponds, or in very low velocity pools, and backwater habitat in rivers. This species prefers water velocities less than 0.06 mps (0.2 fps), and does not tolerate velocities above 0.2 mps (0.66 fps). Largemouth bass are often associated with aquatic plants or other types of submerged structures in which they can hide and ambush their prey. Juvenile and adult largemouth bass feed on large invertebrates and smaller fish. Because largemouth bass are sight feeders, they prefer relatively clear water, with suspended solids (turbidity) less than 25 ppm.

Optimal growth temperatures for largemouth bass is between 23.9 and 30 ^{o}C (75 and 86°F). Growth is reduced at temperatures below 15 and about 36 ^{o}C (59 and above 97°F). Dissolved oxygen levels above 8.0 parts per million (ppm) are considered optimal. Growth is reduced at dissolved oxygen levels below 4.0 ppm.

Water temperatures for spawning and incubation are considered optimal between 20 and 21.1 ^{o}C (68 and 70°F), although a range of 12.8 to 26.1 ^{o}C (55 to 79°F) is acceptable. Largemouth bass spawn on a variety of substrates, including gravel (the preferred substrate), sand, mud, roots, and vegetation. Largemouth bass prefer to spawn at depths of 0.9 to 1.8 m (3 to 6 feet), in relatively stable water levels. The incubation period of largemouth bass eggs is influenced by water temperature. Incubation ranges from approximately 1.5 days at 30 ^{o}C (86°F) to 13 days at 10 ^{o}C (50°F). For young bass (fry), optimal conditions are shallow, warm water (26.7 to 30 ^{o}C; 80 to 86°F) with abundant cover in the form of aquatic vegetation and/or woody debris.

Spotted bass (Micropterus punctulatus)

The spotted bass has similar requirements to largemouth bass but it tends to be more successful than the largemouth or smallmouth bass in streams like Dry Creek (i.e., moderate sized, clear, low-gradient streams). The spotted bass appears to prefer swifter water conditions, and can often be found in otherwise typical (other than the warmer water temperatures) trout habitat, such as at the heads of pools and in pool tailouts throughout the lower portion of Dry Creek. Spotted bass prefer spawning temperatures around 14.4 to 15.6 ^{o}C (58 to 60°F) in late March and April, and summer temperatures ranging from 23.9 to 31.1 ^{o}C (75 to 88°F). These conditions are similar to the lower portions of Dry Creek (downstream from the confluences with Secret and Miners ravines). Spotted bass tend to avoid stream sections with winter water temperatures below 10 ^{o}C (50 °F), such as those that occur commonly during winter in the upper tributaries of Dry Creek, particularly in Secret Ravine. Spotted bass are likely the most important predator on Chinook salmon fry and smolts.

Brown bullhead (Ameiurus nebulosus)

The brown bullhead is the most widely distributed member of the catfish family in California, partially as a result of illegal introductions into lakes, and it is most abundant in habitats that have been altered by human activity. This species has quickly become overpopulated in many water bodies in California, resulting in adverse impacts on native fish species.

This species was introduced to California in 1874 and is well established throughout the Sacramento-San Joaquin River system due to its ability to adapt to a wide variety of habitats, from warm, turbid sloughs to clear mountain lakes. In streams such as Dry Creek, brown bullhead are found mainly in low-gradient, slow-moving reaches and are closely associated with deep pools, high water turbidity, aquatic plant beds, and soft substrates. They can tolerate temperatures from nearly freezing to over 35 ^{o}C (95°F), but optimum temperatures range from 20 to 32.2 ^{o}C (68 to 90°F). The brown bullhead spawning season in California is from May through mid-July, and is usually initiated when water temperatures reach 21.1 ^{o}C (70°F). Spawning brown bullhead build nests in depressions in sand or gravel, in close proximity to instream cover. When the nest is completed, eggs are laid in batches.

Black bullhead (Ameiurus melas)

Black bullhead, like the brown bullhead, have been widely introduced into California waters and typically inhabit ponds, lakes, reservoirs, and pool or backwater areas of streams and rivers. During the day, adult bullhead are generally closely associated with aquatic plants or other types of cover. Black bullhead are extremely temperature tolerant, withstanding temperatures up to 35 ^{o}C (95°F). Black bullhead spawn in the spring when water temperatures exceed 20 ^{o}C (68°F). Preferred substrates and spawning depths are not well documented. The black bullhead diet consists of aquatic insects, crustaceans, mollusks, and occasionally fish. Similar to the brown bullhead, introductions of this species have resulted in adverse impacts on native fish species.

Golden shiner (Notemigonus crysoleucas)

The golden shiner is the most popular baitfish in California. This species has become widely distributed in California since its introduction in 1955. Golden shiner, illegally introduced to high mountain lakes by live-bait anglers, have been known to out-compete young of the year trout and other native fish species.

Golden shiner primarily occupies warm, shallow streams, where they are associated with beds of aquatic vegetation. They can tolerate temperatures up to 35 ^{o}C (95°F), and are often most abundant in low-elevation sloughs with other introduced fishes. Golden shiners occasionally become established in coldwater reaches but are likely to persist only if warm, shallow areas are available for breeding and rearing of young. Golden shiner spawning season extends from March through September in California, which coincides with warmer water temperatures. Spawning is initiated when water temperature reaches about 21.1 ^{o}C (70°F).

Fathead minnow (Pimephales promelas)

The fathead minnow was introduced into California by California Department of Fish and Game (CDFG) as a forage and bait species, and they are well established in the Sacramento-San Joaquin River basin. This species is an aggressive invader that is still expanding its range, posing an increasing threat to native fishes, especially native minnows.

The fathead minnow can survive in a wide variety of habitats, but they prefer pools of small, muddy streams or ponds where other fish are scarce. They can tolerate temperatures up to 32.8 ^{o}C (91°F), but their preferred range is 21.1 to 22.8 ^{o}C (70 to 73°F). They have high reproductive rates, and they tend to overpopulate temporary aquatic habitats. Fathead minnows have the ability to spawn repeatedly throughout the summer once the water temperature exceeds 15 ^{o}C (59°F), although reproduction becomes less frequent at higher temperatures and ceases at 32.2 ^{o}C (90°F). Males are highly territorial and will defend a wide variety of objects (e.g., large stones, boards, branches, root masses, water lilies, old tires, or vertical stakes) as their spawning ground at water depths of 30 to 90 cm (1.0 to 2.0 feet).

Western mosquitofish (Gambusia affinis)

Western mosquitofish are native to central North America, in watersheds tributary to the Gulf of Mexico. Western mosquitofish were introduced to California in 1922 from Texas and have since spread throughout California.

Western mosquitofish survive in a wide range of environmental conditions. They are particularly well adapted to shallow, often stagnant, ponds and along the shallow edges of lakes and streams. They tolerate temperatures of 0.6 to well over 37.8^{o}C (33 to 100°F); but their optimal temperature range is from 10 to 35 ^{o}C (50 to 95°F). They are also capable of withstanding extreme daily temperature fluctuations that commonly occur in shallow-water habitats; however they generally cannot withstand prolonged exposure to cold water temperatures (less than 3.9 ^{o}C or 39°F). In California, mosquitofish can reproduce up to four times a year; however, two generations per year are most typical in the Central Valley. Females store sperm, and eggs may be fertilized from several copulations. The early life stages take place inside the female, although developing young are mainly dependent on the yolk sac for nutrition. The young are expelled by the female, usually in very shallow water or among aquatic vegetation.

The western mosquitofish was brought to California to control mosquitoes. Having been introduced to most low and mid-elevation streams, this species is probably the most widespread freshwater fish in the state. While they serve as an important mosquito abatement technique, they compete with native fish species, especially at the larval stage. In addition, their omnivorous nature can alter food webs in small bodies of water by reducing populations of invertebrate predators and grazers.

Common carp (Cyprinus carpio)

A native to Asia, the common carp was introduced to California waters in 1872, and is common in reservoirs and streams in the Sacramento-San Joaquin river drainage. Common carp are most abundant in warm, turbid streams, with deep, permanent pool habitat, and reservoirs at low elevations. However, they are also found in trout streams and some coldwater reservoirs at high altitudes. Large woody debris and other vegetative cover is vital to carp in areas where the water is clear. Juveniles prefer deep pools, but will move to shallow areas if there are dense beds of submerged aquatic vegetation. Common carp are active at water temperatures from 3.9 to 23.9 ^{o}C (39 to 75°F), although their optimum temperature is in the upper range to 23.9 ^{o}C (75°F). Carp have flourished in the west due to their ability to tolerate adverse conditions. They can

withstand exceptionally high turbidity, sudden water temperature changes, high water temperatures, and low oxygen concentrations. Carp can inhabit estuaries as well as fresh water environments; although, spawning occurs only in freshwater.

Spawning takes place from spring through early summer in beds of aquatic plants, usually close to shore. Eggs are adhesive and stick to plants, tree roots, and stream bottom debris. Embryos also attach to vegetation when they hatch; and, after a week the fry move into beds of emergent and sub-emergent vegetation.

The introduction of the common carp has resulted in adverse effects to native fish species throughout California. Carp have either displaced or reduced populations of native fish throughout the Sacramento-San Joaquin river drainage, and have also been implicated in the localized destruction of shallow waterfowl habitat.

2.2.5.3.2 Fisheries Issues

A preliminary analysis of work conducted by California Department of Fish and Game (CDFG), Native Anadromous Fish and Watershed Branch (Titus unpublished), indicates that there are two general fish community and habitat types in Dry Creek. Below the confluence with Secret and Miners ravines, the fish habitat is characterized by low gradient, slow moving, water, dominated by sand/silt substrate. Water temperatures appear to be 5.6 ^{o}C (10°F) warmer than upstream of the confluence. Available fish habitat is limited to undercut banks, overhanging vegetation, and some instream woody debris. Spotted bass, Sacramento pikeminnow, and Sacramento sucker are the dominant species. Spotted bass, an important predator of juvenile salmon, and to a lesser extent, steelhead, accounts for the largest portion of fish biomass. Upstream of the confluence with Secret and Miners ravines, a broader assemblage of native fish species is present, such as the Sacramento pikeminnow, Sacramento sucker, hitch, Pacific lamprey, and juvenile steelhead. Spotted bass are not relatively abundant. Habitat is much more complex in Secret Ravine, including an abundance of pool habitat, large woody debris, and suitable gravels for spawning.

Temperature

Preliminary water temperature data collected by CDFG in 1999 and 2000 indicate that mean daily summer water temperatures above the confluence never reached 21.1 ^{o}C (70°F), a temperature level regarded as the upper limit for over-summering juvenile steelhead. This is in contrast to mean daily summer water temperatures below the confluence, which peaked to over 26.7 ^{o}C (80°F) in 1999 (considered unsuitable for over-summering steelhead). These data reflect the CDFG catch data. It should be noted that the Roseville WWTP also measured mean daily temperature of greater than 31 ^{o}C in the main stem of Dry Creek during the summer (period of record was 1998 through June, 2003).

Habitat and Cover

No steelhead were collected in electrofishing surveys below the confluence, but they were collected above the confluence. Given the increase in summer streamflows compared to historical conditions, the potential for improvement of existing juvenile

steelhead rearing habitat exists, but it appears that only the uppermost portions of Dry Creek (i.e., Secret Ravine) contain suitable conditions for steelhead production. Vanicek (1993) states, “Poor rearing conditions exist for juvenile salmon during the spring months due to the lack of cover and inadequate food producing areas (i.e., adequate habitat for aquatic insects). These habitat deficiencies also impact and restrict the resident fish populations. It is primarily in the lower reaches that these constraints occur.” He goes on to say, “It is primarily important to protect streamside vegetation because streamside vegetation provides an overhanging canopy that shades the stream and moderates water temperatures, protects banks from erosion, provides overhanging instream cover for fish, and directly contributes to the fish food supply from terrestrial sources. In addition, riparian vegetation enriches the stream’s food web by providing decomposable vegetation.”

The preliminary screw trap data show a large difference in outmigrant smolt Chinook salmon between 1999 and 2000. This is most likely due to interannual and seasonal variation in streamflow and temperature. In a relatively small watershed such as Dry Creek, and an even smaller reach where habitat conditions are suitable for spawning salmonids (i.e., Secret Ravine), timing of fall and winter storms and ambient water temperatures have a large effect on the annual upstream passage, spawning and egg incubation. Large interannual variation in salmonid production under such conditions is expected to occur.

Non-Native Invasive Species

Predation can also have a major effect on Chinook salmon and steelhead populations, especially in the lower portion of Dry Creek where spotted bass and largemouth bass are most abundant. Predation pressure is more likely focused on Chinook salmon smolts because of their small size during emigration. Chinook salmon smolts are also generally weak swimmers, in comparison to steelhead that emigrate at a larger size and are, therefore, generally not as vulnerable to predation.

Impact of Beavers on Anadromous Fish Habitat

Vanicek (1993) identified at least twelve beaver dams between Sunrise Blvd. and Sierra College Blvd. during his surveys of Dry Creek. Current locations of known beaver dams are shown in Figure 2.23. Beaver dams are beneficial to fish habitat because they contribute to creation of pool habitat (both impoundment pools behind dams, and plunge pools in front of dams) and they detain water and release it slowly, potentially assisting in maintaining and stabilizing downstream flows. This can help sustain resident fish populations that would not normally be viable during the summer months. Additional wetland habitat is created by beaver dams, potentially resulting in additional habitat values for wildlife. However, beaver dams also negatively impact fish habitat because they create barriers to fish passage (especially juvenile emigration at low flows), flood spawning sites, and elevate water temperatures.

Barriers to Fish Passage

Barriers to fish passage range include temporary beaver dams, seasonal flashboard dams, pipeline crossings, concrete dams, and natural falls, and their known locations are

presented in Figure 2.23. Temporary dams can be easily modified or removed to allow for fish passage, particularly during seasonal migration periods. The Dry Creek sewer line at the concfluence of Dry and Cirby Creeks, has recenctly undergone modifications that will improve passage conditions. There are also plans for modifying the Secret Ravine water line. Cottonwood Dam remains the largest impediment to upstream migration and blocks many miles of otherwise usable salmonid spawning and rearing habitat. Vanicek (1993) states that, "inadequate conditions exist for the upstream movement of adult salmon during the fall spawning run, due to the lack of holding pools and possibly to the presence of barriers at low flows".

Sediments and Sedimentation

Embeddedness (infilling of intersticial spaces), increased scouring (bank erosion), and potential toxicity are all potential impacts of sediment on fisheries. The summary of reach conditions in Section 2.2.6.12 (below) identifies several reaches with high sedimentation and bank erosion. Additionally, a survey of Miners Ravine found that only 12 of 87 riffles surveyed had embeddedness less than 25% (California Department of Water Resources, 2002). Generally, riffles with embeddedness greater than 20% are considered unsuitable for spawning. This survey also found that the most common substrate fractions were not cobbles and gravel, but sand, silt, and clay (51% aggregate). Sediment toxicity testing, discussed in Section 3.2.4.6.2 (Water Quality, Bioassessment), indicates potential heavy metals toxcitiy associated with sediment in Secret Ravine. Presence of sediment toxicity would greatly affect salmonid eggs and young. A recent risk assessment (below) identified sediment as the primary stressor for Chinook salmon in Secret Ravine.

2.2.5.3.3 Risk Assessment

An ecological risk assessment, for determining anthropogenic stressors on fall-run Chinook salmon in Secret Ravine, was performed by the Bren School of Enviromental Management (Ayres et al., 2003). Twelve sources and ten stressors were analyzed using a Modified Relative Risk Model and compared with stressors identified in the Stressor-Driven Risk Model. Risk is characterized by ranking effect for the Modified Relative Risk Model and by integration of stressors throughout the watershed using "percent effects" for the Stressor-Driven Risk Model. Both models identified sediment as the greatest stressor in the Secret Ravine System. However, the Modified Relative Risk Model identified flow and morphology as secondary and tertiary stressors and the Stressor-Driven Risk Model identified reduced access (barriers to fish passage and migration) and toxicity as secondary and tertiary stressors.

Although the two models did not agree upon secondary and tertiary stressors, agreement of both models on the primary stressor (sediment) indicates that sediments are, indeed, the primary stressor for fall-run Chinook salmon in Secret Ravine. The Stressor-Driven Risk Model even estimated that half of the fall-run Chinook fish mortality was due to internal stressors. Further study and analysis of source contributions is recommended to quantify impacts and to determine specific sources.

Figure 2.23. Known Potential Barriers to Fish Passage

2.2.5.3.4 Specific Creek Fisheries Habitats

These general descriptions were compiled through the review of existing data and reports, data collected for a stream habitat inventory, and ECORP biologists' knowledge of the various creeks. The methodology for the stream habitat inventory was modified from the methods section of the California Salmonid Restoration Stream Habitat Restoration Manual (Flosi and Reynolds, 1994). These data include the most basic classification of pool, riffle and run, the length of the unit, average width, maximum and average depths, substrate percentages, canopy cover, and instream fish cover (with modifiers). Data for portions of Dry Creek and Miners Ravine were collected by drawing each unit on an aerial photograph and identifying the upstream endpoint with a Garmin GPS unit. For Secret Ravine, the creek was walked and each habitat unit was documented with a Trimble Pathfinder ProXR.

Dry Creek

Dry Creek supports a relatively healthy riparian corridor, portions of which contain a largely intact floodplain upstream of Folsom Road to the confluence with Miners and Secret ravines. As Dry Creek flows through Roseville, accompanying vegetation is characterized as remnant riparian, riparian scrub, and landscaping. Upland terraces of the floodplain consist mostly of non-native grasses and remnant mixed oak woodland. Riparian trees are being planted in Dry Creek by the City of Roseville in association with the Dry Creek Reforestation Project. The object of these tree plantings is to reduce thermal loading (temperature) of Dry Creek. Accumulated sediments (e.g., silts and sands) are common as substrate throughout Dry Creek.

Dry Creek functions largely as a migration corridor for anadromous salmonids. However, the upper portion of Dry Creek, immediately below the confluence with Miners and Secret ravines, contains juvenile salmonid rearing habitat in the form of moderate pools

Sierra Creek

Anadromous salmonid habitat is generally non-existent in in this tributary to Dry Creek.

Cirby Creek

Cirby Creek is highly urbanized over its entire length. Little riparian habitat exists. Current flood control construction continues to degrade the riparian habitat. It has been reported that any potential spawning habitat has been covered over with silt and sand over many years of construction activities adjacent to the creek.

Suitable spawning habitat for anadromous salmonids is generally lacking in Cirby Creek. Juvenile rearing habitat is generally limited to the lower portion of Cirby Creek, downstream of its confluence with Linda Creek. Even in that portion of Cirby Creek, instream cover is generally lacking and rearing habitat is marginal at best.

Linda Creek

Linda Creek traverses a highly urbanized area of Roseville. Although a floodplain is generally non-existent, there are areas that could be improved to optimize habitat and flood control. Construction of the City of Roseville's flood control project is currently being completed. In general, the riparian area is dominated by ornamentals and other non-native species. In the upper reach of Linda Creek, mature oaks and mixed riparian species are the dominant vegetation. Substrate conditions in Linda Creek have largely been degraded by past construction activities. Substrates generally consist of sand/silt. In addition, there is a general lack of instream fish cover.

Anadromous salmonid habitat is limited to the lowest portion of Linda Creek, just upstream with its confluence with Cirby Creek, but is generally non-existent, especially during the low flow period.

Strap Ravine

Strap Ravine runs through the center of Roseville and, as such, instream habitat is moderately disturbed from past dredging and mining activities. Riparian resources are intermittent, but relatively healthy. Ornamentals and other non-native species are largely dominant. Substrate conditions throughout Strap Ravine are characterized as being dominated by silt and sand. However, the upper reach also contains cobbles and sandstone. Anadromous salmonid habitat is thought to be non-existent.

Antelope Creek

Antelope Creek is characterized as having varied habitat values, with large expanses of open space and urban development situated side by side. Past and ongoing construction activities adjacent to the creek have resulted in much upland disturbance. This in turn has affected instream habitat, which is generally poor to fair for aquatic resources. Aquatic habitat is low in diversity, generally consisting of flatwater (i.e., shallow run and shallow glide) habitat. Accumulated sediments are common in the lower portion of Antelope Creek. Substrate is generally sand, with occasional cobbles and exposed granite. The riparian corridor consists largely of overhanging vegetation, such as Himalayan blackberry, and remnant oak woodland. Non-native and native grassland uplands are present, as are wetland swales.

Use of Antelope Creek by anadromous salmonids is thought to occur; but, is generally considered to be limited to occasional stray adults during years of at least moderate streamflow. Barriers to fish movement are present in the form of rock dams, shallow flatwater, and beaver dams. Juvenile salmonid habitat is generally limited to shallow pool habitat during years of at least moderate streamflow.

