Chapter 5
Watershed Assessment

This chapter summarizes information assessing current conditions in the Laguna Creek Watershed. The assessment phase of this Plan represents the first effort to perform a comprehensive characterization and assessment of natural resource conditions in the Laguna Creek Watershed. Although several previous projects focused separately on either upper or lower watershed conditions, there were no prior comprehensive efforts to study the watershed as a whole.

5.1 Overview of Watershed Assessment

Purpose and Development of Watershed Assessment

The purpose of the Laguna Creek Watershed Assessment was to gather and evaluate data and information to:

- characterize the existing baseline conditions of the Laguna Creek and its resources;
- provide clues as to the historic form and function of the creek;
- study the drainage functions and response of the Laguna Creek system under existing and future land use scenarios, with emphasis on upper watershed conditions; and

- recommend future actions to protect, restore, and/or enhance stream resources.

In July 2005, the Laguna Creek Watershed Grant Oversight Committee assisted the technical consultants to prepare a matrix outlining questions that the watershed assessment was designed to answer, the types of data to be collected, and the methods of data collection (see Appendix C). The findings and recommendations presented in this chapter address the Watershed Assessment Plan questions by providing as clear a picture as possible of current natural resource conditions within the stream channel and associated upland riparian buffer areas, and recommending further monitoring and actions where necessary.

Defining the Desired Stream Condition

Hydrologic and habitat conditions in the Laguna Creek Watershed have changed dramatically over the past several decades. Increased runoff from agricultural and urban land uses has transformed what once were intermittent channels into low-gradient perennial streams. This transition continues today as development converts land use in the upper watershed, and will likely continue into the future as a result of changing seasonal precipitation patterns (climate change) and growing trends in water use efficiency practices. A watershed in transition presents challenges for watershed management planning.

In the past, water resource management goals for Laguna Creek and its tributaries were based primarily on agricultural and flood reduction considerations. However, changes in both the quantity and quality of stream water, especially during dry weather flows, have brought new opportunities and new challenges for local wildlife, residents, and resource managers alike. Recently transitioned, perennial streams represent new habitat into which aquatic plants and animals can disperse; they provide new opportunities for summer exploration and play for residents, and present challenges for water resource managers who must now integrate water quality, public safety, and flood risk concerns with ecological factors and demands from an informed and vocal citizenry.

The principles and objectives guiding the action and policy recommendations of this Plan reflect the desire to protect, restore, and preserve existing conditions in the watershed. As project and policy goals are refined during the review and implementation of the Plan, it will be important to define desired stream conditions while recognizing the transformed hydrology of Laguna Creek and its tributaries, anticipating the potential for future hydrologic changes to occur, and realizing the benefits of integrating engineering science, ecology, and community participation into management analysis and solutions.

Based on assessment findings and with desired conditions defined, the on-going work of watershed management can proceed from a known starting point towards a defined goal, making watershed management efforts easier to define, explain, monitor, and adaptively manage.

Data Collection

Data was collected for this assessment to characterize current conditions in the Laguna Creek channel including the upland riparian buffer areas along Laguna Creek, and some tributaries to Laguna Creek, primarily Elk Grove Creek and Toad Creek (a.k.a. Tributary #1). Data used in the assessment were obtained from direct field measurements and observations, from review of existing data and reports, and from interviews with agency staff and landowners with experience working in and around the watershed's stream system. All fieldwork, existing data research, and interviews were conducted by members of the consultant team.

The watershed presents water quality and urban runoff pollution problems that need to be studied and managed. These include problems with pesticides, sediment (the upper watershed has natural colloidal clays that do not settle out with

conventional stormwater quality treatment methods) and nutrient loading that may contribute to excessive algae and macrophyte build-up.

In terms of water quality assessment, the SRWTP has established a long-term water quality database (On-site Monitoring Program (OSMP)) for the terminal reach of lower Laguna Creek. Some water quality data were collected in Elk Grove Creek, due to its presence on the State's 303(d) list for diazinon, as mentioned in Chapter 4. Sacramento County's stormwater monitoring data from other local creeks provide evidence of the potential adverse impacts of urban runoff, in the absence of effective water quality treatment.

Hydrology and geomorphology assessment work focused on developing an hydrologic model for the upper watershed (headwaters to Bond Road) that will provide scientific guidance during development of stormwater quality management practices in the currently largely undeveloped upper watershed.

Water quality monitoring, benthic macroinvertebrate (BMI) bioassessment, habitat surveys, and hydrogeomorphic analysis were performed by professional field biologists, hydrologists, and geomorphologists. Protocols, equipment, field data sheets, and quality assurance measures associated with professional monitoring projects are discussed in the *Laguna Creek Watershed Monitoring Program Quality Assurance Project Plan* provided in Appendix C. Existing data and additional information relevant to the Watershed Assessment were obtained by members of the consultant team during the development of the Plan. Table 5-1 lists the types of data that were collected as part of the Watershed Assessment.

Table 5-1
Types of Data Collected
During Watershed Assessment

Data Type	Lead Agency / Group	General Sampling Locations	Collection Date
Climate, Geology, and Soils			
Literature search, NRCS soil maps, channel boundary material field sampling	EDAW, WLA, Geosyntec	upper and lower watershed	2005-2007
Hydrology and Geomorphology			
	GeoSyntec	upper Laguna Creek	2006
	WLA	upper Laguna Creek	2005
	David Ford Engineering / West Yost Associates	Laguna Creek and tributaries within the City of Elk Grove	2005
Water Quality			
pesticides, nutrients, fecal coliform, metals	SRCSD SSWP	Laguna Creek, Morrison Creek at Bufferlands Elk Grove Creek	1997-2006 2004-2006
DO, pH, temperature, EC	several	SRCSD and SSWP sites all BMI bioassessment sites	1997-2006
BMI Bioassessment	CA DPR	Elk Grove Creek	2004
	SSWP	upper Laguna Creek	2004, 2006
	EDAW	upper and lower Laguna Creek, Elk Grove Creek	2006
Biological Resources			
literature search, field surveys (riparian vegetation, Beaver, invasive plant species)	EDAW, LCWC, ULCC	upper and lower watershed	2005-2007

*A summer blanket of yellow primrose (*Ludwigia *sp.) covering Elk Grove Creek.*

5.2 Assessment Methods

Climate, Geology, and Soils

A full assessment of climatic, geologic, and soil conditions throughout the watershed was not within the scope of this project. However some information was obtained through current literature review, archived geologic boring data, and during hydro-geomorphic field assessments of stream channels.

Hydrology and Geomorphology

Geosyntec field crews surveyed nine sites on upper Laguna Creek and one each on ElderCreek and Morrison Creek from May 30 to June 2, 2006. Geosyntec staff walked much of the entire creek length and collected information regarding reach-wide conditions. During 2006 field assessments, Geosyntec staff revisted upper watershed sites surveyed by William Lettice Associates in May–June, 2005 to verify observations and compile a common data set (except for WLA sites 16-18 (unable to access)). Geosyntec's field assessments and hydro-geomorphic models are reported in full detail in the Geosyntec Technical Report (see Appendix), and are available at http://www.lagunacreek.org/.

Supporting materials and reports include William Lettice Associates geological study of upper watershed stream channels (WLA 2005), David Ford Consulting Engineers hydrologic modeling study of the lower watershed (David Ford Consulting Engineers 2005), and several past drainage master plan reports for different parts of the watershed that provided preexisting information relating to watershed hydrology and geomorphology.

Water Quality

Water quality constituents occurring in watershed streams during wet and dry weather flows have been monitored regularly by the SRCSD at three sites along Laguna Creek west of Franklin Road within the Bufferlands area since the early 1990s, and at one site on Elk Grove Creek just upstream of Laguna Boulevard since 2004 by the Sacramento Stormwater Partnership (SSWP). No other data exist for water quality constituents in the watershed other than the common constituents (pH, temperature, dissolved oxygen (DO), and conductivity) collected during bioassessment surveys.

Benthic macroinvertebrate (BMI) bioassessment surveys have been performed by various groups at eight locations throughout the watershed from 2004 to 2006 (CA DPR, SSWP, and the Laguna Creek Watershed Council). EDAW performed BMI bioassessments and riparian vegetation surveys at four locations. Their findings are reported in detail in the Laguna Creek Watershed Protection Program, Biological Assessment Findings Report (see Appendix F), and are available at http://www.lagunacreek.org/.