Clover Valley Creek

Lower Clover Valley Creek is highly channelized and sometimes impounded. The stream course runs through a golf course, a public park, and adjacent to landscaped backyards. Upper Clover Valley Creek flows through oak woodland and grassland habitat. Habitat is present but is inaccessible to anadromous salmonids. A stream

channel survey and fish passage assessment Clover Valley Creek was conducted in February 2001. The survey began at the Argonaut Bridge crossing over Clover Valley Creek, immediately upstream from its confluence with Antelope Creek. The total flow of the creek passes through a culvert approximately 1.5 to 2 feet in height and about 3 feet in width, and for a distance of about 30 feet. On the downstream side, the culvert hangs over the stream channel with an approximate 2-foot drop. Adult steelhead and salmon would not be able to negotiate the flow through the culvert because of its relatively small aperture and that the flow velocity through the culvert causes the streamflow to "jet" from the culvert (i.e., velocity and force of the flowing water falls out of the culvert, describing a moderate trajectory). During flood conditions, the creek can top its banks and spill into and overflow channel, which is the golf course cart path that also passes under the Argonaut Drive Bridge. However, total stream volume and stream velocities that would occur during such an event would create unsuitable conditions for upstream passage.

The stream channel bifurcates upstream of the golf course. At the upper end of the bifurcation, water is impounded in the channel control devices on each of the two channels. This impoundment forms a large, ponded area within an existing residential development, with no provision for fish passage. In addition, the downstream channel is narrow and is heavily vegetated with willows, blackberries, and other encroaching vegetation. The eastern outflow channel is wide and shallow, with little encroaching riparian vegetation. Additional impoundments are present upstream and are barriers to upstream passage of fish.

Miners Ravine

The Miners Ravine Creek watershed is over 20 square miles in size. Habitat values in Miners Ravine range from very good to very disturbed. Past and present development practices from Granite Bay to Roseville are affecting the generally moderate instream habitat. Substrate is generally sand-dominated, with significant sand deposits in pools and along point bars. Sand, cobbles and gravels generally dominate upstream substrate. Rocky outcroppings are also present. Streamflow is perennial, varying from less than 1 cubic foot per second (cfs) during summer low flow conditions, to flood flows in excess of 3,950 cfs (1986). Miners Ravine supports a relatively healthy riparian corridor. Riparian resources range from complex riparian forest to urban landscaping. In a few reaches, the stream has been channelized with homes lining both banks. In addition, many off-stream landscaping ponds occur along the upper reaches. Native and non-native riparian scrub, including overhanging Himalayan blackberries commonly occur. Upland terraces include native and non-native grasses and oak woodland, in addition to adjacent hillside wetland/vernal pool complexes.

Habitat for anadromous salmonids is marginal. Pools and riffles are present; however, beaver dams create most of the pool habitat. Low flow conditions during summer months are a constraint to instream rearing of salmonids. Barriers to upstream fish migration are present, including rubble and debris dams and beaver dams. The most important barrier to fish migration is the Cottonwood Dam at the Hidden Valley Subdivision. This earthen dam has no fish passage facilities, and blocks upstream migration of Chinook salmon and steelhead to the highest quality spawning gravels and juvenile salmonid rearing habitat in Miners Ravine. The Moss Lane weir is also at least a

partial block to upstream migrating salmon and steelhead, and downstream dewatering has occurred during stream storage behind the weir.

False Ravine

Anadromous salmonid habitat and upstream passage is marginal at best in False Ravine and non-existent during low flow conditions.

Secret Ravine

The riparian resources of Secret Ravine range from lush, native oak overstory and mixed riparian complex, to houses with landscaped lawns extending to the stream's edge. Willows and overhanging blackberries dominate portions of the riparian community in the lower story. The upper story consists of mature cottonwoods, alders, and willows.

Secret Ravine contains some of the most suitable habitat conditions in the watershed for spawning and rearing anadromous salmonids, and suitable streamflows are present throughout the year. Riffles with gravel substrate, relatively low in fine sediments, are common in the upper reach. The gravels are smaller and less compacted than those found in Miners Ravine; also, the percentage of fine sediments is lower. In addition, there are large and deep pools, with sufficient fish cover in the form of boulders, logs, undercut banks, and surface turbulence to provide resting habitat for adult salmonids. In particular, deep pools, formed by the old concrete dams just above the confluence with Miners Ravine and just below the Rocklin city limit, provide excellent habitat for adult salmonids. Chinook salmon and steelhead require such holding habitat during their upstream migration. There appears to be adequate streamflow year-round to maintain suitable habitat. However, a recent risk assessment (Ayres et al., 2003) indicates that sediment is the primary internal stressor contributing to Chinook salmon mortality in this reach.

California Department of Fish and Game (CDFG) estimates of salmon escapement in Secret Ravine during 1963 and 1964 were 300 and 800 fish, respectively. In 1991, 72 salmon carcasses were observed in Secret Ravine, and none were observed in 1992.

Sucker Ravine

There are no data available regarding Sucker Ravine, a tributary to Secret Ravine.

2.2.5.4 Special-Status Species

The Dry Creek watershed includes potential habitat for 50 special status species. These include 12 plants, 4 invertebrates, 2 fish, 4 amphibians, 3 reptiles, 21 birds, and 4 mammals. Additionally, several species of oak (*Quercus* spp.) and other native trees are also protected.

These species usually have specific habitat requirements and are not as common as other species, due to the introduction of non-native invasive plant species, non-native

predators, direct habitat loss (to agriculture, development, grazing, etc.), and/or other pressures related to conversion of natural areas (e.g., water quality, water supply, etc.).

There are several different policies and laws under which species that are rare, declining, or are of interest, are afforded protection. Additionally, there are non-governmental organizations such as the California Native Plant Society (CNPS) that also list such species including some not covered by environmental reguations. For the purposes of this plan, the term "special-status" refers to:

- A species that is listed, or formally proposed for listing, as a threatened or endangered species, pursuant to the federal Endangered Species Act of 1973 (ESA), as amended;

- A species that is listed, or formally proposed for listing, as a threatened or endangered species pursuant to the California Endangered Species Act (CESA);

- A species that is considered a candidate for listing pursuant to ESA and/or CESA by the U. S. Fish and Wildlife Service (USFWS) and/or the California Department of Fish and Game (CDFG), respectively;

- A species that is listed by the California Native Plant Society (CNPS) on List 1[1], List 2[2], or List 4[3] (California Native Plant Society 2001).

- A species that is protected according to the Fish and Game Code of California pursuant to Section 3511 (fully protected birds), 4700 (fully protected mammals), 5050 (fully protected reptiles and amphibians);

- A species that is of expressly-stated interest to resource/regulatory agencies and/or local jurisdictions.

Table 2.33 outlines the special-status species potentially occurring in the Dry Creek Watershed. These species are those that would occur within the riparian corridor, as well as the adjacent habitats, such as oak woodland or grassland. A current report from the California Department of Fish and Game's Natural Diversity Data Base (CNDDB) is also included in Appendix 2.10. Figure 2.24 shows the locations of special status species as recorded in the CNDDB.

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1 List 1A: Plants Presumed Extinct in California
List 1B: Plants Rare, Threatened, or Endangered in California and Elsewhere

2 List 2: Plants Rare, Threatened, or Endangered in California, but More Common Elsewhere

3 List 4: Plants of Limited Distribution- A Watch List

Table 2.3. Special Status Species Potentially Occurring, and/or Expected to Occur in the Dry Creek Watershed (page 1)

Table 2.33. Special Status Species Potentially Occurring, and/or Expected to Occur in the Dry Creek Watershed (Continued 2)

Table 2.33. Special Status Species Potentially Occurring, and/or Expected to Occur in the Dry Creek Watershed (Continued 3)

Figure 2.24. Special Status Species Map (Robert)

2.2.5.4.1 Special Status Plant Species

There are 12 special status plant species that occur, or are believed to have the potential to occur in the Dry Creek watershed. They are grouped out below by general habitat type.

Woodland and Valley/Foothill Grassland Species

The following species occur in cismontane woodland and valley/foothill grassland habitats. Although populations of these three species are known to occur within Placer County, there are no known populations within the Dry Creek watershed.

Big-Scale Balsamroot

Big-scale balsamroot (*Balsamorhiza macrolepis var. macrolepis*) has no state or federal special status, but is considered a California Native Plant Society List-1B species. This species typically occurs within chaparral, cismontane woodland and valley/foothill grassland communities. Big-scale balsamroot, a perennial herb, has been documented to be present in Alameda, Butte, Colusa, Lake, Mariposa, Napa, Placer, Santa Clara, Solano, Sonoma, and Tehama Counties (California Natvie Plant Society, 2001). Flowering takes place during March through June.

Depauperate Milk-Vetch

Depauperate milk-vetch (*Astragalus pauperculus*) has no state or federal special status. However, this species is categorized by the California Native Plant Society as a List-4 species. Depauperate milk-vetch occurs within cismontane woodlands and valley/foothill grasslands often underlain with volcanic material. Populations are known to occur within Butte, Placer, Shasta, Tehama, and Yuba Counties (California Native Plant Society, 2001). Flowering occurs during March through June.

Stinkbells

Stinkbells (*Fritillaria agrestis*) is not listed under either the state or federal Endangered Species Acts. However, stinkbells are considered a California Native Plant Society List-4 species. They are documented to occur throughout California typically in chaparral, cismontane woodland, valley/foothill grassland communities, generally underlain with clay or serpentine soil (California Natvie Plant Society, 2001). This perennial herb flowers during March through June.

Vernal Pool Species

The following species occur in vernal pools in grassland habitat. Greene's Legenere and Boggs Lake Hedge Hyssop have been found in the Dry Creek Watershed, and Dwarf Downingia has been found right next to the border of the Dry Creek Watershed. The remainder have been found in Placer and Sacramento Counties.

Ahart's Dwarf Rush

Ahart's dwarf rush (*Juncus leiospermus* var. *ahartii*) is a federal species of concern and a California Native Plant Society List-1B species. This annual herb typically occurs within vernal pools and seasonal wetlands. Populations are known to occur in Butte, Calaveras, Placer, Yuba, and Sacramento Counties (California Native Plant Society, 2001). Flowering occurs during March through May.

Boggs Lake Hedge Hyssop

Boggs Lake hedge-hyssop (*Gratiola heterosepala*) has no federal special status, but is listed as an endangered species, pursuant to the California Endangered Species Act. Additionally, this plant is categorized as a List-1B species according to the California Native Plant Society. This annual herb typically occurs within vernal pools and other seasonally inundated habitats. Populations are scattered throughout California and Oregon (California Native Plant Society, 2001). Flowering occurs during April through August.

Dwarf Downingia

Dwarf downingia (*Downingia pusilla*) has no state or federal special status. However, it is considered a List-2 species by the California Native Plant Society. It is a diminutive annual species that grows in the wetter portions of vernal pools, occurring in clay soil under moist and vernally-flooded conditions. Its distribution is throughout portions of the Central Valley, Sierra Nevada foothills, and Coast Range (California Native Plant Society, 2001). Flowering occurs in March and May.

Greene's Legenere

Greene's legenere (*Legenere limosa*) is a federal species of concern and a California Native Plant Society List-1B species. This annual forb typically occurs within vernal pools and seasonal wetlands, and they have been found in scattered locations in the Sacramento Valley (California Native Plant Society, 2001). Flowering occurs during April through June.

Hoary Navarretia

Hoary navarretia (*Navarretia eriocephala*) has no state or federal special status. However, this species is categorized by the California Native Plant Society as a List-4 species. Hoary navarretia typically occurs in vernal pools within valley/foothill grasslands and cismontane woodlands. Known populations occur within Amador, El Dorado, Calaveras, Placer, and Sacramento Counties (California Native Plant Society, 2001). Flowering occurs during May through June.

Red Bluff Dwarf Rush

Red Bluff dwarf rush (*Juncus leiospermus* var. *leiospermus*) has no state or federal status. However, this species is categorized by the California Native Plant Society as a List-1B species. This species typically occurs in seasonally wet habitats including drainages and vernal pools within chaparral, woodlands, and valley/foothill grasslands. Red Bluff dwarf rush is known to occur within Butte, Shasta, and Tehama County (California Native Plant Society, 2001). Flowering occurs during March through May.

Slender Orcutt Grass

Slender Orcutt grass (*Orcuttia tenuis*) is listed as an endangered species, pursuant to the California Endangered Species Act and listed as a threatened species, pursuant to the federal Endangered Species Act. Additionally, this plant is considered a List-1B species by the California Native Plant Society. Slender Orcutt grass is known to occur in Lake, Lassen, Plumas, Sacramento, Shasta, Siskiyou, and Tehama Counties (California Native Plant Society, 2001). This annual grass occurs within vernal pools. Flowering occurs during May through October.

Sacramento Orcutt Grass

Sacramento Orcutt grass (*Orcuttia viscida*) is listed as an endangered species pursuant to the California Endangered Species Act and the federal Endangered Species Act. Additionally, this plant is considered a List-1B species by the California Native Plant Society. Sacramento Orcutt grass is known to occur only in Sacramento County (California Native Plant Society, 2001). This annual grass occurs within vernal pools. Flowering occurs during April through July.

Perennial Wetland/Stream Species

Sanford's Arrowhead

Sanford's arrowhead (*Sagittaria sanfordii*) is not listed and protected by either the state or federal Endangered Species Acts. However, it is considered a federal species of concern and a California Native Plant Society List-1B species. Sanford's arrowhead is known to occur within freshwater marshes, swamps, and ditches, and has been documented from Butte, Del Norte, Fresno, Kern, Merced, Sacramento, Shasta, San Joaquin, and Tehama Counties. It is considered extirpated from Southern California (California Native Plant Society, 2001). Flowering takes place during May through October.

Native Oaks and Other Trees

Many counties and towns have individual Tree Preservation Ordinances. Table 2.34 is a compilation of the different Tree Preservation Ordinances that occur in the Dry Creek Watershed.

Table 2.34 Native Oak and Other Tree Policies

2.2.5.4.2 Special Status Animals

There are 30 special-status animal species that occur, or are believed to have the potential to occur, in the Dry Creek watershed.

Invertebrates

There are 4 special status invertebrates that occur, or are believed to have the potential to occur, in the Dry Creek watershed. CNDDB records show that the vernal pool tadpole shrimp is the only species that has not been reported in the watershed. However, it is found in Sacramento County.

California Linderiella

The California linderiella (*Linderiella occidentalis*) is endemic to California's vernal pools and seasonal ponds. The California linderiella is not listed and protected pursuant to either state or federal Endangered Species Acts, but is considered a federal species of concern by the USFWS. California linderiella are present within seasonal ponds, vernal pools and swales during the wet season, December through May. This species ranges from Tehama County south through the Central Valley to Fresno County with disjunct populations in Mendocino and Lake Counties, south to Ventura and Santa Barbara Counties (Eriksen and Belk, 1999). They hatch from cysts during late December when water temperatures are below 20°C, more commonly at 10°C (Eriksen and Belk, 1999). *Linderiella occidentalis*, due to their tolerance for warmer water, may persist until the pools evaporate completely (Helm, 1998).

Valley Elderberry Longhorn Beetle

The Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) is federally listed as threatened under the federal ESA as threatened. The adult beetles are thought to feed on the foliage and flowers of the elderberry shrubs during March through June (Barr 1991). Females lay eggs within bark crevices or within the nodes on the elderberry shrub. The larva develops within a chamber in the pith of the stem and upon maturation and transformation to an adult, emerges through an exit hole (Barr 1991).

Valley elderberry longhorn beetle have been documented to occur within elderberry shrubs in riparian forests and adjacent grasslands (Barr 1991). Valley elderberry longhorn beetle exit holes have been found on elderberries throughout the Central Valley. According to the CNDDB, Valley elderberry longhorn beetle evidence (i.e., exit holes) have been documented to occur within the watershed.

Vernal Pool Fairy Shrimp

Vernal pool fairy shrimp (*Branchinecta lynchi*) are federally listed as a threatened species. They are known from Shasta County south through the Central Valley, with several disjunct populations in southern California. Vernal pool fairy shrimp are present within seasonal ponds, vernal pools and swales during the wet season, December through May. Pools in which vernal pool fairy shrimp are found range in size from 0.56

m^2 to over 10 hectares (Eriksen and Belk, 1999). The shrimp hatch from cysts when colder water (10°C or less) fills the pools and they mature in as few as 18 days, under optimal conditions (Eriksen and Belk, 1999). At maturity, mating takes place and cysts are dropped. If water temperatures are lowered to 10°C or less, these cysts are likely to hatch (Helm, 1998).

Vernal Pool Tadpole Shrimp

Vernal pool tadpole shrimp (*Lepidurus packardi*) are federally listed as an endangered species. They are known to range within the Central Valley from Shasta County south to Merced County, with a disjunct population in Alameda County. Vernal pool tadpole shrimp are present within seasonal ponds, vernal pools, and swales during the wet season, December through May. They hatch from cysts during the wet season and reach maturity in a few weeks.

Fish

There are 2 special status fish that occur in the Dry Creek watershed.

Chinook salmon

Chinook salmon (*Oncorhynchus tshawytscha*) are anadromous, spending three to five years at sea before returning to freshwater to spawn. Central Valley ESUs of Chinook salmon pass through the Sacramento River and Delta to reach their upstream spawning grounds. Juvenile "smolt" salmon use Sacramento River and Delta as a migration corridor to reach the Pacific Ocean. Smoltification is the physiological acclimation of juvenile salmon to full strength seawater that occurs after completion of the freshwater rearing phase. The Chinook salmon population in the Sacramento River and Delta is comprised of four races: fall-run, late fall-run, spring-run and winter-run. Each of these spawning populations is separated based on the timing of adult upstream migration, spawning, and juvenile downstream migration. The Central Valley ESU winter-run is federally listed as endangered, and the Central Valley ESU spring-run is federally listed as threatened. Neither of these races is present in Dry Creek. However the candidate Central Valley ESU fall-run is present.

The fall-run Chinook salmon may enter the American River and its tributaries (e.g., Dry Creek), from mid-September through January. There is high variability from year to year, but peak upstream migration occurs from mid-October through December. Though spawning may occur from mid-October through February, the bulk of spawning occurs from mid-October through December. The fall-run exhibits “ocean type” behavior, where adult salmon spawn immediately upon entering the spawning tributary. This strategy is in contrast to “stream type” behavior, so called because the sexual products (eggs and sperm) become mature while the fish is in the stream environment (e.g., winter-run and spring-run Chinook salmon). Adults of all races of Chinook salmon die soon after spawning. Fall-run Chinook salmon fry are known to emerge from the American River (and likely from Dry Creek) spawning gravels from January through mid-April. They rear to smoltification in the American River from January through mid-July, leaving freshwater habitat within their first year of life. Again, there is high variability between years, and the

bulk of rearing occurs from February through May. The range of water temperatures for optimal survival of incubating eggs is between 6.1 to 14.4 ^{o}C (43 and 58 ^{o}F).

Steelhead

Steelhead (*Oncorhynchus mykiss*) populations in the Central Valley Evolutionary Significant Unit (ESU) have been listed by the National Marine Fisheries Service (NMFS) under the federal ESA as threatened. In addition, Dry Creek is designated by NMFS as Critical Habitat for the Central Valley ESU steelhead.

Steelhead, the anadromous form of rainbow trout, historically inhabited most streams tributary to the Sacramento River, including Dry Creek. The life history of steelhead is similar to that of Chinook salmon with two major differences. First, steelhead do not necessarily die after spawning, thus maintaining their ability to return to the Pacific Ocean after spawning in freshwater. Second, juvenile steelhead may spend up to four years rearing in freshwater prior to emigrating to the ocean as smolts. However, juvenile steelhead typically emigrate as age 1 fish (one year in fresh water) through the Sacramento River and the Sacramento-San Joaquin Estuary from November through May. Juvenile steelhead emigration from Dry Creek likely occurs from late March through May.

Spawning steelhead require gravel or cobble substrate (0.6 to 13 cm diameter) in which to lay their eggs. Fine sediments (e.g., silts, fine sands and clays) act to suffocate the egg by preventing the transport of dissolved oxygen from the water to the eggs. Generally, steelhead eggs require temperatures of less than 16.1 ^{o}C (61 ^{o}F) for successful hatching. Both fry and older juveniles require instream object cover, generally in the form of cobble or boulders, large woody debris, undercut banks, or submerged and overhanging vegetation, for protection against predators.

Amphibians

There are 4 special status amphibians that occur, or are believed to have the potential to occur in the Dry Creek watershed. Western spadefoot toad is the only species that is documented as being present in the watershed.

California Red-Legged Frog

The California red-legged frog (*Rana aurora draytonii*) is listed as federally threatened, and is the largest native frog in the western United States. It is endemic to California and Baja California, Mexico, where it is typically found from sea level to elevations of approximately 1,500 meters (U.S. Department of Interior, 2001). The historical range of the *R. a. draytonii* extended from the vicinity of Point Reyes national Seashore, Marin County, California, and inland from the vicinity of Redding, Shasta County, California southward to northwestern Baja California, Mexico (Jennings and Hayes, 1985; Hayes and Krempels 1986). Today *R. a. draytonii* are known to occur in 248 streams or drainages in these 26 counties, primarily in the central coastal region of California (U.S. Department of Interior, 2001).

R. a. draytonii occupies a fairly distinct habitat combining both specific aquatic and riparian components (Jennings, 1988). The adults require dense, shrubby or emergent riparian vegetation closely associated with deep (>7 meters) still or slow moving water (Hayes and Jennings, 1988). The largest densities of *R. a. draytonii* are associated with deep-water pools with dense stands of overhanging *Salix* spp. and an intermixed fringe of Typha *spp.* (Jennings, 1988). Well-vegetated terrestrial areas within the riparian corridor may provide important sheltering habitat during winter. *R. a. draytonii* aestivate during the dry season in small mammal burrows and moist leaf litter (Jennings and Hayes, 1994). *Rana a. draytonii* disperses upstream and downstream of their breeding habitat to forage and seek estivation habitat (U.S. Department of Interior, 1996).

California Tiger Salamander

The California tiger salamander (*Ambystoma californiense*) is currently a candidate for federal listing, and a species of special concern to the California Department of Fish and Game; the petition to list the species as endangered or threatened has been found to be, "warranted but precluded by pending listing actions on higher priority species" (U.S. Department of Interior, 1994). They are most commonly associated with annual grassland habitats but may also be found within open woodland areas of low hills and valleys (Stebbin, 1985). The California tiger salamander is known to occur from Yolo County south through the Central Valley to Kern County, and from Santa Barbara County north through the inner coast range to Sonoma County (Shaffer and Stanley, 1992; U.S. Department of Interior, 1992). Three distinct genetic forms of the salamander have been identified; these include populations from the eastern side of the Central Valley, populations from the west of the Valley, and a third isolated series of populations from northern Santa Barbara County (Shaffer and Stanley, 1992).

Necessary habitat components of the California tiger salamander include suitable underground retreats and breeding ponds. Tiger salamanders spend most of their adult life within suitable underground refugia, such as ground squirrel or gopher burrows. Suitable breeding sites are vernal pools, seasonal wetlands, stockponds, or slow-moving streams that do not support fish. Adult tiger salamanders, which are generally nocturnal, may migrate over long distances (up to one mile) from underground refuges to breeding ponds (U.S. Department of Interior, 1992). Breeding and egg laying typically occurs between December and early February. Eggs are deposited on submerged debris and vegetation. Larvae feed upon various planktonic aquatic invertebrates and occasionally larvae of other amphibian species. The salamander larvae transform into adults during late spring or early summer. Postmetamorphic juveniles soon seek refuge in underground refugia.

Foothill Yellow-Legged Frog

The foothill yellow-legged frog (*Rana boylii*) is not listed or protected under either state or federal Endangered Species Acts, but it is a species of concern to both the CDFG and USFWS. It is also a California Code of Regulations, Title 14, fully protected species. Foothill yellow-legged frogs are found within the Sierra Nevada foothills and the Coast Range. They require shallow, flowing water, in small to moderately sized streams with a cobbly substrate (Hayes and Jennings, 1988). They may be susceptible to predation by introduced aquatic predators (i.e., rainbow trout, bullfrog) (Hayes and Jennings, 1986).

Western Spadefoot Toad

The western spadefoot toad (*Spea hammondii*) is considered a species of special concern to CDFG and USFWS and is a California Code of Regulations fully protected species. It is most commonly associated with lowland annual grassland habitats but also occurs within chaparral and pine-oak woodlands (Stebbins, 1985). Within California, western spadefoot toads are known to be found from the vicinity of Redding, Shasta County southward to northwestern Baja California, at elevations below 1363 m. (California Department of Fish and Game, 1994).

Necessary habitat components of the western spadefoot toad include suitable underground retreats and breeding ponds. The species is mostly terrestrial and spends most of its adult life within underground burrows excavated in loose soil, or in other suitable refugia, such as rodent burrows. Suitable breeding sites include temporary rain pools, such as vernal pools and seasonal wetlands, or deep portions of intermittent drainages (California Department of Fish and Game, 1994). Breeding and egg laying occurs at night, typically between late February and May (California Department of Fish and Game, 1994). Eggs are deposited on submerged debris and vegetation. After hatching, larvae complete their development within 3-11 weeks, and postmetamorphic juveniles feed and immediately seek underground refugia.

Reptiles

There are 3 special-status reptiles that inhabit, or are believed to have the potential to inhabit the Dry Creek watershed. None of these species have occurrences documented in the watershed by the CNDDB.

California Horned Lizard

California horned lizards (*Phrynosoma coronatum frontale*) are classified as a species of special concern to CDFG and USFWS and as a California Fish and Game Code fully protected species. It can be found within a variety of habitats including scrubland, annual grassland, valley-foothill woodlands and coniferous forests, though it is most most commonly inhabit areas along lowland sandy washes (Stebbins, 1985). In the Central Valley the species ranges from southern Tehama County southward; in the Sierra foothills, from Butte Co. to Tulare Co. (typically below 2000 ft.); and throughout the Coast Range from Sonoma Co. south into Baja California. They are active during spring and summer months.

Giant Garter Snake

The giant garter snake (*Thamnophis gigas*) (GGS) is one of the largest garter snakes, reaching lengths of over five feet. The GGS is currently state and federally listed as threatened. It is a semi-aquatic snake which is found along sloughs, ponds, low gradient streams, and irrigation/drainage canals throughout portions of the Central Valley from the vicinity of Gridley in Butte County to Burrell in Fresno County. The snake feeds primarily on small fish, frogs, and tadpoles. It is typically active between April and October. Most

GGS are in winter retreats (hibernaculae) by November, where they remain until the following spring.

Northwestern Pond Turtle

The northwestern pond turtle (*Clemmys marmorata marmorata*) is a subspecies of the western pond turtle (*Clemmys marmorata*). Northern and southern subspecies exhibit morphological differentiation and intergradation over a relatively broad range in central California (California Department of Fish and Game, 1994). The Northwestern pond turtle is currently a species of concern to CDFG and USFWS and is California Fish and Game Code fully protected.

Pond turtles can inhabit a variety of waterbodies (ponds, lakes, streams, etc.), though it requires "some slack- or slow-water aquatic habitat" (California Department of Fish and Game, 1994). The species prefers areas that support suitable basking areas for thermoregulation. Western pond turtles are typically active between March and November. Mating typically occurs during late April and early May, and eggs deposited between late April and early August. Eggs are deposited within excavated nests in upland areas with sandy friable soils, usually in the vicinity of aquatic habitats.

Birds

There are 21 special status birds that inhabit, or are believed to have the potential to inhabit the Dry Creek watershed. Great egret (*Ardea alba*) and white-tailed kite (*Elanus leucurus*) have occurrences documented in the CNDDB.

Bald Eagle

Bald eagle (*Haliaeetus leucocephalus*) is listed as endangered and protected pursuant to the California Endangered Species Act. It is currently proposed for de-listing under the federal Endangered Species Act. In addition, it is considered a fully protected species according to the Fish and Game Code of California, Section 3511. Bald eagles winter throughout California, including the Central Valley, but generally nest in the foothill and mountainous regions nears lakes, rivers, and reservoirs. Bald eagles feed upon fish, waterfowl, and carrion.

Bank Swallow

Bank swallow (*Riparia riparia*) is listed as a threatened species and protected pursuant to the California Endangered Species Act, but has no federal special status. This species occurs along rivers and creeks, where exposed banks are used for nesting. Most colonies within California are located in the extreme northern portion of the state with scattered populations along the north coast, Central Valley, Mono Basin, and Crowley Lake (Mono County) (Small, 1994). Burrows are typically excavated within banks that have friable soils, and nesting occurs during May through July.

Burrowing Owl

Burrowing owl (*Speotyto cunicularia*) has no protected status under either state or federal Endangered Species Acts, but is currently a California Department of Fish and Game species of special concern, federal species of special concern, and U.S. Fish and Wildlife Service migratory bird of management concern. Burrowing owls typically use abandoned ground squirrel (or other mammal) burrows, abandoned culverts, rubble piles, or any other substrate that is a burrow analog, within open grasslands and savannah in the Central Valley. They may feed upon insects, small rodents, and lizards. Nesting season occurs during April through July.

California Thrasher

The California thrasher (*Toxostoma redivivum*) is not listed or protected pursuant to either state or federal Endangered Species Acts, but is considered a federal species of concern and a USFWS bird of management concern. California thrashers can be found within the Sierra Nevada foothills and Coast Range. They nest within chaparral or riparian thickets during February through July.

Cooper's Hawk

Cooper's hawk (*Accipiter cooperii*) is a California Department of Fish and Game species of special concern, but has no federal special-status. Typical nesting and foraging habitat includes riparian woodland, dense oak woodland, and other woodlands near water. Breeding range generally includes the Central Valley and the Sierra Nevada and Coast Range foothills.

Ferruginous Hawk

Ferruginous hawk (*Buteo regalis*) is currently a California Department of Fish and Game species of special concern, federal species of special concern, and U.S. Fish and Wildlife Service migratory bird of management concern. This species typically occurs in open habitats and nests from Oregon into Canada. Nesting has recently been documented to occur in Lassen County, California (Small, 1994). For the remainder of the state, including the Central Valley, ferruginous hawk occurrences are restricted to the non-breeding season (September through April). Winter foraging occurs within a variety of open habitats, including open grassland and savannah.

Golden Eagle

The golden eagle (*Aquila chrysaetos*) is a California Department of Fish and Game species of special concern. Additionally, golden eagles are fully protected according to the Fish and Game Code of California, Section 3511. Golden eagles generally nest on cliff ledges and/or large lone trees in mostly rolling to mountainous terrain. Occurrences within the Central Valley floor are usually of post-breeding dispersers, non-breeding sub-adults, or migrants. Foraging habitat includes open grassland and savannah.

Grasshopper Sparrow

The grasshopper sparrow (*Ammadramus savannarum*), a federal species of concern, is an uncommon and local, summer resident and breeder in foothills and lowlands west of the Cascade-Sierra Nevada crest from Mendocino and Trinity counties south to San Diego County (Zeiner et al., 1990). The grasshopper sparrow is generally found in its' preferred habitat consisting of dry, dense grasslands, especially those with a variety of grasses and forbs. Thick cover of grasses and forbs is essential for nesting and concealment. The grasshopper sparrow builds a hidden ground nest of grasses and forbs at the base of an overhanging clump of grasses or forbs. Summer residents generally arrive March to May, breed from early April to mid-July (with a peak in May and June), and most migrate south in August or September (Zeiner et al., 1990).

Great Blue Heron

Great blue herons (*Ardea herodias*) are not listed under either the state or federal Endangered Species Acts. However, they are monitored by the California Natural Diversity Data Base as a colonial nesting waterbird. Breeding colonies exist throughout California, including the Central Valley. Wintering and post-breeding great blue herons are common and widespread throughout the state. Great blue heron breeding rookeries are typically situated in secluded trees near shallow-water foraging areas. They rarely nest on the ground. Nesting season ranges from February through July.

Great Egret

Great egrets (*Ardea alba*) are not listed under either the state or federal Endangered Species Acts. However, they are monitored by the California Natural Diversity Data Base as a colonial nesting waterbird, and are considered a California Department of Forestry sensitive species. Breeding colonies exist throughout California, including the Central Valley. Wintering and post-breeding great egrets are common and widespread throughout the state. Great egret breeding rookeries are typically situated in trees near shallow-water foraging areas. The large nests are generally located high within tall trees or snags and made up of sticks and marsh vegetation. Nesting season ranges from March through July.

Lark Sparrow

The lark sparrow (*Chondestes grammacus*) is not listed pursuant to either state or federal Endangered Species Acts, but is considered a federal species of concern and a USFWS bird of management concern. Lark sparrows can be found throughout California, generally west of the Sierra Nevada. They nest within a wide variety of communities including oak woodland, chaparral, and grassland savannahs, among others. Their nests are constructed on the ground or small trees and shrubs. The nesting period range from April through May.

Loggerhead Shrike

Loggerhead shrike (*Lanius ludovicianus*) is considered a USFWS migratory bird of management concern and a federal and California Department of Fish and Game

species of concern. Loggerhead shrike are not listed pursuant to either state or federal Endangered Species Act. They nest within small trees and shrubs in woodland and savannah vegetation communities, and forage in open habitats throughout California. Nesting seasons ranges from March through May.

Merlin

The Merlin (*Falco columbarius*) is a California Department of Fish and Game species of special concern, but has no federal special-status. This falcon breeds in Canada and Alaska and occurs in California as a migrant and during the non-breeding season (September through April). Foraging habitat includes a wide range of open habitats including seacoast estuaries, desert, open grasslands, and semi-open woodlands.

Modesto Song Sparrow

The Modesto song sparrow (*Melospiza melodia mailliardi*) is a common resident subspecies of the song sparrow. It is not listed pursuant to either state or federal Endangered Species Acts, but is considered a CDFG species of special concern. The Modesto song sparrow can be found throughout the Central Valley and nests within riparian thickets and freshwater marsh communities. The nesting period ranges from April through May.

Northern Harrier

Northern harrier (*Circus cyaneus*) has no federal status, but is a California Department of Fish and Game species of special concern. It is known to nest within the Central Valley, along the Pacific Coast, and in northeastern California. Northern harriers are ground nesters, and typical nesting substrates include emergent wetland/marsh, open grasslands, or savannah habitats. Foraging occurs over a variety of open habitats, such as marshes, agricultural fields, and open grasslands. Northern harriers feed upon rodents, birds, amphibians, reptiles, crustaceans, and insects.

Purple Martin

Purple martin (*Progne subis*) is a California Department of Fish and Game species of special concern, but has no protected status under either the state or federal Endangered Species Acts. They can be found nesting within woodland vegetation communities in the foothills of the Sierra Nevada and the Coast Range to the Pacific Coast. Additionally, several small sub-populations occur within the city limits of Sacramento. Purple martins nest in tree cavities or other n structures that mimic tree cavities (i.e. nest boxes).

Sharp-shinned Hawk

The sharp-shinned hawk (*Accipiter striatus*) is a California Department of Fish and Game species of special concern, but has no federal special-status. Sharp-shinned hawks generally nest in woodlands at middle to high elevation and may be found throughout the Central Valley during winter, post-breeding dispersal, and/or migration (September through April).

Swainson's Hawk

The swainson's hawk (*Buteo swainsoni*) is a state-listed threatened species, and is protected pursuant to the California Endangered Species Act. The Swainson's hawk is considered a neotropical migrant. It nests in North America (Canada, western United States, and Mexico), and winters in South America (mainly Argentina). However, recent telemetry studies indicate that some or all of Swainson's hawk nesting in California migrate only as far as Mexico or Southern California, or stay within the Central Valley region during winter months. In California, the Swainson's hawk nesting season ranges between mid-March and late August.

Swainson's hawks nest within tall trees in a variety of wooded communities including riparian, oak woodland, roadside landscape corridors, urban areas, and agricultural areas, among others. Foraging habitat includes open grassland, savannah, low-cover row crop fields, and livestock pastures. Typical dietary composition of Swainson's hawks within the Central Valley include California vole (*Microtus californicus*), California ground squirrel (*Spermophilus beecheyi*), ring-necked pheasant (*Phasianus colchicus*), many passerine birds, and grasshoppers (*Melanopulus* spp.). The relationship of Swainson's hawks and agricultural mowing, harvesting, discing, and irrigating has been well documented (Estep, 1989) where prey becomes increasingly available as vegetative cover is reduced by such farming activities.

Tricolored Blackbird

The tricolored blackbird (*Agelaius tricolor*) is currently a California Department of Fish and Game species of special concern, federal species of special concern, and U.S. Fish and Wildlife Service migratory bird of management concern. This colonial nesting species is distributed widely throughout the Central Valley and Coast Range. Suitable nesting habitat includes emergent marsh, willow thickets, blackberry thickets, and tall herbs. Open grassland and agricultural fields are characteristic foraging areas. Nesting occurs during April through July.

White-Tailed Kite

The white-tailed kite (*Elanus leucurus*) has no special status under either state or federal Endangered Species Acts. However, white-tailed kites are fully protected according to the Fish and Game Code of California, Section 3511. It is also a federal species of concern, and USFWS migratory bird of management concern. White-tailed kites nest in trees within riparian, oak woodland, and savannah habitats of the Central Valley and Coast Range, typically during May through August. White-tailed kites forage within open grassland, savannah, and agricultural cropland habitats, mainly on rodents, but may also eat insects, reptiles, amphibians, and birds.

Yellow-Breasted Chat

The yellow-breasted chat (*Icteria virens*) is a California Department of Fish and Game species of special concern, and a U.S. Fish and Wildlife Service bird of management concern. Yellow-breasted chats nest in North America and winter in Mexico and

Guatemala. This warbler typically nests within thick riparian scrub habitat in lower to middle elevations of the Sierra Nevada and Coast Range foothills. Nesting occurs during May through August.

Mammals

There are five special status mammals that inhabit, or are believed to have the potential to inhabit the Dry Creek watershed. None of these species have occurrences documented in the watershed by the CNDDB.

Western Red Bat

The western red bat (*Lasiurus blossevillii*) has been included in the draft revisions of the state mammalian species of special concern list. It is found throughout California at elevations below 4000 feet, and is typically associated with forested and riparian habitats. This species roosts almost exclusively in trees and is not colonial. They feed on a variety of insects, usually foraging in or near riparian areas. This species is a year-round resident of California, however, they do migrate seasonally and the extent of these movements is not well understood (Shump and Shump, 1982; Philpott, 1996).

Yuma Myotis

The Yuma myotis (*Myotis yumanensis*) is considered a federal species of special concern. It is found throughout California in a variety of habitats. Yuma myotis readily roosts in man-made structures such as barns, attics, or bridges; or in more natural habitat features such as trees, caves, or rock crevices. They feed primarily on emergent aquatic insects and thus forage mainly over open water or adjacent riparian vegetation (Philpott, 1996).

Small-footed Myotis

The small-footed myotis (*Myotis ciliolabrum*) is listed as a federal species of special concern and as a Bureau of Land Management sensitive species (CDFG, 2003). The small-footed myotis is found throughout California in a variety of habitats including grasslands and oak woodlands. This species of bat prefers to roost in natural crevices in rocks, tree hollows, or under exfoliating bark. They may also roost in man-made structures such as barns, attics, or bridges. Small-footed myotis feed on a variety of terrestrial and aquatic insects and prefer to forage in open areas (Philpott, 1996).

Townsend's Big-Eared bat

The Townsend's big-eared bat (*Corynorhinus townsendii*) is considered a federal and state species of special concern. They occur throughout California, and are considered a cave obligate species. Although they will occasionally use a tree as a roost, this species prefers caves, mines, bridges, or buildings for roost sites. They are particularly sensitive to disturbance and may abandon a roost site permanently after only one slight human disturbance (e.g., humans walking into a cave or mine). Townsend's big-eared bats will roost alone or in groups of 15-100 individuals. They feed primarily on moths

and prefer to forage along the edge of clumps of native vegetation. They are year-round residents in California and, while they hibernate during the winter, they do occasionally forage during the winter months (Kunz and Martin, 1982; Philpott, 1996).

Pallid Bat

The pallid bat (*Antrozous pallidus*) is considered a state species of special concern. The pallid bat occurs throughout California (Hermanson and O'Shea, 1983). This species is found in a variety of habitats including grasslands and oak woodlands (Philpot,t 1996). This species typically roosts in rock crevices, tree hollows, or various man-made structures such as attics, barns, and bridges (Orr, 1954; O'Shea and Vaughan, 1977; Lewis, 1994; Philpott, 1996). Pallid bats are primarily insectivores and feed by gleaning prey from the ground or off vegetation (Bell, 1982). In the Central Valley, one of the preferred prey items is the Jerusalem cricket (subfamily: Stenopelmatinae) (Ramones, 2001).

Following a winter hibernation which ends in late March or early April, Pallid bats are gregarious in the spring and summer months, forming colonies of approximately 30-100 individuals (Orr, 1954). Females typically give birth in May and June to twins. The young are weaned at 6-8 weeks. Colony size decreases during the fall, and by October the bats move to winter locations. Their winter locations and patterns of local migration are not well understood.