Water quality and BMI bioassessment sampling locations are shown in Figure 5-1. Water quality conditions were determined to the extent possible from these data.

Biological Resources

Additional assessment data associated with the watershed's biological resource conditions include riparian zone and upland vegetation surveys conducted at four bioassessment sites (see EDAW Biological Assessment Technical Memo in Appendix F), invasive weed maps created for lower watershed reaches, beaver habitat survey results for the upper watershed developed for the ULCC's Beaver Management Plan, South Sacramento County HCP Program flora and fauna data for the area of the Laguna Creek Watershed, and discussions with watershed residents, landowners, and agency staff.

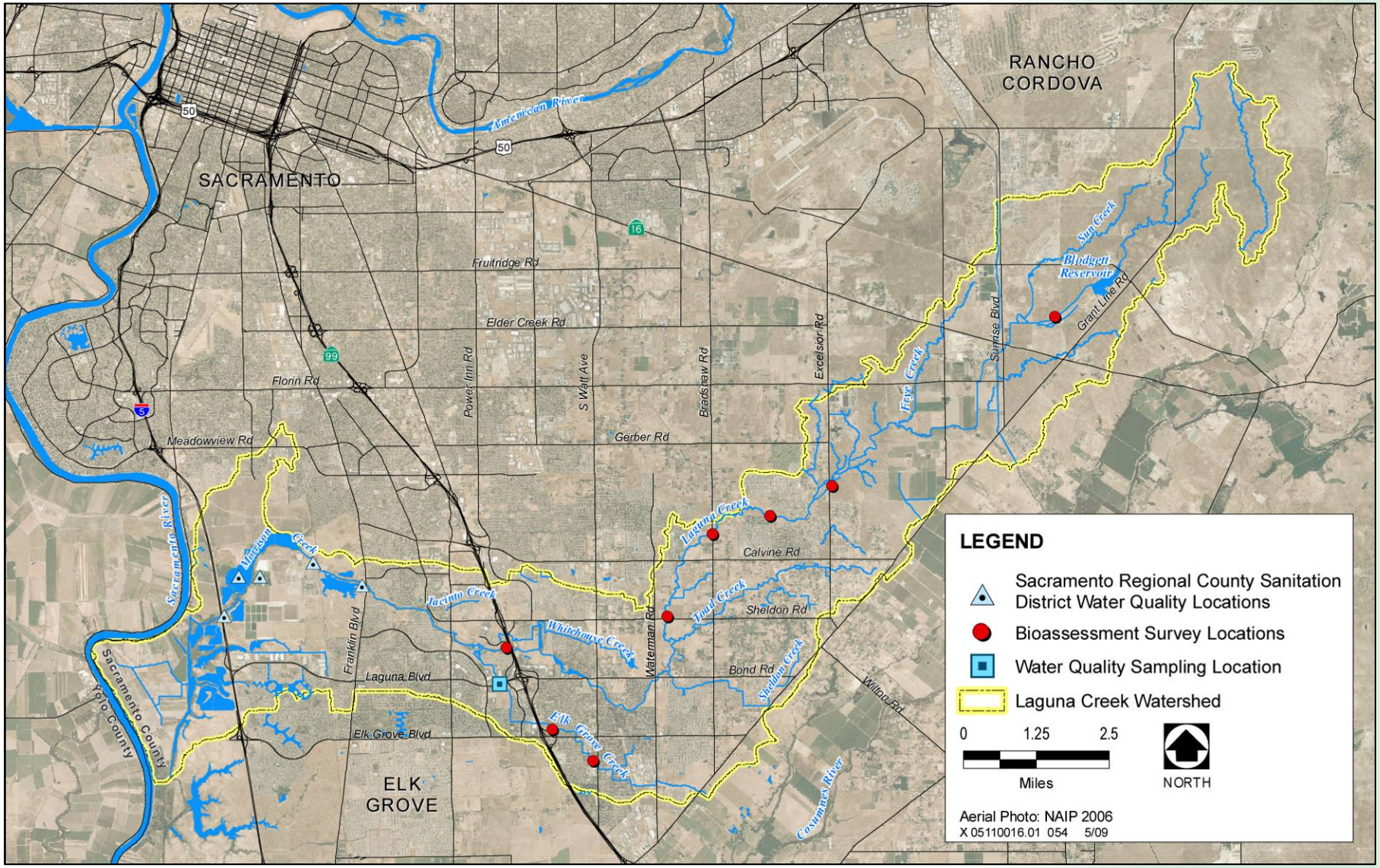


Figure 5-1 Water Quality and Bioassessment Sampling Locations

5.3 Assessment Findings

The watershed assessment findings build on the more general descriptive information presented in Chapter 2 and provides additional discussion of resource processes, including response to potential changes (e.g., land use) in the watershed.