2.2.5.5 Invasive Plant Species

Non-native plants can have a variety of negative effects on wildlands, including the alteration of ecosystem processes, displacement of native species, support of non-native animals, fungi or microbes, and alteration of gene pools through hybridization with native species. Invasive species are now recognized worldwide as posing a threat to biological diversity second only to direct habitat loss and fragmentation (Pimm and Gilpin, 1989; Scott and Wilcove, 1998). Compared to other threats to biological diversity, non-native invasive plants present a complex problem that is difficult to manage and has long-lasting effects.

Unfortunately, many non-native invasive species are firmly established in the Dry Creek watershed. Other species are just beginning to invade or have been noted nearby, but have not yet been found within the watershed. Additionally, most of the studies done for the watershed have identified Himalayan blackberry (*Rubus discolor*) as the most pervasive invasive riparian species in the watershed. Although this is likely the case, there are additional non-native species that occur in the watershed that should receive the same degree of scrutiny before they become problems of similar magnitude. This section includes abstracts on notable non-native invasive species with a view toward increasing awareness of these species and stopping their spread or managing their populations

2.2.5.5.1 Brief History of Non-Native Plants in California

The first recorded visit by European explorers to the territory now called California occurred in 1524, but people of Old World ancestry did not begin to settle here until 1769. Available evidence indicates that the vast majority of non-native plants now established in California were introduced after this time. Once settlers began to arrive, they brought non-native plants accidentally, in ship ballast and as contaminants of grain shipments; and intentionally for food, fiber, medicine, ornamental use, ano other uses (Frenkel, 1970; Gerlach, 1998). The number of non-native species rose from sixteen during the period of Spanish colonization (1760-1824), to seventy-nine during the period of Mexican occupation (1825-1848), to 134 by 1860, following American pioneer settlement (Frenkel, 1970). Today there are reports of 1,045 non-native species established in California (Randall *et al.,* 1998). Rejmanek and Randall (1994) remarked that, although non-native species continue to establish in California, the rate of increase in their numbers appear to be slowing after roughly 150 years of rapid growth.

Very generally, there are four main types of habitat present within the watershed: wetland habitats, grassland habitats, woodland habitats, and riparian habitats. There are almost no data regarding what plant species were present in any of these habitats prior to European settlement. Ecologists from the mid-west prairies visited California in the early 20th century and surmised that purple needlegrass (*Nassella pulchra*) was the dominant grass across the Central Valley simply because small patches were found in remaining native vegetation. There is good evidence that much of the native grasslands were covered with colorful annual spring flowers (Hamilton, 1997). Relict patches of native grasslands continue to provide homes to a host of native wildflowers in the spring. In most California native grasslands, there are fewer species of grass and grass-like plants and far more species of broad-leafed plants. Small patches of native grassland scattered across the landscape are often the only clues we have as to what species of native grasses were once prominent (Stromberg and Kephart, 2003). It is estimated that 99% of California's native grassland has been converted to non-native annual grassland (Ornduff *et al.,* 2003).

One of the reasons that non-native grasses have become wide spread is livestock grazing. Early grazing practices were hard on the perennial bunch grasses because continuous grazing weakens them. Grazers have also been observed to preferentially seek out perennial grasses in the summer because they remain green. Conversely, annual grasses sprout, grow, and set seed quickly, allowing them to take over from the hard hit perennial grasses.

Wetland and riparian habitats, such as creeks, marshes, and seasonal wetlands have been inundated by non-native invasive species. Perennial pepperweed (*Lepidium latifolium*), Himalayan blackberry (*Rubus discolor*), tree of heaven (*Ailanthus altissima*), and water hyacinth (*Eichornia crassipes*) are all species that have spread rapidly throughout California. Wetland and riparian species often present a particularly difficult challenge. For example, chemicals are often the easiest and most cost-effective way to remove these species; however, to control these invasive species in wetland and riparian habitas, they must be applied in or near the water, thereby creating a potential impact to water quality.

Although some non-native invasive species are becoming part of the California wetland flora, some wetland types have remained islands of native, often endemic species. Vernal pools for example represent one habitat type that have, for the most part, retained their full suite of native species. These habitats have maintained their integrity, mostly due to the presence of some abiotic factor such as soil type, hydrologic cycle, or climate. The non-native species are not well adapted to surviving these special conditions.

Some of the non-native invasive species found in the Dry Creek watershed were purposely introduced by man and have now escaped cultivation and proliferated in natural habitats. Giant reed (*Arundo donax*) was introduced for its usefulness in musical instruments. The edible fig (*Ficus cairica*) was cultivated for its fruits, as were the Himalayan blackberry and other escaped fruit trees (*Prunus* spp.). Catalpa (*Catalpa bignonioides*) was planted for the caterpillars that live solely off the foliage; they make great fish bait. Tree of heaven was brought by the Chinese miners for its cultural significance. Plants such as mimosa (*Albizia julibrissin*), scarlet wisteria (*Sesbania punicea*), blue gum eucalyptus (*Eucalyptus globulus*), greater periwinkle (*Vinca major*), Chinese tallow tree (*Sapium sebiferum)*, German ivy (*Senecio mikanioides)*, purpletop vervain (*Verbena bonariensis*), pampas grass (*Cortaderia jubata*), black lotus (*Robinia pseudoacacia),* Scotch and French broom (*Cytisus scoparius* and *Genista monspessulanus)* were all brought to California as fast growing ornamentals for horticultural purposes. Pennyroyal (*Mentha pulegium)* and sweet fennel (*Foeniculum vulgare*) were brought in as herbs in gardens. Some other non-native invasives, such as yellow star-thistle (*Centaurea solstitialis)*, were brought as contaminants in fodder for cattle.

Other species have unknown or multiple vectors of introduction, including Bermuda grass (*Cynodon dactylon)*, purple loosestrife (*Lythrum salicaria),* water hyacinth, parrot feather (*Myriophyllum aquaticum)*, Japanese knotweed (*Polygonum cuspidatum),* tamarisk (*Tamarix spp.)*, and perennial pepperweed (*Lepidium latifolium)*.

2.2.5.5.2 Invasive Species of the Dry Creek Watershed

Many of the non-native invasive plants that are found in the Dry Creek watershed occur in the riparian areas. The presence of these plants has, in some areas. significantly altered this habitat, changing the natural ecosystem previously established before their presence. These weeds have resulted in decreased plant and wildlife diversity, displaced native vegetation, and threatened rare habitats.

According to Bossard et al. (2000), there are two types of invasive plant species: plants that displace native species, and plants that alter the ecosystem process <u>and</u> replace native species. According Bossard et al. (2000), ‘the invasive species that cause the greatest damage are those that alter ecosystem processes such as nutrient cycling, intensity and frequency of fire, hydrological cycles, sediment disposition, and erosion” (Sawyer and Keeler-Wolf, 1995). Of the weeds present in the Dry Creek watershed (or known from a neighboring watershed, such as the Pleasant Grove Creek watershed), tamarisk, catalpa, Chinese tallow, Tree of Heaven, German ivy, perennial pepperweed, and blue gum eucalyptus are potential plants that alter the ecosystem process and replace native species.

Both tamarisk and perennial pepperweed are deep rooted and have been shown to pull up saline water from deep within the soil and leave the associated salts deposited near the surface (Blank and Young, 1997; Carmen and Brotherson, 1982). The resulting environment would select for plants that have a higher salt tolerance than others. Perennial pepperweed contributes to increased erosion in riparian areas (Renz, 2000) due to its reduced surface cover and less stabilizing root system. Blue gum eucalyptus (Bean and Russo, 1986), catalpa (Coder, 1999) and Tree of Heaven (Mergen, 1959) produce chemicals that restrict growth and establishment of other plants within their vicinity (allelopathy). Chinese tallow is able to alter nutrient cycles (Cameron and Spencer, 1989). German ivy seems to have the possibility of poisoning an aquatic environment. There is evidence that shows it may be toxic to aquatic organisms such as freshwater shrimp and habitat of Coho salmon (Sigg, 1999).

The remaining non-native invasive species present are plants that displace native species. Giant reed, black lotus, Bermuda grass, Himalayan blackberry, Japanese knotweed, parrot feather, purple loosestrife, scarlet wisteria, pampas grass, periwinkle, purpletop vervain, fennel, and water hyacinth can all rapidly invade riparian habitats from a few introduced individuals, forming monospecific populations that compete with other native species for light, nutrients, and oxygen. When established, they have a strong ability to outcompete and completely suppress native vegetation and displace associated wildlife. Other non-native invasives, such as the fig, mimosa, pennyroyal, yellow starthistle, and Scotch and French broom, can severely reduce the sunlight and nutrients available for other plants, as well as reduce wildlife habitat and forage, displace native plants, and decrease native plant and animal diversity. Dense infestations not only displace native plants and animals, but also threaten natural ecosystems and natural reserves by fragmenting sensitive plant and animal habitat. These weeds can also reduce land value and reduce access to recreational areas.

The list of non-native invasive plant species that has been compiled for this plan (Table 2.35) does not represent a comprehensive list of non-native species that occur in the watershed. An emphasis has been placed on riparian or wetland species that would be associated with the creek corridors. An abstract for each identified invasive species has been compiled, and is provided in Appendix 2.11.

2.2.5.5.3 Non-native invasive Plant Species Management

Management of non-native invasive plant species is usually a costly process that may take years to achieve. For example, the California Native Plant Society (CNPS), Sacramento Area Flood Control Agency (SAFCA), and the Sacramento County Department of Parks and Recreation are targeting the removal of Chinese tallow, scarlet wisteria (red sesbania), giant reed, Spanish broom, and tamarisk. The cost for Phase I one of this program (which addresses 653 acres) is estimated at $630,000 (Lower American River Taskforce, 2002).

Management and removal may be done by mechanical (or hand) methods, with chemicals or with biological controls. Each of those abstracts appearing in Appendix 2.11 has a section outlining basic methodologies available for management. This information is provided to give the reader an idea of the management strategies for each

Table 2.35 Invasive Plant Species Present by Subwatershed

species. Before undertaking the removal of any invasive species, it is recommended that workers get more detailed information and find out if new, better techniques are currently being employed.

2.2.6 Summary Stream Descriptions

The intent of this section is to describe each of the tributary streams in the watershed. General descriptions for each stream are provided, followed by reach-by-reach descriptions, which are correlated with reaches identified in Figure 2.25. Reach-by-reach descriptions are presented in Section 2.2.6.12. Each time a new study is conducted or more detailed information regarding a portion of a creek becomes available, it should be added to the reach description. This will be most valuable in identifying changes in the creeks over time, identifying areas for restoration, and providing a basis for future preservation. Discussions are presented organized from downstream to upstream.

2.2.6.1 Methods

Literature Review

ECORP conducted a search of the reports and literature available on each creek and combined all of the reach-specific information. Reaches were delineated primarily by the system used by Bishop (1997) because she conducted the majority of reach-specific assessments. Defined reaches are depicted on Figure 2.25. In all cases, an effort was made to define the reaches by bridges or other easily identifiable structures. Unless the entirety of the tributary had been described, an additional reach, “To End”, was added. If these additional areas are studied in the future, further reaches can defined at that time.

Pipe, Ditch, and Outfall Inventory

The intent of the pipe, ditch and outfall inventory is to inventory sources of stormwater runoff into each reach. The methods were adapted from the *Adopt-A-Stream* (2003) survey protocol. For each outfall, this inventory included the location, size, material, flow presences, trash evidence, sediment, or algae associated with it. Even if it was unclear if a pipe was an outfall, inventory data were still collected. This inventory includes portions of Dry Creek, Miners Ravine, and Secret Ravine. Prior to the collection of Secret Ravine data, the location of each outfall was approximated on an aerial photograph and documented with a Garmin GPS unit. The Secret Ravine data were collected with a Trimble Pathfinder ProXR GPS unit. See Appendix 2.12 for the data sheets.

Habitat Inventory

Portions of Dry Creek, Miners Ravine, and Secret Ravine were inventoried for salmonid habitat characteristics. The stream habitat inventory methods were modified from the

Figure 2.25 Reach Map (Robert)

fish sampling methods section of the *California Salmonid Restoration Stream Habitat Restoration Manual*. Attributed inventoried included the most basic classification of pool, riffle and run, the length of the unit, average width, max and average depths, substrate percentages, canopy cover, instream fish cover (with modifiers). For Dry Creek and portions of Miners Ravine, habitat data was collected by drawing each unit on an aerial photograph and the upstream endpoint was documented with a Garmin GPS unit. Beginning with Secret Ravine, the creek was walked with a Trimble Pathfinder ProXR and each habitat unit was documented for input into GIS. See Appendix 2.13 for the data sheets.

Vegetation

Assessment in the field was conducted using the California Native Plant Society (CNPS) Vegetation Rapid Assessment Protocol developed by the CNPS vegetation committee (November 5, 2001) based on the types found in A Manual of California Vegetation (Sawyer and Keeler-Wolf, 1995). This methodology allows for a quick but informational assessment, which includes information on dominant tree, shrub, and herbaceous species in addition to recording non-native species, anthropogenic impacts, and topography. Time and financial constraints only allowed a very small portion of the watershed to be assessed by ECORP, but because of the detailed information it provides it would be a worthwhile endeavor to continue (see Appendix 2.8 for the data sheets).

Daily Summary

The biological inventory summary data sheets were also modified from the *Adopt-A-Stream* (2003) survey protocols. These consist of a series of checkboxes that relate to the qualities of the streambed, water, vegetation, riparian zone, land use, trash, potential open space, recreation, aquatic and riparian habitat/species and a narrative describing the portion of creek covered each day. See Appendix 2.14 for the data sheets.

Photo Documentation

In order to create a visual catalog of the creeks in the watershed and to provide a basis for future comparison, photo documentation of each surveyed creek was undertaken. A digital photo was taken of each stream habitat unit, each potential outfall, and each vegetation unit. Additional photos were taken of other features such as erosion, bank protection, and beaver dams. Portions of Dry Creek, Miners Ravine, and Secret Ravine were documented. Prior to Secret Ravine documentaion, these data were collected by marking each photo point and photo direction on an aerial. Beginning with Secret Ravine, each photo point was documented with a Trimble Pathfinder ProXR. See Appendix 2.15 for the photo log and thumbnail prints of the photos.

2.2.6.2 Dry Creek

Dry Creek is approximately 17.6 miles long. In the lower reaches, it splits around Cherry Island and reconverges prior to discharge into Steelhead Creek (a.k.a., the Natomas East Main Drain). All other creeks of the watershed discussed in this plan are tributary to the Dry Creek mainstem. A good deal of its length is urban, although there are areas

that are undeveloped. The portion that is within the City of Roseville is very degraded. There are several reaches where the riparian buffer to the creek is non-existent, both sides of the banks are covered in rip-rap or other bank protection structure and the majority of the vegetation is non-native. The City of Roseville and the Dry Creek Conservancy have recently been awarded several large grants to restore these areas and to plan for the future management and restoration of this creek.

Almost all of the non-native invasive plant species that have been identified in the watershed can be found along Dry Creek. However, there are several reaches where the native riparian forest is still present. Many native plants typical of the Valley's riparian areas are found along its banks such as: Valley oak (*Quercus lobata*), Oregon ash (*Fraxinus latifolia*), box elder (*Acer negundo*), California walnut (*Juglans californica*), and wild rose (*Rosa californica*). Where buffers are adequate and the adjacent uplands are still undeveloped, Dry Creek remains a haven for wildlife.

The Dry Creek watershed supports limited runs of steelhead and Chinook salmon. However, Dry Creek proper is a only a migration corridor to Secret and Miners Ravines where the fish spawn. Sedimentation of Dry Creek has left only a limited number of adequately sized pools for fish to rest in as they migrate. It has also resulted in the reduction of instream cover. There are three potential barriers to fish passage currently identified on Dry Creek. These are Hayer Dam in Sacramento County, a rubble dam just downstream of the Watt Ave. bridge in Sacramento County, and the sewer line crossing at the confluence of Cirby and Dry Creeks in the City of Roseville. None of these structures are complete barriers to fish passage, although they may reduce the number of fish that make it upstream. The City of Roseville is currently modifying the sewer line crossing to make it more passage friendly.

Individual reach descriptions are provided in Section 2.2.6.12.

2.2.6.3 Cirby Creek

Cirby Creek is a perennial stream, approximately 2.7 miles long, with a watershed area of approximately 3.4 square miles. Linda Creek is the only major tributary to Cirby Creek, whidh outflows directly into Dry Creek. The Cirby Creek watershed (excluding the upper reaches of Linda Creek) is almost entirely within the urbanized area of the City of Roseville.

The Cirby Creek riparian corridor varies in width. Vegetation consists of some native riparian vegetation with a mixed weedy understory, including Himalayan blackberry (*Rubus discolor*), German ivy (*Senecio mikanioides*), and periwinkle (*Vinca spp.*) (Bishop, 1997). Although anadromous fish may have once used Cirby Creek, it is unlikely that they do now (GANDA, 1998).

2.2.6.4 Linda Creek

Sources of information for Linda Creek include Bishop (1997), GANDA (1998), and ECORP (2003). Linda Creek is a perennial stream, approximately 10.8 miles long. The subwatershed drainage area is 12.2 square miles and there are 7.3 miles of intermittent drainageways and 11.2 miles of perennial, first-order streams. Other waterbodies within this subwatershed are Baldwin Reservoir, Swan Lake, an unnamed reservoir, and approximately 10 unnamed ponds/lakes. Baldwin Reservoir was recently restored and currently supports 4.7 acres of wetlands and tree plantings.

The lower reaches of Linda Creek fall within the City of Roseville and Placer County. Linda Creek flows from within the community of Granite Bay in Placer County, through a portion of Sacramento County, and then back into Placer County in the City of Roseville. Adjacent land uses are primarily open space and urban in the lower reaches, rural residential and open space in the middle portion, and low density residential the upper reaches in Granite Bay.

In the lower reaches of Linda Creek, there are remnant areas of oak woodland and riparian vegetation. In some areas, the buffers are quite large and in others the creek corridor is small. Non-native invasive plant species in the Linda Creek subwatershed include German ivy (*Senecio mikanioides*), Himalayan blackberry (*Rubus discolor*), Japanese knotweed (*Polygonum cuspidatum*), pampas grass (*Cortaderia jubata*), tree of heaven (*Ailanthus altissima*), and water hyacinth (*Eichornia crassipes*). Himalayan blackberry is the dominant non-native invasive species, especially in the rural areas, where fewer of the other species are present. East of Hazel Ave. the native habitats are higher in quality. Above the dam at the Granite Bay Golf Course, the creek becomes much smaller and, in the extreme upstream areas, is more of a “drainage ditch”, with areas that are landscaped.

Only two suitable sites for spawning were noted by GANDA during their assessment work done in 1998. One was upstream of Cherry Ave. and the other was near the Old Auburn Road crossing of Linda Creek. Similar to all of the other creeks in the Dry Creek watershed, areas that may perhaps be suitable for spawning or reaches historically may have had spawning habitat have been impacted by sedimentation. Although this is the case, it is possible that Chinook salmon or steelhead migrating up Dry Creek may enter Linda Creek and attempt to spawn.

Individual reach descriptions are provided in Table 2.33a and 2.33b.

2.2.6.5 Strap Ravine

Strap Ravine is a tributary to Linda Creek that historically was probably intermittent, but has become perennial due to urban runoff. It is approximately 3.6 miles long and drains an area of approximately 4.8 square miles. There are 4 unnamed ponds located on the U.S. Geological Survey (USGS) topograph for this subwatershed, and several more that are not.

There have been significant dredge/mining operations within Strap Ravine, as evidenced by Bishop's (1997) descriptions and the presence of dredge tailings on the USGS topograph. Mining has affected stream channel configuration. Some areas are high in native plant species composition with habitats such as riparian, oak woodland and wetlands being present. Other areas are ruderal in nature and contain landscaping and ornamental species. Notable non-native species include Himalayan blackberry (*Rubus discolor*) and water hyacinth (*Eichornia crassipes*). Although no in depth studies have taken place, Strap Ravine is not believed to provide habitat for anadromous salmonids.

2.2.6.6 Antelope Creek

Antelope Creek is a perennial creek draining the northeast portion of the Dry Creek watershed. The mainstem is approximately 9.5 miles long and the subwatershed area is 21.4 square miles. From USGS topographs, Antelope Creek is composed of approximately 12.4 miles of intermittent tributaries in addition to the major tributary, Clover Valley Creek (7.1 miles long; watershed area of 10.2 square miles). In addition to these tributaries, Aitken Reservoir is within the Antelope Creek subwatershed.

Antelope Creek is not as well studied as the other headwater tributaries of Dry Creek. This could be because of it's smaller size, or because it is not currently viewed as appropriate habitat for anadromous salmonids. Adjacent land uses in this subwatershed vary from protected open space to urban development. Industrial, high density residential, low density residential, rural residential, and golf course land uses are present. There are areas of undeveloped land that may eventually be developed.

The vegetation adjacent to Antelope Creek is generally either riparian, grassland, oak woodland and/or ornamental/ruderal. Bishop (1997) noted that there are areas along the creek that still possess a large component of native vegetation and areas of oak regeneration. Other areas, especially adjacent to development, are more likely to have ornamental plants. As with the entire watershed, Himalayan blackberry is widespread.

Antelope Creek is characterized as having varied fisheries habitat values. Past and ongoing construction activities adjacent to the creek have resulted in much upland disturbance. This in turn has affected instream habitat, which is generally poor to fair for aquatic resources. Aquatic habitat is low in diversity, generally consisting of flatwater (i.e., shallow run and shallow glide) habitat. Accumulated sediments are common in the lower portion of Antelope Creek. Substrate is generally sand, with occasional cobbles and exposed granite.

Utilization of Antelope Creek by anadromous salmonids is thought to occur in the extreme lower reaches (see the following description of Antelope Creek by reach), but is generally believed to be limited to occasional stray adults during years of at least moderate streamflow. Vanicek (1993) noted two potential spawning sides and one good resting pool near Antelope Creek's confluence with Dry Creek. Barriers to fish movement are present in the form of rock dams, shallow flatwater, and beaver dams. Juvenile salmonid habitat is generally limited to shallow pool habitat during years of at least moderate streamflow.

2.2.6.7 Clover Valley Creek

Clover Valley Creek (7.1 miles long; watershed area of 10.2 square miles) is a major tributary to Antelope Creek. Surrounding land uses are urban, including low-density residential, park, and golf course. A significant portion of the land adjacent to the upper reaches is undeveloped. Vegetation in the undeveloped portions of the creek have been described as riparian, foothill woodland, blue oak woodland, and annual grassland. Alhtough Antelope Creek is currently believed to support a few stray migrating salmon in its extreme lower reaches, Clover Valley creek certainly does not due to an impassable culvert located just upstream of the confluence with Antelope Creek.

2.2.6.8 Miners Ravine

Miners Ravine is a perennial tributary to Dry Creek. It is second only to Secret Ravine in the amount of information that has been gathered. The main channel, which is entrenched within an alluvial valley floor, is approximately 15.2 miles long and drains approximately 20.1 square miles. In addition to streams and creeks, Miners Ravine includes other water features such as Oak Lake, Cottonwood Lake, Pine Lake, Laurel Lake, Mammoth Reservoir, an unknown reservoir, and more than approximately 20 small, unnamed ponds.

The vegetation along Miners Ravine is most often either oak woodland, or riparian with a good suite of native species (except Himalayan blackberry) or the vegetation is degraded due to the practices of adjacent land owners. Where riparian vegetation is removed, it is most often replaced by non-native species such as, German ivy (*Senecio mikanioides*) periwinkle (*Vinca major*), pampas grass (*Cortaderia jubata*), Japanese knotweed *(Polygonum cuspidatum)*, and scarlet wisteria (*Sesbania punicea*).

Regardless of impacts or degradation, Miners Ravine is still known to support anadromous fish, including fall run Chinook salmon and steelhead. During the Department of Water Resources surveys in 2002 (Department of Water Resources, 2002), potential barriers to fish passage were identified. Although there were several types of barriers located, Cottonwood Dam, due to it's potential to be a complete barrier to passage, and beaver dams, because of their sheer numbers, are important. Beaver dams like other dams can result in an increase in stream temperature, barriers to passage, sedimentation or conversion of spawning habitat to pool habitat. Upstream of Cottonwood dam, the best habitat was observed by DWR, although Titus (1993) noted several marginal potential spawning areas near the confluence with Secret Ravine.

Sediment is another of the important issues for Miners Ravine as it is for all the tributaries in the Dry Creek watershed. The lower reaches are sediment impacted while the upper reaches of Miners Ravine are not. The channel substrate consists primarily of bedrock material, and the gradient is steep enough to flush eroded sediment downstream. However, livestock grazing results in trampled stream banks and stirred up sediments that increase erosion. Additionally, removal of riparian vegetation contributes to bank instability and erosion.

2.2.6.9 False Ravine

False Ravine is tributary to Miners Ravine, and will be preserved in open space. Historically it would have been intermittent, but with development surrounding the entirety of this creek, it has become perennial. With more perennial water, more riparian vegetation has begun to grow over the last several years. During the ECORP assessment (2002), construction was ongoing adjacent to False Ravine. False Ravine, although tributary to Miners Ravine, is unlikely to support even the stray salmon or steelhead. Consequently, the assessment of False Ravine centered on classification of vegetation and outfall mapping. Ongoing construction makes it unlikely that all of the outfalls were mapped. The vegetation along False Ravine is blue and live oak woodland, and riparian. In areas where the creek slows and pools, cattails (*Typha spp.*) and other wetland vegetation exists. The only notable non-native species in the False Ravine corridor observed during the assessment were Himalayan blackberry (*Rubus discolor*) and star-thistle (*Centaurea solstitialis*). Several small elderberries (*Sambucus mexicana*) are present in False Ravine. During the survey they were too small to provide potential habitat for the federally-listed threatened Valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*).

2.2.6.10 Secret Ravine

Secret Ravine is the most studied tributary in the Dry Creek watershed. Secret Ravine is a 7.8-mile long perennial stream that flows in a narrow valley underlain by recent alluvial deposits. The contributing subwatershed area is approximately 22.3 square miles. Secret Ravine has one little-known or studied tributary, Sucker Ravine. Roseville Reservoir and several small ponds are also located within this subwatershed.

Above the 220-ft elevation, Secret Ravine is incised in the granitic bedrock and the riparian corridor is very narrow. Species here include white alder (*Alnus rhombifolia*), buttonwillow (*Cephalanthus occidentalis*), and Himalayan blackberry (*Rubus discolor*). Beyond the narrow riparian corridor, the vegetation (where not landscaped) is oak woodland. Typical species include blue oak (*Quercus douglasii*), live oak (*Quercus wislizenii*), Valley oak (*Quercus lobata*), and gray pine (*Pinus sabiniana*). In the lower watershed, the bedrock is composed of volcanic cap rock. Soils in the watershed uplands are very shallow or very impermeable; consequently, surface and subsurface runoff are rapid. The Central Valley alluvial soils are coarse-grained and highly permeable decomposed granite, resulting from products of Placer mining and sluicing and runoff from quarry spills. The riparian corridor here is slightly wider. Fremont cottonwoods (*Populus fremontii*) and willows (*Salix* spp.) are present more often here than in higher reaches. Non-native plant species include catalpa (*Catalpa bignonioides*), fennel *(Foeniculum vulgare*), fig (*Ficus carica*), scarlet wisteria (*Sesbania punicea*), tree of heaven (*Ailanthus altissima*), yellow star-thistle *(Centaurea solstitialis*) , and Himalayan blackberry (*Rubus discolor*).

A 1999 survey by Li and Fields noted that much of the Secret Ravine channel bed consisted of deposited sand material composed primarily of decomposed granitic sand. The source of this material is considered to be from the Gold Rush mining that released large amounts of fine sediment into the watershed in just a few years. This release of

sediment was coupled with irrigated orchards replacing native oak woodlands, creating more highly erodible soil conditions on the uplands compared to the historically vegetated communities. In recent years, rapid development, livestock streamside impacts, off-road vehicle traffic, and the use of the channel as a horse trail has contributed to bank erosion and instability (Fields 1999).

While the source of sedimentation is sand from the historical disturbance associated with quarries and Placer mining, it is also an unfavorable channel morphology that does contribute to riffle and pool flushing that perpetuates this problem. There is an excessive supply of sediment, and channel hydraulics cannot distribute it appropriately. Consequently, excess sand has buried spawning riffles and may negatively affect fry emergence. It has degraded rearing habitat for aquatic invertebrates and salmon and steelhead. The sand buries riffles, reduces gradients, and blocks access to gravel or buried cobbles and interstitial spaces. The sand is also suspected to contribute to unhealthy warming of the stream by slowing water flow (increasing travel time) and making the stream shallower. Despite the sediment-degraded system, Secret Ravine still produces fall-run Chinook salmon and steelhead, despite urban encroachment and other human influenced impacts (Fields 1999).

2.2.6.11 Sucker Ravine

Sucker Ravine is a tributary to Secret Ravine that has not been studied.

2.2.6.12 Reach-By-Reach Descriptions

Reach-by-reach descriptions for Dry Creek and all major tributaries are provided in the following tables. Biological parameters, adjacent land use, and cultural elements are reported in Table 2.36a, while hydrology, physical descriptions, and man-made structures are reported in Table 2.36b

Table 2.363a. Reach by reach tributary descriptions, land use, cultural resources, and biological resources elements (1 pages)

Table 2.363a. Reach by reach tributary descriptions, land use, cultural resources, and biological resources elements (2 pages)

Table 2.363a. Reach by reach tributary descriptions, land use, cultural resources, and biological resources elements (3 pages)

Table 2.363a. Reach by reach tributary descriptions, land use, cultural resources, and biological resources elements (4 pages)

Table 2.363a. Reach by reach tributary descriptions, land use, cultural resources, and biological resources elements (5 pages)

Table 2.363a. Reach by reach tributary descriptions, land use, cultural resources, and biological resources elements (6 pages)

Table 2.363a. Reach by reach tributary descriptions, land use, cultural resources, and biological resources elements (7 pages)

Table 2.363a. Reach by reach tributary descriptions, land use, cultural resources, and biological resources elements (8 pages)

Table 2.363a. Reach by reach tributary descriptions, land use, cultural resources, and biological resources elements (9 pages)

Table 2.363a. Reach by reach tributary descriptions, land use, cultural resources, and biological resources elements (10 pages)

Table 2.363a. Reach by reach tributary descriptions, land use, cultural resources, and biological resources elements (11 pages)

Table 2.363a. Reach by reach tributary descriptions, land use, cultural resources, and biological resources elements (12 pages)

Table 2.363a. Reach by reach tributary descriptions, land use, cultural resources, and biological resources elements (13 pages)

Table 2.363a. Reach by reach tributary descriptions, land use, cultural resources, and biological resources elements (14 pages)

Table 2.363a. Reach by reach tributary descriptions, land use, cultural resources, and biological resources elements (15 pages)

Table 2.36b. Reach by reach tributary descriptions, hydrologic and physical elements, and man-made structures. (1 pages)

Table 2.36b. Reach by reach tributary descriptions, hydrologic and physical elements, and man-made structures. (2 pages)

Table 2.36b. Reach by reach tributary descriptions, hydrologic and physical elements, and man-made structures. (3 pages)

Table 2.36b. Reach by reach tributary descriptions, hydrologic and physical elements, and man-made structures. (4 pages)

Table 2.36b. Reach by reach tributary descriptions, hydrologic and physical elements, and man-made structures. (5 pages)

Table 2.36b. Reach by reach tributary descriptions, hydrologic and physical elements, and man-made structures. (6 pages)

Table 2.36b. Reach by reach tributary descriptions, hydrologic and physical elements, and man-made structures. (7 pages)

Table 2.36b. Reach by reach tributary descriptions, hydrologic and physical elements, and man-made structures. (8 pages)

Table 2.36b. Reach by reach tributary descriptions, hydrologic and physical elements, and man-made structures. (9 pages)

Table 2.36b. Reach by reach tributary descriptions, hydrologic and physical elements, and man-made structures. (10 pages)

Table 2.36b. Reach by reach tributary descriptions, hydrologic and physical elements, and man-made structures. (11 pages)

2.3 Human Environment

Development within the region surrounding the City of Sacramento is rapidly increasing in response to growth pressures in the City. The move towards Placer County is stimulated by its proximity to the City of Sacramento, the Sierra foothills, recreational activities, and available housing. The location of the Dry Creek Watershed along Interstate 80 enhances the likelihood for expansion and development within this watershed, because I-80 provides ready access to other cities along the corridor, passage through the mountains, and efficient transportation of goods and services from nearby communities. Along with an increase in population comes an associated increase in services and development of infrastructure.

The communities within the Dry Creek Watershed approach the current growth pressures with different priorities. For example unincorporated Granite Bay residents are more concerned about preserving their quality of life than with economic development, while, the Town of Loomis must find a balance between maintaining a more rural culture and allowing sufficient growth necessary for providing the economic base for municipal**.**

2.3.1 Population

Current (Census 2000, U.S. Census Bureau, 2001) and past (Census 1990, U.S. Census Bureau, 1997) population within the watershed is reported in Table 2.37 and shown in Figures 2.26 and 2.27; where each dot represents 100 people. Each census block partially within the watershed boundary was assigned a population based on the proportion of its area within the watershed. Census 2000 designated “Urban” and “Rural” areas are also shown on Figure 3.24. Currently, 66% of the watershed is considered urbanized, while 34% remains rural. As expected, the highest population densities are located within the Cities of Roseville and Rocklin in Placer County; and the unincorporated Antelope and Granite Bay areas of Sacramento and Placer Counties. The unincorporated Granite Bay portion supports a moderate population density, with most of the people located in the southwest area.

Table 2.37. Population Estimates By Geographic Area, 1990 and 2000

	1990	2000	Change
Placer County			
Dry Creek Watershed	55295	104328	89%
Other	117501	144071	23%
Subtotal	***172796***	***248399***	***44%***
Sacramento County			
Dry Creek Watershed	45945	67401	47%
Other	995274	1156098	16%
Subtotal	***1041219***	***1223499***	***17.5%***

Source: U.S. Census

Figure 2.26. Census 2000 Map (Robert)

Figure 2.27. Census 1990 Map (Robert)

Several observations are evident:

1. Growth has been more than twice as fast in Placer County than in Sacramento County,

2. Growth in the Dry Creek watershed has been more than twice as fast as in the surrounding region.

3. Most (i.e., 65%) of the growth experienced in Placer County has been within the Dry Creek Watershed.

While the Dry Creek watershed supports a relatively minor proportion of the Sacramento County population (i.e., 5.5%); as of 2000, approximately 42% of the population of Placer County resides within it. Given that this watershed comprises only 6.7% of the land area in Placer County, it is an important economic base for Placer County. Figures 2.26 and 2.27 indicate that most of the population growth between 1990 and 2000 has occurred in the cities of Roseville and Rocklin, and the unincorporated areas of Antelope (Sacramento County) and Granite Bay (Placer County). Table 2.38 reports growth experienced in some particular Placer County geopolitical units.

Table 2.38. Population Growth By Geopolitical Area, 1990 and 2000

Geopolitical Unit	1990	2000	Difference	Difference Proportion of 1990
Roseville	44685	79921	35236	47%
Rocklin	19033	36330	17297	23%
Loomis	5705	6260	555	0.8%
Placer County (Remainder)	103373	125888	22515	30%
Placer County (Total):	172796	248399	75603	100%

Source: U.S. Census

These data indicate that most of the growth (i.e., 70% of the total growth experienced in Placer County) has occurred within the incorporated cities of Roseville and Rocklin. Also, of particular note is the apparent increased population in the upper portions of the Clover Valley Creek, Secret Ravine, and Linda Creek subwatersheds.

2.3.2 Water Resources

Residents within the Dry Creek watershed rely on water supplies from a variety of sources: surface water, untreated groundwater, and treated groundwater. The major public water suppliers are the City of Roseville and the Placer County Water Agency (PCWA). The PCWA operates several water treatment plants, reservoirs, dams, storage tanks, and miles of pipelines and canals within Placer County. Three groundwater wells are also operated by the PCWA. All of these water supplies are from outside of the Dry Creek Watershed; consequently, any PCWA water used within the watershed are additions to the system hydrology.

The Roseville Wastewater Treatment Plan (WWTP) is owned and operated by the City of Roseville. The Placer County Treatment Plant is operated by the Placer County Facilities Services Department. The Roseville WWTP has a total operating capacity of 18 million gallons per day (MGD) and the Placer WWTP has a total capacity of 0.75 MGD.

2.3.3 Economic Base

Approximately two-thirds of the watershed area within Placer County is in unincorporated sections of Placer County. The Cities of Roseville and Rocklin, and Town of Loomis represent the major urban areas within the watershed that compose the remaining one-third. Most of the Sacramento County portion of the watershed lies within unincorporated sections; only a very small fraction is within city limits (Folsom, Citrus Heights, and Sacramento).

Tourism and recreation are considered major industries within Placer County; and, in general, regions that rely on these industries have high unemployment rates, due to the seasonal nature of employment (California Employment Development Department (CEDD, 2002). However, in Placer County, recreational activities are year-round and include a variety of activities, from winter sports and skiing to summer sports and boating (CEDD, 2002). This, combined with its proximity to the City of Sacramento and other cities, has resulted in low unemployment and rapid growth.

Placer County has experienced strong economic growth that is expected to continue. Interstate I-80 longitudinally bisects the upper watershed, providing infrastructure for continued growth within the watershed area. Growth pressures from surrounding areas are likely to affect Placer County and the Dry Creek watershed region. Many residents commute from higher within the Sierra Nevada foothills to municipalities within the Dry Creek Watershed area (Rocklin and Roseville) (Kelley, 2000). Additionally, residents within the watershed may commute to work outside of the watershed to areas such as Folsom and the City of Sacramento.

Fiscal year 1999-2000 revenues in Placer County were $238,347,483 ($978 per capita) and expenditures were $217,937,924 ($894 per capita) (CEDD, 2002). The workforce was 127,900 with an unemployment rate of approximately 3.6%. Unemployment was down from a high of approximately 8.2% in 1992; however, trends appear to be flattening, or on the increase. The percent of residents living in poverty (1999 rate) was 5.8%. The Dry Creek watershed poverty rate was 6.8% in 1990 (Census 1990). In 1995, taxable retail sales, per captia, were $6,786 for Sacramento County and $8,637 for Placer County (Umback, 1997).

In 2000, the City of Roseville began a Sports Tourism campaign for economic development and diversification of the economic base within the City. From 2000 through 2002, there was a direct impact of $4.3 million (2000) to $6.5 (2002) million new dollars contributing to the Roseville economy arising from this initiative (Roseville, City of Economic and Community Services Department, 2002).

Unemployment within the municipalities of Roseville, Rocklin, and Loomis is low, and the workforce is employed in diverse industries. There is no dominant industry employing the majority of the workforce within these municipalities. The top five employment categories are listed in Table 2.39, along with total unemployment and median income (Census 2000).

Table 2.39. Roseville, Rocklin, and Loomis Workforce

City	Unemployment	Median Income	Employment Category	Percent of Workforce
	%	*$*		*%*
Roseville	2.6	57,367	Education, Health, and Social Services	19.8
			Retail Trade	13.2
			Manufacturing	11.3
			Professional, Scientific, Management, Administrative, Waste Management	10.3
			Finance, Insurance, Real Estate, Rental, and Leasing	9.6
Rocklin	1.9	64,737	Education, Health, and Social Services	16.9
			Retail Trade	14.2
			Professional, Scientific, Management, Administrative, Waste Management	10.8
			Manufacturing	10.3
			Finance, Insurance, Real Estate, Rental, and Leasing	9.2
Loomis	1.6	60,444	Education, Health, and Social Services	17.5
			Retail Trade	12.4
			Manufacturing	10.0
			Professional, Scientific, Management, Administrative, Waste Management	9.9
			Construction	9.3

SOURCE: Census 2000

A similar trend is seen for county-wide employment statistics (Table 2.40), although county-wide unemployment rates are slightly higher than the unemployment rate for each municipality. Generally, Placer County has a lower unemployment rate, higher median income, and more diverse workforce than Sacramento County. In fact, from 1990 to 2001, the 72% per capita increase in Placer County income was higher than any of the surrounding counties (Sacramento Area Commerce and Trade Organization, 2003).

Table 2.40. Placer and Sacramento County Workforce.

County	Unemployment	Median Income	Employment Category	Percent of Workforce
	%	$		%
Placer	2.6	57,535	Education, Health, and Social Services	17.4
			Retail Trade	12.2
			Professional, Scientific, Management, Administrative, Waste Management	10.0
			Manufacturing	9.9
			Construction	9.2
Sacramento	4.2	43,816	Education, Health, and Social Services	18.4
			Public Administration	12.3
			Retail Trade	11.5
			Professional, Scientific, Management, Administrative, Waste Management	10.3

SOURCE: Census 2000

The majority of the workforce is employed primarily within private industries (68.9% to 75.7%). However, 23% of the workforce in Sacramento County is employed by the government sector, compared to 17% of the Placer County workforce. The Town of Loomis has the largest self-employed populations (14.4%), and the City of Roseville the lowest (6.9%).