Climate, Geology, and Soils

The climate, geology, and soils of the Laguna Creek Watershed influence all natural resource conditions and land uses. One of the most important aspects of these attributes for other natural resources in the watershed is the relationship between seasonal temperature and precipitation patterns and physical land form and stability. While precipitation and temperature patterns are virtually the same throughout the watershed, geology and soils can vary and thus their influence can be more localized.

Climate

As changes in global climatic patterns present new challenges worldwide, much uncertainty remains about potential future effects at the regional and watershed level. This uncertainty underlines the need to integrate flexibility into plans involving assessments of hydrologic conditions and water resource management.

In recent years, the scientific consensus has broadened to consider increasing concentrations of greenhouse gases, attributable to anthropogenic activities, as a primary cause of global climate change. Today, the issue of global climate change has begun to play an increasing role in scientific and policy debates over multiple issue areas, such as land use planning, transportation planning, energy production, habitat and species conservation, management of water resources, and agricultural production. Of particular concern are existing and future increases in greenhouse gas emissions and existing and potential future effects of global climate change on hydrologic systems and water management (e.g., domestic water supply, agricultural water supplies, flood control, and water quality).

Plants and animals in the watershed have evolved over time with annual and inter-annual cyclic variations in climate that are recognized as mechanistic drivers. The result is a diverse community of specialized organisms that have adapted to tolerate high levels of environmental variation throughout the year and from year to year.

Geology

The watershed's underlying geology provides creek stability, grade control, upland topography, and supports groundwater recharge and presence. Soils in the watershed infiltrate rainfall, withstand runoff, and support aquatic ecosystems, agricultural crops, and human land uses. Importantly, soils are critical for supporting diverse vegetation communities and specialized habitats including vernal pool/swale complexes, especially in areas of the upper watershed.

Preserving groundwater recharge is extremely important in the Laguna Creek Watershed. Uncertainties exist regarding areas of the watershed with high potential for recharge versus those that are more impervious. Boring data obtained from U.S. Bureau of Reclamation for Folsom South Canal cores and a few cores to the west of Sunrise Boulevard and to the north and south of Florin Road indicate a depth of at least 30 feet below the surface before percolation becomes possible. A groundwater injection feasibility study prepared for the Sacramento County Water Agency (SCWA) in 1998 (Luhdorff & Scalmanini 1998) found that the southeast region of the SCWA's Laguna well field (completed within the Laguna Formation) represented the most feasible location for groundwater injection well development within the SCWA's

Zone 40 area. Well data exist for local landower wells and may provide additional information regarding potential groundwater recharge sites, but obtaining these data are beyond the scope of this project. Local well data may not have the resolution of geologic data necessary to determine recharge areas.

Soils

Generally, upland soil types throughout the watershed are consolidated and resistant to sheet erosion. As a result, soil transport in the watershed appears to be supply limited under undisturbed upland soil conditions (Geosyntec 2007). However, disturbance such as grading associated with construction can lead to increased erosion, decreased ability to support native vegetation communities, sedimentation of waterways, and overall degradation of natural resources.

Hydrology and Geomorphology

This section summarizes the hydro-geomorphic assessment findings of the Geosyntec report, presented in Appendix E of this plan. This summary of hydro-geomorphic assessment information is focused on information most relevant to the Action Recommendations presented in Chapter 6. Readers are encouraged to read the full report and its appendices to examine more in-depth technical information whose scope and depth are not fully reflected in the following summary. The full report also contains photo essays of each transect site location.