Manufacturing (production workers, engineers, computer engineers, assemblers, and others), services (computer support, janitors and cleaners, instructors and coaches, systems analysts, and others), and retail trade (retail salespeople, cashiers, waitpersons, supervisors and retail managers) are the major growth industries within Placer County. Projected growth in these industries is 5.0 to 7.6% per year (CEDD 2002). Leading manufacturing and service employers within the Dry Creek Watershed region of Placer County are listed in Table 2.41 below. Figures are current through the end of 2000.

Table 2.41. Leading Manufacturing and Service Employers

Manufacturing:	Product Service Description	Location	Number of Employees
Hewlett Packard	Computers and peripheral equipment	Roseville	5,500
NEC Electronics, Inc	Integrated circuits, semiconductors	Roseville	2,000
Formica Corporation	Plastic and composite products	Rocklin	470
TASQ Technology, Inc	E-commerce technology and services	South Placer	440
Hamilton Hallmark	Semi-conductors	Rocklin	300
Oracle Corporation	Internet and network software applications	Rocklin	300
ACE Hardware	Distribution Center	Rocklin	285
Herman Miller, Inc.	Office furniture	Rocklin	285
Prima Publishing	Book publishing	Roseville	240
PASCO Scientific	High-tech products for science education	Roseville	165
Service:			
Pride Industries, Inc	Outsourced business services	Roseville, Rocklin, Auburn	1,712
Sutter Roseville Medical Center	Medical services	Roseville	1,412
Kaiser Permanente Medical Center	Medical services	Roseville	1,412
Sierra Joint Community College	Education, junior college	Rocklin	1,200
Adventist Health System/West	Health care services	Roseville	

SOURCE: EDD, 2002

2.3.4 Projected Growth

Development within the Dry Creek Watershed is occurring at a rapid pace, and this is expected to continue in the future. New businesses are moving into the region, and existing ones are expanding (Kelley, 2000). Additionally, population is growing rapidly, as people move into the area with the businesses, and as growth pressures in surrounding areas push people into this region.

2.3.4.1 Population

Placer County is one of the fastest growing population areas in the state (CEDD, 2002). Total population by 2010 is expected to be approximately 294,350, and by 2020, approximately 406,070 (CEDD, 2002). The population within the Dry Creek Watershed, in particular, is expected to continue to grow. From 1990 to 2000, population in the Dry Creek Watershed grew by approximately 69.6%, or 6.96% per year, based on 1990 population. If this trend continues in a linear fashion, the Dry Creek Watershed population can be expected to reach 211,390 by 2020, or almost one half of the population projected for all of Placer County. Population in 2030 would be approximately 239,050.

2.3.4.2 Water Resources

The major water suppliers in the Dry Creek Watershed are the City of Roseville and the Placer County Water Agency (PCWA). The PCWA manages 255,400 acre-feet (ac-ft) of water. Placer County uses only 8,800 ac-ft of PCWA water; 55,000 ac-ft are exported to the City of Roseville and San Juan Water District (Lamb, 2002). The City of Roseville currently uses 19,800 ac-ft and projected surface water demands by 2030 are expected to rise to 54,900 ac-ft (Lamb, 2002).

In addition to surface water, a large amount of groundwater is used within both Sacramento and incorporated Placer Counties. Groundwater demands in the base year, 1990 were 756,200 ac-ft for Sacramento County and 54,200 ac-ft for Placer County (Water Forum, 2000). By the year 2030, or when full-build out is reached, without incorporation of water use conservation practices, demands for Sacramento County are expected to rise to 957,000 ac-ft and 175,288 ac-ft for Placer County. The increased water usage in Placer County is based on a population growth rate of 3.2% per year from 1990 to 2030. It should be noted that population increases for Placer County, based on census statistics from 1990 to 2000, were actually 4.4%, and the future growth rate may be even higher.

Without conservation measures, the increase in surface and groundwater resource consumption may be three times the current levels. Historical groundwater use resulted in a drop in the confined aquifer hydraulic head, which contributed to changing the regional groundwater hydrology. This impact on groundwater was mitigated in the 1970s by switching from using groundwater resources to more reliance on surface water. However the Dry Creek Watershed overlays the aquifer recharge area, where groundwater resources are recharged by surface water. Consequently, tripling both groundwater and surface water consumption could have a deleterious effect on both regional surface water and groundwater resources and availability. For the Dry Creek Watershed, impacts will likely be greater for groundwater resources, since most of the surface water supplies are within other watersheds.

Wastewater treatment is an additional water resource issue often impacted by increasing population and growth. Wastewater discharges into surface water systems often discharge high nutrient wastewater and other constituents that can contribute to degradation of the water quality. The Roseville Waste Water Treatment Plant (WWTP) is

expected to undergo two expansions to bring capacity up to 100 MGD. Another plant, has been constructed on Pleasant Grove Creek, it has a 12 MGD capacity, bringing southwest corner of Placer County service capacity to 30 MGD.

2.3.5 Public Access/Recreation

Recreation

Tourism and recreation are major attractions of Placer County. The Dry Creek Watershed area, just north and east of the City of Sacramento provides a unique location for access to employment, services, and recreational opportunities. Figure 2.28 shows the public recreational areas within the Dry Creek Watershed.

Birding

Several birding hotspots exist within Placer County; but, none in particular are noted for the Dry Creek Watershed itself. Although the habitat is suitable for a variety of birds, public access is limited. Implementation of the planned Dry Creek Greenway will likely provide more habitat, and allow for public access. Additionally, the Miners Ravine/Secret Ravine bike trail system through Roseville provides some public access to good bird habitat.

Conservation

The Sacramento Valley Open Space Conservancy recently (1999 and 2001) acquired conservation easements for two parcels in the Dry Creek Watershed near Rio Linda. These parcels total 356.3 acres of grazing/habitat land or riparian habitat/grazing lands (Sacramento Valley Open Space Conservancy, 2002). An additional 80 acres was purchased jointly by the Sacramento Valley Conservancy and Sacramento Area Flood Control District in 2002 as part of the Dry Creek Parkway (Sacramento Valley Conservancy, 2002).

Golf

Golf courses within the watershed provide recreational opportunities; but, generally require extensive chemical and irrigation management. Placer County golf courses in the watershed include Indian Creek County Club; Sunset Whitney County Club on Clover Valley Creek; Granite Bay Golf Club, and the Roseville Rolling Greens Golf Course, on an unnamed tributary to Linda Creek. In Sacramento County, the Antelope Greens Golf Course and the Cherry Island Golf Course are immediately adjacent to Dry Creek. The Lawrence Links Golf Course, located on Sierra Creek may soon be converted to a residential development.

Figure 2.28 Public Recreational Areas within the Dry Creek Watershed (Robert)

Parks

Several community parks, recreation areas and preserves are within the Dry Creek Watershed. These provide for public recreation, open space, and habitat. Table 2.42 provides a list of these facilities. In order to facilitate contact with appropriate planning authorities, the list is organized by geopolitical jurisdiction. Where the park has an identified association with a tributary waterway, it has been noted.

Table 2.42. Parks within the Dry Creek Watershed (by geopolitical jurisdiction)

Folsom, City of
- Santa Juanita Neighborhood Park

Loomis, Town of
- Sunrise-Loomis Park

Placer, County of (unincorporated)
- Douglas Ranch Park
- Griffith Quarry Park
- Loomis Regional Park (on Secret Ravine)
- Miners Ravine Nature Preserve (on Miners Ravine)
- Sabre City Recreation Park
- Traylor Ranch Nature Preserve (on Antelope Creek)
- Treelake Park

Rocklin, City of
- Antelope Creek Park (on Antelope Creek)
- Clover Valley Park (on Clover Valley Creek)
- Sunset East Riverwood Park (on Antelope Creek)
- Johnson Springview Park
- Monte Vista Park
- Quarry Park
- Quarry Ridge Park
- Sasaki Park
- Sierra Meadows Park
- Vista Grande Park
- Woodside Park

Roseville, City of
- Cirby Creek Park (on Cirby Creek)
- Cresthaven Park
- Crestmont Park
- Eastwood Park (on Cirby Creek)
- Ferreti Park
- Garbolino Park
- Hillsborough Park
- Kaseberg Park
- Kenwood Oaks Park
- Lincoln Estates Park (near Dry Creek)
- Maidu Regional Park
- Marco Dog Park
- Mark White Park
- Olympus Park
- Ray Lockeridge Park
- Royer Park (on Dry Creek)
- Saugstad Park (on Dry Creek)
- Sculpture Park (on Miners Ravine)
- Sierra Gardens Park (on Cirby Creek)
- Unnamed Park (Corrington Drive)

Table 2.42. Parks within the Dry Creek Watershed (by geopolitical jurisdiction) (continued)

Unnamed Park (Holmfirth Drive)
Unnamed Park (Park Oak Drive, near Secret Ravine)
Unnamed Park (Poppyfield Drive)
Unnamed Park (Scarborough Drive, near Secret Ravine)
Unnamed Park (Sunrise Boulevard at Sun Tree Drive)
Weber Park
Willard Dietrich Park
William Taylor Park (near Dry Creek)

Sacramento, City of
Hansen Ranch Park (on Dry Creek)
Ueda Parkway (on Dry Creek)

Sacramento, County of
Antelope Community Park
Antelope Station Park
Blue Oak Park
Brock Park
Cherry Island Soccer Complex (on Dry Creek)
Depot Park (on Dry Creek)
Dry Creek Parkway (on Dry Creek)
Gibson Ranch County Park
Indian Stone Corral (on Linda Creek)
Lone Oak Park
Memorial Park
Northbrook Park
Orangevale Community Center and Park
Orangevale Park (on unnamed tributary to Linda Creek)
Orangevale Youth Center Park
Pokelma Park
Rio Linda Central Park (on Dry Creek)
Roy E. Hayer Park (on Dry Creek)
Sierra Creek Park (on Sierra Creek)
Tetotom Park
Unnamed Park (Antelope Road at Eagle Point Way)
Unnamed Park (Cherry Lane on Dry Creek)

Future Projects

In response to the need for preservation of public open space and wildlife habitat within a rapidly developing watershed, two projects have been proposed: the Dry Creek Greenway (Placer County) and Dry Creek Parkway (Sacramento County). The Master Plans have been prepared and are available for review at the Counties' offices. The intent of both of these plans is to provide a continuous corridor of green-space along Dry Creek. The planned Dry Creek Greenway is also expected to serve as a linkage within the Folsom Lake State Park, American River Parkway, Ueda Parkway, and Dry Creek Parkway systems; to complete connections between non-contiguous sections.

Additionally, under the Placer Legacy program, habitat conservation planning is being undertaken in the entire portion of the West Placer County. This is anticipated to result in a Habitat Conservation Plan (HCP) and Native Community Conservation Plan (NCCP)

2.3.6 Public Education

Existing educational opportunities provide mechanisms for information dissemination, citizen involvement, and education towards voluntary compliance with the Plan and Plan objectives. Training people in good watershed management techniques and fostering a commitment to their watershed will reinforce structural management practices and other operational management practices. Schools, special interest groups, parks, government agencies, and special programs can assist in the public education process. A few potential participant organizations are listed below:

- Dry Creek Conservancy Citizen Monitoring Program
- Sierra Community College
- Sacramento Valley Open Space Conservancy
- Elementary School districts
- High School districts
- NPDES phase II Stormwater Management Plans (public education programs)

Additionally, entities outside of the watershed (e.g., U.C. Davis, BREN Environmental School) may help provide educational opportunities within the watershed and further watershed improvements.

2.4 Regulatory Environment

Regardless of the Plan objectives and goals, recommended actions must mesh with current regulations regarding land use development and management. Within the Dry Creek watershed, this can be quite complicated, since many jurisdictions overlap. The following section summarizes pertinent regulations applicable to water resources management within the Dry Creek watershed.

2.4.1 Regulatory and Policy Issues

With respect to activities proposed in special resource areas, such as streams, creeks, riparian zones, and wetlands, several federal and state agencies typically must provide permits or other clearances. Table 2.43 summarizes the regulatory environment.

Table 2.43. Natural Resource Permits/Environmental Documentation and Administering Agencies

Authority/Regulation	Permit/Approval/Decision	Agency
Federal Clean Water Act, Section 404	Authorization for fill in "waters of the U.S."	U.S. Army Corps of Engineers
Federal Clean Water Act, Section 401	State Water Quality Certification of Federal Clean Water Act, Section 404 Permit	Central Valley Regional Water Quality Control Board
Federal Clean Water Act, Section 402	General Permit to Discharge Stormwater Associated with Construction Activity	Central Valley Regional Water Quality Control Board
National Historic Preservation Act, Section 106	Concurrence with Federal Agency's "No Effect" Determination	State Historic Preservation Office
Federal Endangered Species Act, Section 7	Incidental Take Authorization	U.S. Fish and Wildlife Service
Federal Endangered Species Act, Section 7	Incidental Take Authorization	National Marine Fisheries Service
California Fish and Game Code, Section 1600-	Streambed Alteration Agreement	California Department of Fish and Game
California Fish and Game Code, Section 2050-	Take Authorization	California Department of Fish and Game
California Environmental Quality Act	Negative Declaration or Environmental Impact Report	Local Jurisdiction or State Agency
National Environmental Policy Act	Finding of No Significant Impact or Environmental Impact Statement	Federal Agency
The Magnuson-Stevens Fishery Conservation and Management Act	Recommendations regarding Essential Fish Habitat	National Marine Fisheries Service

Each of these is discussed, briefly, below.

Federal Clean Water Act, Section 404

Regulated wetlands and other waters of the U. S. are subject to U.S. Army Corps of Engineers' (Corps') jurisdiction, pursuant to Section 404 of the Clean Water Act. Wet areas that may not be regulated by the Corps would include "maintained" stock ponds, irrigated fields, operational agricultural ditches created in upland areas, and "isolated" wetlands.

There are two primary mechanisms for obtaining authorization for impacts to waters of the U. S. from the Corps: a Nationwide Permit and an Individual Permit. The nationwide permit program, which operates using the presupposition that proposed impacts would be minimal, expedites the permitting process by incorporating specific timeframes and alleviating public notice requirements. The individual permit process is more complex than the nationwide permit process and includes an alternatives analysis (to satisfy Clean Water Act, Section 404(b)(1) Guidelines) and public notice. The Letter of

Permission (LOP) is a streamlined version of the Individual Permit, and may be applicable at the discretion of the Corps.

Federal Clean Water Act, Section 401

In California and certain other states, authorizations by the Corps under Section 404 (through both nationwide and individual permits) require the permittee to obtain water quality certification, or a waiver, under Section 401 of the Clean Water Act, from the state-level water quality authority. In California, the appropriate agency is the Regional Water Quality Control Board (RWQCB). The RWQCB may further require anti-pollution type mitigation measures in conjunction with certification. The application must include proof of California Environmental Quality Act (CEQA) compliance (i.e., negative declaration, EIR, statutory exemption, or a categorical exemption); and a processing fee which varies with the amount of impact authorized.

Federal Clean Water Act, Section 402

In California, the National Pollutant Discharge Elimination System (NPDES) is also administered by the Regional Water Quality Control Board. At present, construction activities affecting more than 1 acre of ground disturbance are required to comply with the "General Permit to Discharge Storm Water Associated with Construction Activity (WQ Order No. 99-08-DWG)". In order to comply, a Notice of Intent (NOI) must be filed along with a $1000 application fee. The applicant must prepare and keep on site a Stormwater Pollution Prevention Plan (SWPPP) along with appropriate records from self-monitoring.

Within approximately 4.5 years, each municipality with a population greater than 10,000 will have to have developed and implemented a Stormwater Management Plan. These plans will identify data gaps, priority areas and issues, pre- and post- construction BMPs, and educational programs for stormwater flooding and water quality protection. Most of the municipalities and Placer County have completed their NPDES Phase II plans, and these efforts are in progress.

National Historic Preservation Act, Section 106

Section 106 of the National Historic Preservation Act requires that each federally-sponsored or permitted project consider how that undertaking could affect historic properties. To ensure that historic properties are protected, three steps may be required.

First, there should be a review of all the available information that could help determine whether there may be historic properties in the area of potential effect (APE). Based upon that review, it is determined whether additional survey work is needed to locate historic properties. In this step, the federal sponsoring or permitting agency would determine whether the potential for impact to historic properties has been adequately addressed. If potential impacts are identified, then the federal agency and the State Historic Preservation Office (SHPO) together would apply the National Register criteria to determine whether identified properties are eligible for listing, and thus subject to the Section 106 process. Second, the potential project effects upon eligible (or listed) properties should be assessed. Third, if potential project effects are identified,

consultation with the SHPO and the Advisory Council should be undertaken to identify appropriate mitigation strategies.

Federal Endangered Species Act

Under the federal Endangered Species Act, the U. S. Fish and Wildlife Service (USFWS) and/or the National Marine Fisheries Service (NMFS) regulate the incidental take of federally listed threatened and endangered species. Impacts to such species can be authorized if the take is incidental to otherwise lawful activities and would not jeopardize the continued existence of the species.

If a proposed activity might affect a federally-listed species and requires federal agency authorization (e.g., Clean Water Act, Section 404 permit) or has federal sponsorship, the permitting or sponsoring federal agency must initiate formal consultation with the USFWS and/or NMFS (as appropriate for the species potentially effected) to determine whether their action (e.g., 404 permit issuance) would jeopardize the continued existence of the species.

This dialogue between the two federal agencies is known as a Section 7 Consultation, referring to Section 7 of the Federal Endangered Species Act. The USFWS or NMFS is required to issue a jeopardy, or non-jeopardy Biological Opinion and an incidental take statement, if appropriate, within 135 days. If it is determined that the federal action (e.g., Section 404 authorization) would jeopardize a species, no incidental take statement would be issued. If an incidental take statement is issued in a Biological Opinion, the Corps (or other consulting agency) must adopt any required mitigation measures as conditions of the approval.

In the absence of other federal involvement, incidental take authorization must be obtained directly from the U.S. Fish and Wildlife Service through an application for a Section 10(a) Incidental Take Permit.

California Fish and Game Code, Section 1600-

Under Section 1600 *et seq.* of the California Fish and Game Code, the California Department of Fish and Game requires project applicants to obtain a Streambed Alteration Agreement for projects affecting the bed, bank, or channel of a lake, river, stream. The application to CDFG must include proof of CEQA compliance and a processing fee proportional to the cost of the project. Processing time for Streambed Alteration Agreements includes a 30-day review of the application for completeness, followed by an additional 30-day period to develop a draft agreement.

California Fish and Game Code, Section 2050-

The California Endangered Species Act (CESA) provides protection for threatened and endangered species under Sections 2050-2098 of the California Fish and Game Code. CESA prohibits the “take” of a species, which is further defined as to kill, hunt, pursue, capture, or catch a species. Recently, this definition has been expanded to include habitat modification. The California Department of Fish and Game (CDFG) requires a Take permit that includes substantial biological documentation and requires full

mitigation for the impacts to the species. Where a state-listed species is also federally-listed, the required state-level incidental take authorization may be obtained via a "consistency determination" to be made by CDFG regarding the federal Biological Opinion from the USFWS.

California Environmental Quality Act

The California Environmental Quality Act (CEQA) requires local, regional, and state agencies to document and consider environmental implications of any project. A project is further defined as the "whole of an action which has the potential for resulting in a physical change in the environment, directly or ultimately." The purpose of CEQA is to identify potential adverse environmental impacts that would result from a project and, where possible, to identify mitigation measures or alternatives to reduce adverse impacts to a *less-than-significant* level, where the environmental effect of the proposed project does not reach the threshold of significance, as defined by the Lead Agency. Where such impacts cannot be reduced to a less-than-significant level, the process forces that acknowledgement in an informed public decisionmaking process.

The CEQA compliance process can include the preparation of an initial study to determine whether a negative declaration or an environmental impact report (EIR) would be required. The development of an Initial Study and subsequent negative declaration may take 60-90 days to prepare and process. An EIR may take considerably longer.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires that federal agencies carry out their programs in accordance with the environmental protection policies found at 42 USC 4321. This requires that proposed federal actions be subject to broad-scope environmental analysis to identify environmental effects in order to support informed decisionmaking. A federal agency is "involved" if it sponsors, funds, or permits a proposed activity. Where a proposed action is identified to have a substantial effect, NEPA requires the development of an Environmental Impact Statement (EIS) to disclose the identified effects more fully. Where, lesser impacts are identified, an Environmental Assessment (EA) (the initial analysis) may suffice. A "Finding of No Significant Impact" (FONSI) is supported by such an EA. Where impacts would be substantial if not mitigated, many federal agencies utilize an EA, along with stipulated mitigation measures, to support a so-called "mitigated FONSI."

The Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act establishes measures to protect Essential Fish Habitat (EFH). Congress defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. 1802(10)). The National Marine Fisheries Service (NMFS) must coordinate with other federal agencies to conserve and enhance EFH. Federal agencies must consult with NMFS on all actions or proposed actions authorized, funded, or undertaken by the agency that may adversely affect EFH. In turn NMFS must provide recommendations to federal and state agencies on such activities to conserve EFH. These recommendations may include measures to avoid, minimize, mitigate, or

otherwise offset adverse effects on EFH resulting from actions or proposed actions authorized, funded, or undertaken by that agency.

EFH is considered on the watershed level, which means that it is defined by Hydrologic Unit. Section 305(b)(2)-(4) of the Magnuson-Stevens Act outlines a process for NMFS and the Councils to comment on activities proposed by Federal action agencies that may adversely impact areas designated as EFH. Federal action agencies are required to consult with NMFS on any action authorized, funded, or undertaken that may adversely impact EFH. This consultation process is usually integrated into existing environmental review procedures in accordance with the National Environmental Policy Act, Endangered Species Act, or Fish and Wildlife Coordination Act.

Within 30 days of receiving NMFS' conservation recommendations, Federal action agencies must provide a detailed response in writing to NMFS that includes measures proposed for avoiding, mitigating, or offsetting the impact of a proposed activity on EFH. If the Federal action agency chooses not to adopt NMFS' conservation recommendations, it must provide an explanation. Examples of Federal action agencies that permit or undertake activities that may trigger the EFH consultation process include: Army Corps of Engineers, Environmental Protection Agency, Federal Energy Regulatory Commission, the Department of the Navy, and the National Oceanic and Atmospheric Administration. Fishery Management Councils may also choose to comment on proposed actions that may adversely impact EFH.

In summary, this act expands NMFS jurisdiction over upland development activities. Prior to the Magnuson-Stevens, NMFS was concerned with direct impacts to "instream habitat" and individuals of a special-status fish, including anadromous salmonids, (i.e., all races of Chinook salmon, coho salmon and steelhead). Post Magnuson-Stevens, NMFS has expanded its definition of instream habitat, which now includes not only the entire flood plain, but also any upland action, which may affect conditions in the flood plain ("hydrologic unit"). Prior to Magnuson-Stevens, Designated Critical Habitat for steelhead, included all "waters connected to the Pacific Ocean". Habitat was no longer designated as critical when it could be shown that upstream passage is precluded. However, because of the "hydrologic unit" concept, even activities upstream of designated critical habitat are also under review of NMFS, because of potential downstream effects, including sediment input and increased thermal loading.

2.4.2 Local Land Use Regulation

Although specific activities in special resource areas, such as wetlands, riparian zones, and stream corridors are generally regulated by resource agencies at the state and federal level; in general, land use regulation is generally accomplished at the local level. Various general, specific, and community plans, developed and adopted by the local jurisdictions, regulate almost every aspect of land use within their boundaries. Attendant environmental effects and compliance with these plans are identified, assessed, and mitigation required, pursuant to the California Environmental Quality Act (CEQA).

Figure 2.29 shows general, specific, and community plan coverages in the Dry Creek Watershed. These plan documents range from very simple and general statements of

guiding principles and goals to extremely complex and specific rules and regulations covering almost every consideration in land use planning.

Despite the complexities involved, familiarity with the content of these plans and with the local planning/review/approval process is vital to watershed management, because many of the relevant land use considerations are regulated only at the local level. Because of this variability and complexity, it is not feasible to present each of them within the scope of discussion in this document. Instead, each plan within the watershed has been reviewed, and those policies and statements relevant to the scope of this watershed planning effort have been excerpted and/or summarized. Those excerpts and summaries have been compiled in Appendix 2.16 accompanying this document.

In certain instances, it is known and recognized that plan updates are underway which would render the currently-adopted plans obsolete and/or superseded. Nevertheless, with the exception of the Dry Creek Parkway Master Plan, only currently adopted plans have been presented, because until the new plans are adopted, they are not legally binding, and they could be changed. Further, given the adaptive management approach to be pursued by this plan, it is our intent to update this Plan periodically (as discussed below) to keep it current and relevant. Although the Dry Creek Parkway Master Plan is, technically, still a draft, it has been included herein because it is specific for, and particularly relevant to, a large portion of the lower watershed.

Table 2.43 is a local land use policy matrix providing a simplified representation of the issues dealt with in each of these plans. It is intended only as a guide for the reader to determine whether a particular plan addresses an issue in question in a specific manner and is worthy of more considered review. The omission of a particular element in this matrix doesn't mean that it is not of concern or discussion in the particular plan document, only that a specific (read implementable) policy statement was not identified during review.

The excerpts and discussions presented in Appendix 2.16 are more detailed, and where possible, the actual plan policy language and numbering or internal organization system has been retained. While every effort has been made to provide an objective and thorough review, where strict interpretation of plan language is critical, the reader is encouraged to consult the original document.

Each of the relevant plan documents is described briefly below. Consistent with their presentation in Table 2.44, they have been organized by County, then alphabetically by local planning jurisdiction, and finally, alphabetically by plan name:

Figure 2.29 (Robert)

Table 2.44

2.4.2.1 Placer County Plans

2.4.2.1.1 Loomis, Town of

General Plan

The Town of Loomis covers approximately 7.33 square miles, all of which is located in the Dry Creek Watershed. The Antelope Creek, and Upper and Lower Secret Ravine subsheds are included within its boundaries. This plan calls for the establishment of biking, pedestrian, and equestrian trails. The community's "right to farm" is explicitly acknowledged, and the clustering of development (Planned Unit Development) is recognized as a viable strategy to conserve significant natural resources. Specific setbacks from streams are defined, with prohibitions against building within the 100-year floodplan and the removal of riparian vegetation. The plan calls for the establishment of a long-term maintenance and monitoring program for the Secret Ravine Corridor. The use of on-site stormwater detention is required and Best Management Practices to control sedimentation are called for.

2.4.2.1.2 Placer, County of

Dry Creek-West Placer Community Plan

The Dry Creek-West Placer Community Plan covers approximately 14 square miles. Only the eastern portion of the planning area (approximately 6.74 square miles) is contained within the Dry Creek Watershed (Upper Dry Creek subwatershed). Expressed concerns include ground and surface water quality and quantity, retention of rural character, flooding hazards, Dry Creek riparian corridor preservation, wildlife preservation, and trail connections to Sacramento and Roseville. Denser urban/suburban development, adjacent to agricultural use, is prohibited by restriction of the subdivision of larger parcels to rural residential densities. Infill development is encouraged, as are Planned Unit Developments. The plan calls for pedestrian, bicycle, and equestrian trails. It encourages both public and private ownership of open space to retain natural values. Specific setbacks from streams are specified, along with preservation of the complete Dry Creek floodplain.

General Plan

The Placer County General Plan (1994) covers approximately 2.59 square miles of the Dry Creek watershed located within unincorporated Placer County that is also outside of adopted Specific Plan areas (e.g., Horseshoe Bar/Penryn or Granite Bay). County General Plan policies actually provide the framework for adopted Specific/Community Plan policies, and where the two might appear to disagree, the Plan with the most specific language policy would prevail.

The Placer County General Plan is a very comprehensive policy statement. Specific setback buffers from streams, riparian zones, and other sensitive habitats are defined. Such resources are to be identified prior to development and avoidance of areas "rich in wildlife or of a fragile ecological nature" may be required. Protection is extended to significant vegetation, wildlife, and habitat zones (e.g., riparian zones), as well as to

cultural resources. The Planned Unit Development concept is identified as a way to accommodate density transfer to non-resource rich areas. The permanent preservation of buffer zones through land acquisition, purchase of development rights, conservation easements, and/or deed restrictions is anticipated. The document calls for inclusion of natural land forms and environmental features in the site planning process, and makes explicit the concept that maximum allowable densities may not necessarily be achieved at the expense of such features. It calls for the preservation of agricultural land use in large, appropriately buffered parcels. Regulation of grading activities and the implementation of Best Management Practices (BMPs) to limit soil erosion are stipulated. Development of equestrian, bicycle, and pedestrian trails with regional linkages is a stated objective. The development and use of public water supplies, use of reclaimed wastewater and water conserving landscaping, is encouraged to limit groundwater drawdown. The use of public sewer systems for new developments is required, in order to avoid potential surface water and groundwater quality concerns due to the use of septic systems. The retention of drainageways in their natural state is stipulated; as is the development and use of natural siltation and water quality control practices (e.g., grassy swales). Floodplains are recognized as manageable resources, with prohibitions against development in the floodplain and against increasing downstream flows.

Granite Bay Community Plan

The Granite Bay Community Plan Area covers about 25 square miles. Approximately 23.5 square miles are within the Dry Creek Watershed. It is relevant to the Upper Miners Ravine, Lower Miners Ravine, Strap Ravine, and Linda Creek subwatersheds.

Trails, pedestrian and bicycle, are called for. Stream corridors, including riparian vegetation, are to be kept free of structures and maintained in a natural condition. Building within the 100-year floodplain is generally prohibited. Specific setbacks from streamcourses are defined. The use of Planned Unit Developments is encouraged as a tool to achieve appropriate densities, while protecting natural resources. A Tree Preservation Ordinance is referenced. The plan Calls for Best Management Practices, and references the Placer County Grading Ordinance. The use of easements and/or deed restrictions is recognized as a mechanism to preserve private open space.

Horseshoe Bar/Penryn Community Plan

The Horseshoe Bar/Penryn Community Plan covers approximately 25 square miles. Approximately 20.0 square miles are within the Dry Creek Watershed. It is relevant to the Antelope Creek, Upper Secret Ravine, and Upper Miners Ravine subwatersheds. This plan states the intent to preserve the areas rural residential character, and preserve valuable open space resources, in both public and private ownership using easements and/or deed restrictions. Building in the 100-year floodplain is generally prohibited and specific setbacks from streams and riparian areas are defined. On-site stormwater detention is required. Pedestrian, bicycle, and equestrian trails are called for. Planned Unit Developments (PUDs) are encouraged to provide flexible densities to preserve valuable open space and natural resources. It encourages streetfront riparian habitat orientation, and references a Tree Preservation Ordinance. It refers to a Grading Ordinance and the use of Best Management Practices to control sedimentation.

Groundwater monitoring and restrictions upon the use of groundwater for new development are stated. Although a rural area, the use of septic systems is regulated.

Newcastle Downtown Design Plan

This plan covers a very small area in downtown Newcastle (approximately 0.17 square miles). It recommends that natural open spaces, including the "ravine along the freeway" be cleaned up and improved. It is relevant to the Upper Secret Ravine subwatershed.

2.4.2.1.3 Rocklin, City of

General Plan

The City of Rocklin covers approximately 12 square miles. 9.60 are within the Dry Creek Watershed. The Clover Valley Creek, Antelope Creek and Lower Secret Ravine subsheds are included within it. The plan prohibits grading and other activities within the 100-year floodplain. The use of on-site stormwater detention and water quality treatment measures (e.g., oil-grit separators) is called out. Pedestrian trails and bikeways are supported.

2.4.2.1.4 Roseville, City of

The City of Roseville covers approximately 30 square miles. 13.1 are within the dry Creek Watershed. It is within Roseville that all of the major tributary drainage systems converge to Dry Creek. Thus, the City of Roseville contains parts of the Antelope Creek, Lower Secret Ravine, Lower Miners Ravine, Strap Ravine, Linda Creek, Cirby Creek, and Upper Dry Creek watersheds. The City is also covered by several specific plans, which, generally, are very comprehensive and very specific with respect to policy items. Policy items such as setbacks from streams, instead of being specified in terms of a number of feet from the streams, riparian zones, and/or floodplains, instead are defined by development of parcel maps, with specific policies particular to these parcels. The "Infill" area is not covered by a specific plan, but relies upon the policy statements in the General Plan for guidance with respect to development issues. The following specific/general plans, generally organized from upstream to downstream, are relevant to the Dry Creek Watershed:

- Stoneridge Specific Plan
- Northeast Roseville Specific Plan
- Southeast Roseville Specific Plan
- North Central Roseville Specific Plan
- Infill (City of Roseville General Plan)
- Northwest Roseville Specific Plan

Because of the breadth and complexity of this combination of Specific Plans and General Plans, no attempt to summarize policy issues has been made in this discussion. Instead, the reader is encouraged to determine which Specific Plan is relevant to his/her particular interest, then review the excerpt/summary presented in Appendix 2.16. In general terms, the content of each is represented in Table 2.43.

2.4.2.2 Sacramento County Plans

2.4.2.2.1 Citrus Heights, City of

General Plan

The Citrus Heights General Plan covers the area within the incorporated City of Citrus Heights in Sacramento County. There is very minor overlap with the Dry Creek Watershed, consisting of only 0.42 square miles.

With the exception of designated open spaces, the area is almost completely developed. The open space land use designation provides for "outdoor recreational uses, habitat protection, agriculture, drainage features, public and quasi-public uses, and other areas typically limited for human occupation due to public health and safety features such as floodways or unstable soils or environmentally-sensitive features", including cultural resources. The plan requires that requests for rezonings to increase the allowable residential density in all neighborhoods shall only be approved for projects providing superior design and enhanced community benefit, with the burden of proof placed upon the applicant to demonstrate superior design and enhanced community benefit, including no negative effect upon storm drainage (within the local area), and adequate public infrastructure, including streets, water, and sewer, is available to serve the project. New developments are required to preserve and enhance significant natural features (such as creeks, wetlands and trees) and retain the existing topography, with the concept that natural allowable densities may not necessarily be achieved at the expense of such resources. Resource conservation policies include the preservation of continuous riparian corridors and adjacent habitat along the City's creeks and waterways. Development standards are to protect habitat areas from encroachment of exotic landscaping, lighting, and toxic substances; and prevent the removal of significant vegetation, including native trees. Flood control and other maintenance activities in the City's creeks and waterways are to be carried out in compliance with Memoranda of Understanding with the California Department of Fish and Game, and will not create habitat that exceeds thresholds established by the Sacramento-Yolo Mosquito and Vector Control District. The City will provide for recreational trail rights-of-way along local creek channels through development easements and agreements which recognize the rights of adjoining property owners, the safety of users, and maintenance of natural areas. New developments are to provide linkages to existing and planned open space systems. The City commits to work with Sacramento County and other local, regional, state and federal agencies to develop flood-control measures, and to finance, construct and plan improvements to minimize flooding in and around the City of Citrus Heights; and to continue to implement floodplain zoning to comply with State and federal floodplain development requirements. Channels, pipes and inlets of the storm drain system are to be maintained annually, and building, grading, and fill within natural swale areas is prohibited. This plan requires implementation of Best Management Practices (BMPs) and design guidelines for all development to use to meet Federal National Pollution Discharge Elimination System requirements. New development must ensure that adequate water supply and distribution facilities are available to serve the community. In order to combat groundwater drawdown, new development is to be approved only if water purveyors can demonstrate an adequate water supply and delivery system. The plan requires that the City will work with the Sacramento North

Area Groundwater Management Authority to formalize combined use agreements among regional water providers, encourage retrofitting of existing developments with waterconserving devices and landscaping, and support efforts of the Sacramento County Regional Sanitation District in wastewater reclamation.

2.4.2.2.2 Folsom, City of

General Plan

The Folsom General Plan covers the incorporated City of Folsom in Sacramento County. There is minor overlap, consisting of 0.60 square miles, within the Dry Creek Watershed.

The primary goal of the Folsom General Plan is to "retain and enhance Folsom's quality of life, separate identity and sense of community," believed defined by, among other things, the American River, tributary streams, natural vegetation, topography, and native wildlife. A grading ordinance is implemented to ensure that natural vegetation, landscape features, and open space are protected. Development along streams requires development of a long-term management plan for the corridor. Only areas served by municipal utilities may be developed, and inclusion of open space is a requirement for all projects, 30% for residential developments. Oak savannas are specifically identified as worthy of preservation. Clustering and density transfer is encouraged to protect significant natural features. Bicycle and pedestrian trails are specifically identified goals. A tree ordinance is implemented to protect Heritage trees. Significant natural habitat systems (e.g., riparian habitats, oak woodlands, marshes, and wetlands) are targeted for long-term preservation. Surface and groundwater quality are specifically protected. Runoff surface water quality and quantity are monitored and controlled. Building within the 100-year floodway, while not specifically prohibited, is regulated to ensure no change in flows.

2.4.2.2.3 Sacramento, City of

North Sacramento Community Plan

The North Sacramento Community Plan covers approximately 13 square miles, but only approximately 0.50 square miles in the northwest corner lie within the Dry Creek Watershed. This area includes a large expanse of floodplain at the extreme downstream terminus in Lower Dry Creek subwatershed. The plan acknowledges this areas use for open space and calls for the establishment of a bikeway with linkage to the regional system. The plan calls for an enhancement of the visual amenity of the Dry Creek corridor and long term maintenance by maintenance district.

2.4.2.2.4 Sacramento, County of

Antelope Community Plan

The Antelope Urban Study Area Community Plan (1984) covers approximately 5.59 square miles in the central portion of the lower watershed. This area has been subject to intense growth over the last few years. Groundwater monitoring and the development of surface water supply is recommended. Maintenance of drainageways in their natural

condition, and the development of associated trail systems, in conformance with the design standards of the *Sacramento County Bikeways Master Plan,* is recommended.

Dry Creek Parkway Master Plan

The Dry Creek Greenway Master Plan, although still a draft, has been included in this section because it represents a comprehensive policy statement regarding development and management of a distinct and geographically significant portion of the watershed, namely the Dry Creek corridor from the Sacramento-Placer County line downstream to the edge of the City of Sacramento. This area, a 60 mile open space and trail system, is located in the unincorporated portion of Sacramento County, and is subject to the land use policies of other Specific Plans in the (i.e., Rio Linda/Elverta and Antelope), however the Parkway Master Plan is much more specific to (and thus, relevant to) management of the creek corridor and adjacent areas. Specific setbacks and allowable uses in the Parkway are described, as are prohibitions against destructive vegetation management practices, and uncontrolled and concentrated runoff. The plan's many policies are oriented toward maximizing the areas potential for flood storage/conveyance, recreational potential, and use for wildlife habitat.

East Antelope Specific Plan

The East Antelope Specific Plan area covers only approximately 1.05 square mile in the extreme east end of the Antelope Community. It is located entirely within the Upper Dry Creek subwatershed, with a small portion of the western end draining to Sierra Creek. Density transfers between subareas in the plan are allowed (Planned Unit Development). Pedestrian and bicycle trail development is specified. A master drainage plan, which includes on-site stormwater detention is required. The use of groundwater is restricted. Septic systems are allowed in rural residential zones.

General Plan

The Sacramento County General Plan, adopted in 1993, underlies the various specific and special area plans covering the unincorporated portions of the watershed in Sacramento County. The land use diagram identifies Agricultural-Residential (1-10 dwelling units/acre), Low Density Residential (1-12 dwelling units/acre), Recreation, Natural Preserve, and Agricultural-Recreation Reserve land uses within the Dry Creek watershed corridor. These designated land uses allow for population densities ranging from 0.25-30 persons/acre, and recognize the value of natural resources and recreation potential within the plan area. The Land Use Element recognizes the inevitability of growth, but directs it to "urban growth areas" (not within the Dry Creek watershed corridor). Applicable stated objectives include "efficient buildout of existing agricultural-residential areas [located within the Dry Creek watershed corridor] to meet rural residential demand without contaminating or overdrafting groundwater aquifers. For those areas where one and two acre lots are allowed, public sewer and water systems are to be extended, and septic systems are not to be replaced when obsolete. Habitat enhancement, open space protection, and cohesive urban design are to be accomplished by coordination with local, state, and federal resource regulating agencies (e.g., Corps of Engineers, U.S. Fish and Wildlife Service, California Department of Fish and Game). The Circulation Element incorporates the 2010 Bikeway Master Plan by

reference. The Conservation Element calls for the maintenance of surface water flows and water quality to protect environmental resources and provide recreational benefits, Best Management Practices (BMPs) to protect water quality, surface water quality monitoring, groundwater monitoring (for quantity and quality), management of marsh habitats and riparian woodlands (actually to accomplish a 10% increase in area by 2010), and prohibition of fill in the floodplain. The Open Space Element calls for fee title acquisition and/or dedication of development rights for parks, floodplains, and other open space areas, as well as density transfers to achieve appropriate open space preservation.

North Highlands/Foothill Farms Community Plan

The North Highlands-North Central Area Community Plan covers the unincorporated area in Sacramento County between the City of Citrus Heights and the Rio Linda-Elverta Community. It is bounded on the north by the Antelope Community. There is relatively minor overlap (1.10 square miles) with the Dry Creek Watershed. It calls for open spaces with integral trails systems, and the acquisition of easements to provide for regional trail linkage. Drainages are to be left in their natural condition, with only parkway and open space uses allowed in the flood plain. Potential enhancements could be provided by a tree-planting program. Finally, the plan calls for cooperative planning among local water service agencies to provide for public water supply (rather than using groundwater wells).

Orangevale Community Plan

The Orangevale community covers approximately 10 square miles. Approximately 5.17 square miles are in the Linda Creek subwatershed. This very old (i.e., 1976) plan encourages the retention of rural-residential community with significant residentially based agricultural use. It calls for the use of Planned Unit Developments to preserve valuable natural resources.

Rio Linda/Elverta Community Plan

The Rio Linda and Elverta Community Plan area overlaps approximately 4.60 square miles of the Lower Dry Creek watershed. The 1998 Policy Plan document states that guiding principles for the plan are to support the future Dry Creek Parkway as a major open space/recreational resource, to recognize and maintain opportunities for trail systems, and to preserve and enhance areas of natural resources (including cultural resources). Relevant policies include the establishment of buffers along drainage corridors to mitigate environmental effects and to provide for trails. Clustering is identified as a method to maintain large open space areas. New development is required to dedicate open space, and the stream environments of the tributaries to Steelhead Creek are to be maintained in their natural condition. With respect to trail development, the Sacramento County Open Space Task Force, Trails and Bikeway Report and the Rio Linda and Elverta Park and Recreation Master Plan are to be implemented. The comprehensive Dry Creek Parkway Plan (still draft) is to be implemented. All new development is to be served by public water and sewer. No further draw-down of groundwater is to be allowed, and Best Management Practices are to be implemented to protect surface water quality. On-site stormwater detention is to be

implemented for new development projects, while a regional approach is encouraged to remediate the existing situation. Building and vegetation removal in the Dry Creek floodway are generally prohibited.

3.0 WATERSHED MANAGEMENT ANALYSIS AND IDENTIFICATION OF KEY ISSUES

Assembled data regarding known watershed conditions, discussed in Section 2.0, were assessed in light of the overall management goals. The Dry Creek watershed is a complicated system; the physical environment, history of modifications, current management practices, growth pressures, and demographics all affect the current status.

3.1 Key Issues

Recognized planning issues were derived from the discussions at regular Dry Creek Watershed Council meetings, as well as those identified by the consulting team developing the plan, based on analysis of available data. Six major issues were identified as follows:

1. **Fisheries Management**

   The general perception is that development throughout the watershed has had a detrimental effect upon what is believed to have been, historically, relatively productive fisheries habitat, particularly within Miners and Secret Ravines. Development is perceived to have damaged fisheries habitat.

2. **Riparian and Floodplain Habitat Management**

   Although also contributing to a perceived degradation of fish habitat, the loss of riparian and floodplain habitat in and of itself, is generally perceived to be a significant negative impact resulting from development.

3. **Water Resources Management**

   Water resources management addresses public water supplies, wastewater, stormwater, and nuisance/augmented flow. Development is perceived to have negatively modified watershed hydrology and water quality by modifying flow conveyances, water storage, water supplies/amount within the watershed, and input of pollutants. While these functions are related to Fisheries Management and Riparian Habitat and Floodplain Management, they are also separate issues as related to human use and resource needs. Flooding affects developable area, and has affected development historically within the floodplain. Removal of levees for management of Fisheries, Riparian, and Floodplain Habitat could negatively impact current human resources and use. Additionally, water quality standards for human use, as well as aquatic life support, are applicable to the water bodies within the watershed.

4. **Development and Growth**

   Although development is considered a negative factor in terms of impact on watershed health indicators, it nonetheless contributes to serve the population's socioeconomic, physical, and quality of life needs. Unless population growth is curtailed, solutions must consider balance and compromise between competing issues.

5. **Open Space Preservation**

   Preservation of habitat, including non-riparian habitat, is important for ecological health and special status species support. Designated Open Space areas are intended to serve the function of habitat preservation. Non-riparian habitat management issues must also be addressed in light of development and overall watershed management.

6. **Public Education and Involvement**

   In order to ensure the rehabilitation and long-term preservation of the naturally functioning watershed, it is necessary to have public support. In order to generate public support, it is necessary to educate and involve them. In this way, persons previously uninvolved become new "stakeholders", with an enhanced understanding and appreciation of the resource.

Several human and environmental factors are inherently involved in management of these key issues. Environmental factors affecting management of these issues are discussed in the table below (Table 3.1), along with potential constraints and opportunities for management. These constraints and opportunities represent both long term planning issues (e.g., physical resources; land use, public facilities, habitat conservation), as well as operational issues (e.g., point source discharge uses, flow control facilities, water quality practices, Best Management Practices (BMPs) for agriculture).

3.2 Key Opportunities

In addition to addressing the perceived problems discussed above, the group has recognized that there are key opportunities to improve the existing conditions with respect to long-term management:

1. Development of Recreational Resources

   Many of the relevant local land use plan documents call for the development of trail systems and reference a regional planning effort for multi-use (i.e., bicycle and pedestrian) trails. The regional concept plan would provide linkage from the American River Parkway (near Folsom), through the Dry Creek watershed, to the

Table 3.1. Causes of Impairment, Opportunities, and Constraint

Table 3.1. Causes of Impairment, Opportunities, and Constraint (Continued2)

Table 3.1. Causes of Impairment, Opportunities, and Constraint (Continued3)

Table 3.1. Causes of Impairment, Opportunities, and Constraint (Continued4)

Table 3.1. Causes of Impairment, Opportunities, and Constraint (Continued5)

Table 3.1. Causes of Impairment, Opportunities, and Constraint (Continued6)

Table 3.1. Causes of Impairment, Opportunities, and Constraint (Continued7)

Table 3.1. Causes of Impairment, Opportunities, and Constraint (Continued8)

Table 3.1. Causes of Impairment, Opportunities, and Constraint (Continued9)

Table 3.1. Causes of Impairment, Opportunities, and Constraint (Continued10)

Dry Creek Parkway (north of Sacramento). Linkage with existing trails there would establish a 70-mile loop. Linkage through the Dry Creek watershed would significantly contribute to recreational resources and open space enjoyment available to residents of both Sacramento and Placer Counties. Pursuit of this strategy involves several local land use jurisdictions with various levels of commitment and funding. Portions of this potential regional network, like those in Roseville and in the lowest portions of the watershed, are already in place. Although the upstream portions of Antelope Creek, Secret Ravine, and Miners Ravine may be too severely constrained by private property ownership, there may be some opportunity to develop "spur" trails into these tributary systems.

2. Restoration/Enhancement of Biological Resources

In general terms, the potential for restoration and enhancement of biological resources resides in publicly-owned and or –controlled open spaces, typically within the regulated area of the 100-year floodplain. For the most part, such areas only exist in the lower portions of the watershed, beginning at Rocklin and Roseville and extending downstream. There, the potential exists for riparian revegetation efforts which could achieve not only fish and wildlife habitat enhancement and open space enjoyment, but also simultaneously address bank stabilization and flood control issues.

3. Land/Conservation Easement Acquisition

In order to permanently protect the floodplain and the investment made in such efforts as restoration and enhancement projects and drainage controls, every opportunity should be taken to acquire such open spaces, or to place them under permanent conservation easements. In addition to public ownership or holding of easements, several private-sector non-profit organizations have become locally-established alternatives, largely in response to agency-issued (i.e., Corps of Engineers) permit requirements. Those operating in our area include:

- Center for Natural Lands Management
- Environmental Stewardship Foundation
- Habitat Management Foundation
- Trust for Public Land
- Sacramento Valley Open Space Conservancy
- Wildlife Heritage Foundation

4.0 RECOMMENDED DRY CREEK WATERSHED MANAGEMENT PLAN

While it is important to look at all data regarding a system, there is an inherent danger in considering anecdotal information and single occurrence data as representing fact. This type of information should not be ignored, as it is useful in indicating the potential situations and impacts that may be present and avenues of investigation; but not relied upon as definitive determinants of stressors or watershed health. However, complicated ecological systems cannot be simplified or easily managed. There will likely never be a sufficient level of understanding to be absolutely certain that all stressors have been identified, all stressors' impacts on watershed health are known, and what particular management strategies will solve the problems. Nonetheless, unless action is taken in the near future, unless specific issues are identified and goals and management strategies identified, conditions will continue to degrade. Consequently, Adaptive Management is the key to effectively managing such environments. As more information is obtained, management strategies and priorities are revised towards reassessed goals.

4.1 Adaptive Management

The concept of adaptive management, acknowledges the dynamic nature of natural systems and the changing state of knowledge and developing management strategies. Quite simply, adaptive management involves acknowledging new information, and making objective judgments regarding whether to change strategies to better achieve management objectives. This plan should be considered a "living" document. Where experience shows that there is little value to the pursuit of a particular strategy, or line of inquiry, that avenue should be abandoned. If new information indicates an alternative strategy is effective, the plan should provide the flexibility and allow the latitude to pursue it. If strategies or necessary changes to management are not evident, a more experimental approach may be used, where different approaches are tried.

It is difficult (if not impossible) to predict what adjustments might be necessary or desirable in the future. This document has been structured so that technical information can be accumulated in the Appendices as it is compiled, while general descriptive information and strategic issues remain in the body of the document. Thus, when a particular project report is issued, or a technical study is completed, it can be added to the appendices without the need to revise the plan document (per se). Nevertheless, it is recommended that additions to the appendices occur only with the approval of the DCWC.

In order to keep the plan document current and relevant, it is recommended that the following items be reviewed on an annual basis:

- The goals and objectives for the collaborative planning effort should be reviewed, revised as necessary, and readopted.
- The list of signatories to the Memorandum of Understanding should be updated.

- All local planning jurisdictions should be canvassed for newly-adopted General, Specific, and/or Community Plan documents. They should be reviewed by the appropriate subwatershed team (if established), maps revised as appropriate, and excerpts/summaries should replace existing discussions in the appendices to the plan.
- All resource permitting requirements should be reviewed, and revised as appropriate.
- The California Department of Fish and Game's Natural Diversity Data Base should be queried on an annual basis to identify new occurrences of special-status species.
- Monitoring data from ongoing programs should be reviewed to determine whether plan revisions or changes to management strategy are warranted.
- Other newly reported data, coming to the group's attention by any means during the preceding 12 months, should be evaluated by the group and a determination made regarding whether it warrants a revision to the plan discussion or strategy.
- Specific goals should be periodically reassessed to determine if they have been met and if prioritization or tasks should be changed based on the outcome of the above assessments.
- A summary record of revisions made should be kept on the title page in order to document revisions.

4.2 Potential Environmental Stressors and Management Goals

Evaluation of available data for the Dry Creek watershed allows for identification of potential impacts associated with each identified management issue. It also identifies data gaps that preclude adequate assessment/determination of either impacts or sources of impacts. These impacts are grouped into categories that identify potential stressors or sources, based on the evaluation of the watershed existing environment, in order to remove some confusion that may be introduced by grouping items into the management issues identified in the previous section. Specific stressors, their potential impacts, and associated issues were derived from analysis of the available data. Some stressors or factors that may impact issue management were not included due to either the inability to manage or alter that particular stressor (e.g., soils, geology) or because the other stressors appeared to have a more significant impact following analysis. However, additional information will indicate whether other stressors need to be included or some eliminated from analysis. Additionally, in light of the identified stressors and their impact on management issues, specific goals were identified for mitigation. Table 4.1 lists the management issues, the potential stressors affecting the system, and specific goals for mitigation.

Table 4.1. Specific Impacts, Stressors, and Specific management Goals

Table 4.1. Specific Impacts, Stressors, and Specific management Goals (continued2)

Table 4.1. Specific Impacts, Stressors, and Specific management Goals (continued3)

Table 4.1. Specific Impacts, Stressors, and Specific management Goals (continued4)

Table 4.1. Specific Impacts, Stressors, and Specific management Goals (continued5)

Table 4.1. Specific Impacts, Stressors, and Specific management Goals (continued6)

Table 4.1. Specific Impacts, Stressors, and Specific management Goals (continued7)

Table 4.1. Specific Impacts, Stressors, and Specific management Goals (continued8)

Table 4.1. Specific Impacts, Stressors, and Specific management Goals (continued9)

Table 4.1. Specific Impacts, Stressors, and Specific management Goals (continued10)

5.0 PLAN IMPLEMENTATION

This plan is meant to provide a starting point for managing the Dry Creek Watershed. It is meant to act as a starting point in determining initial management issues and identifying management goals. In order for this plan to be successful, management goals must be prioritized and key areas of action targeted. Considering the issues, stressors, opportunities and constraints, and specific goals identified in the previous sections, the Dry Creek Watershed Council (DCWC) can prioritize goals and tasks for mitigation of watershed health.

5.1 Policy Considerations

The following policy recommendations will facilitate management and implementation of the watershed management plan (WMP) and its component plans:

1. The DCWC should provide continuous long-term management of the WMP. It must provide ongoing assessment of progress toward assessment and project goals. Some projects listed in component plans have already been accomplished.

2. The DCWC should develop an MOU among watershed entities to cooperate to implement the WMP.

    a. The DCWC should develop a budget for implementing the WMP based on administration and projects. Local plans and projects should budget for coordination of the watershed management plan. Funds can come both from organizational budgets and for grants funding projects and administration.

    b. Entities should agree to share resource data and GIS files. Plans, data and other information should be compiled on CD and /or posted on a website for unrestricted access.

    c. Entities should agree to coordinate projects to reduce competition for funding.

    d. Local jurisdictions should adopt measures to streamline approval and permitting of WMP sponsored projects.

3. Divide the watershed into subwatersheds to facilitate assessment and project implementation. Subwatersheds should be prioritized for assessment and project development and implementation. Assessment of impervious cover should be a priority in each subwatershed.

4. Cataloge all public and private land areas that have open space associated with them such as school, parks, cemeteries, golf courses, open space, mitigation areas, preserves, any easement protected areas, and any other set aside areas.

Describe and map these areas to provide a basis for evaluating the overall condition of the remaining natural area of the watershed, and for developing management strategies that will improve watershed function, especially corridors for wildlife.

5. The plan should develop target values for water quality parameters, habitat values, stormwater hydrographs, and other parameters.

6. The plan should develop management standards and specific projects to be recommended to local jurisdictions that will help reach target values, as sufficient information becomes available.

7. The DCWC must make an effort to inform watershed residents of the Plan and involve them in plan implementation.

5.2 Priority Assignment

5.2.1 On-going External Actions

Table 5.1 identifies the current projects and actions and their status being undertaken within the watershed. The current projects and actions may be used to target and prioritize specific goals and to identify initial actions arising from this Plan. Data from these on-going projects will assist in the follow-up determination of actions and in assignment of priorities.

In light of DCWC's recognized issues, concerns, and/or identified opportunities, the DCWC should be pursuing external actions. External actions recommended may include the pursuit of:

- Political involvement at the local level
- Participation in the regulatory processes
- Education and Public Involvement
- Site-specific improvement projects
- Landscape level (i.e., watershed or subwatershed) improvement programs
- Endorsement, adoption, and/or implementation of plans
- Identification of funding sources for implementation

Table 5.1. On-Going Projects and Studies with Dry Creek Watershed

Table 5.1. On-Going Projects and Studies with Dry Creek Watershed (Continued2)

Table 5.1. On-Going Projects and Studies with Dry Creek Watershed (Continued3)

Table 5.1. On-Going Projects and Studies with Dry Creek Watershed (Continued4)

Table 5.1. On-Going Projects and Studies with Dry Creek Watershed (Continued5)

5.2.2 Prioritization

Specific goals identified in Section 4.0 are prioritized in Table 5.2. These items are organized in according to the primary stressors that are identified in the above discussion regarding perceived problems. They are prioritized according to the following criteria:

- Urgency
- Majority of Effect
- Availability
- Implementability

In a joint exercise, the DCWC has identified specfic goals to pursue, and as information and opportunities become available, will detail specific tasks to meet the these goals. Table 5.2 is a working document for assigning priorities to meet overall watershed management issues. Priorities are assigned based on:

Tier 1 – These goals must be considered for all actions and studies undertaken within the watershed; active effort for funding and implementation

Tier 2 – These goals are likely to fit under other initiatives and implementation and funding opportunities will be researched and applied.

Tier 3 – Additional needs that are considered priority goals for the watershed. Implementation will depend upon available funding and resources.

5.3 Action Plan

Coordination between the DCWC and experts will enable appropriate selection of tasks to meet the priority goals. This section provides a starting point for identifying the specific actions supported by the DCWC, the personnel responsible for oversight, and how the effectiveness of each task will be evaluated in terms of meeting the priority specific goals. Tasks will be adapted as goals and needs change and as data is gathered and assessed (new prioritization or specific impacts may come to light during the life of this watershed plan). Funding opportunities and implementation strategies will also be identified for the priority tasks listed in Section 5.2.

5.3.1 Recommendations for Internal (DCWC) Action

Dry Creek Watershed Council Organization

The Dry Creek Watershed covers over 101 square miles, includes nine tributary drainage systems, and spans 8 geopolitical jurisdictions with over 22 relevant adopted general, specific, or community/area plans. Given this complexity, it is recommended that the DCWC organize itself into smaller functional units specific to subwatersheds, as outlined in Table 5.30. Each subwatershed team would then have a smaller area of responsibility, fewer political issues to track, and more specific technical considerations upon which to focus. This would allow more efficient application of volunteer time and

Table 5.2. Specific Management Goals Priorization

Table 5.2. Specific Management Goals Priorization (Continued2)

Table 5.2. Specific Management Goals Priorization (Continued3)

Table 5.2. Specific Management Goals Priorization (Continued4)

Table 5.2. Specific Management Goals Priorization (Continued5)

Table 5.2. Specific Management Goals Priorization (Continued6)

Table 5.2. Specific Management Goals Priorization (Continued7)

Table 5.2. Specific Management Goals Priorization (Continued8)

Table 5.2. Specific Management Goals Priorization (Continued9)

Table 5.2. Specific Management Goals Priorization (Continued10)

effort to specific areas of concern. The integrity of the watershed group as a whole, would still be maintained by the regular monthly meetings, with updates provided by each of the subwatershed groups.

The recommended internal DCWC structure is presented in Table 5.3.

Members of each subwatershed team should actively track development applications and policy developments within their subwatershed area. Specifically:

- Local planning jurisdictions should be canvassed monthly for new development/project applications.
- The Corps of Engineers web-site should be required monthly for public notices
- Planning commission, City Council, and/or Board of Supervisors meetings should be attended or agendas and the minutes reviewed for relevant discussion items.
- Relevant items should be brought to the DCWC's attention at regular monthly meetings.

5.3.2 Preliminary Cost and Funding

To be determined based on prioritization and task identification, in light of grant and other funding cycles available at the times of determination.

Table 5.3. Recommended Internal Organization

Subwatershed Team	Geopolitical Jurisdictions	Planning/Policy Documents
Antelope/Clover Valley Creek	Placer County City of Rocklin City of Roseville	❑ Placer County General Plan ❑ City of Rocklin General Plan ❑ City of Roseville- North Central Specific Plan ❑ City of Roseville- General Plan (Infill Area)
Secret Ravine	Placer County Town of Loomis City of Rocklin City of Roseville	❑ Placer County General Plan ❑ Horseshoe Bar/Penryn Community Plan ❑ Town of Loomis General Plan ❑ City of Rocklin General Plan ❑ City of Roseville- Northeast Specific Plan
Miners Ravine	Placer County City of Roseville	❑ Horseshoe Bar/Penryn Community Plan ❑ Granite Bay Community Plan ❑ City of Roseville- Stoneridge Specific Plan ❑ City of Roseville- Northeast Specific Plan
Linda Creek/Strap Ravine/Cirby Creek	City of Folsom Placer County Sacramento County City of Roseville	❑ City of Folsom- General Plan ❑ Granite Bay Community Plan ❑ Orangevale Community Plan ❑ City of Roseville- General Plan (Infill Area) ❑ City of Roseville- Southeast Specific Plan
Upper Dry Creek	City of Roseville Placer County Sacramento County	❑ City of Roseville-General Plan (Infill Area) ❑ Dry Creek-West Placer Community Plan ❑ East Antelope Specific Plan ❑ Antelope Community Plan
Sierra Creek/Lower Dry Creek	Sacramento County	❑ Antelope Community Plan ❑ North Highlands-Foothill Farms Community Plan ❑ Rio-Linda Elverta Community Plan ❑ Dry Creek Parkway Plan ❑ North Sacramento Community Plan

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