Stream channel stability is an ephemeral condition that occurs when a dynamic balance exists between sediment supply, sediment transport, and channel boundary material characteristics. Unfavorable relationships between these factors result in failure of the integrity of channel morphology (see Geosyntec Technical Report Appendix C, Chapter 1 for more on sediment supply, sediment transport, channel boundary conditions, and their relationship to channel stability in Laguna Creek). Some amount of morphological change over differing geologic and temporal scales is natural for stream channels. Stream bank erosion, stream bed incision and aggradation become concerns when changes in channel morphology effect both the safety of people and property, and the viability of associated aquatic and riparian ecosystems.

The Laguna Creek Watershed sediment supply appears to be naturally very low and the system appears to be supply limited. The landscape is fairly flat and hummocky, and consists mostly of rural residential and pasture with moderate to high density of grass cover. Vernal pools and drainage swales are present over much of the landscape capturing and slowing the rate of runoff. There is very little loose unconsolidated bed material or bar deposits in the channel. Point bars and channel beds are generally grass covered and are not mobilized very frequently. Loose bed material that is available for transport is thin and believed to have originated from bank erosion and failures. Where bank failures were observed, deposition was not far from the failure location. Because of this condition, reduction in sediment supply does not appear to be a condition of concern for the Laguna Creek Watershed. The morphology and potential for change is primarily a function of the surrounding channel materials controlling bank and bed conditions. Appendix A of the GeoSyntec report provides more detailed assessment findings on the geomorphic character of the watershed and creek upon which sediment supply and channel stability conclusions are based. Emphasis is given on the largely undeveloped upper watershed reaches as these are considered most at risk of undergoing changes due to future upland land use changes.

Taking field measurements to assess channel conditions for upper Laguna Creek.

Channel Stability

The findings detailed in Appendix A of the GeoSyntec report identify stream reaches as stable, unstable or meta-stable. Chapter 6 of this Plan presents action recommendations to

address channel stability reaches of concern. Channel stability reaches of concern are summarized below.

Stable Reaches

Figure 5-2 illustrates the observed channel stability conditions for Laguna Creek as described in Geosyntec (2007). The majority of both upper and lower Laguna Creek channel reaches are stable under current conditions.

Unstable Reaches

Laguna Creek Downstream of Blodgett Reservoir. The 800m reach of Laguna Creek downstream of Blodgett Reservoir is a manmade channel that was constructed with the reservoir in the 1940s. The constructed channel relocated the original channel beyond the perimeter of irrigated pasture fields. The banks of this straightened, entrenched reach are steep beyond their ability to withstand the high flows that overtop the Blodgett Reservoir spillway, and have experienced slumping at several locations along the 800m reach. Modifying the channel profile to reduce bank angles and restoring meanders to the channel planform would stabilize channel conditions along this reach. These channel restoration approaches are being explored as part of the future Arboretum development in this area.

Sun Creek Downstream of Jaeger Road. Discharge from road culverts has begun to erode the Sun Creek channel downstream of Jaeger Road where the channel has been channelized and straightened as part of the Anatolia III development. Restoration of the eroded channel section and future maintenance of Jaeger Road would restore channel stability downstream of Jaeger Road and prevent erosive forces from propagating upstream of Jaeger Road.

Laguna Creek within the Vineyard Springs Planning Area. The Laguna Creek channel from Excelsior Road downstream to Calvine Road has been identified as an unstable reach due to a combination of factors including past and current channel maintenance and stormwater management practices, past channel modifications from upland agricultural use, and the natural geology of stream channel materials, and the translation of downstream channel instability to upstream reaches.

Past dredging practices along the Laguna Creek channel downstream of Vineyard Road to Calvine Road has lowered the steam bed, created high channel banks, and constrained flows within the channel. Additionally, constructed bank weirs along portions of this reach have raised channel bank walls to further constrain flows within the channel. The result of these past modifications has created an entrenched channel with bank angles too steep to support overlying material. Bank slumping and bank toe erosion occur throughout the reach. Bank material along this reach is a less consolidated soil type than found elsewhere in the watershed, increasing the instability of channel banks. High water flows that would naturally have overtopped banks and spread both water and the hydrological forces associated with them across a wide upland floodplain are currently constrained within the stream channel, delivering the full range of hydraulic stresses to channel bed and banks while disconnecting the stream channel from its floodplain.

Additionally, the lowered streambed in this reach is promoting back cuts to the streambed immediately upstream. Currently, consolidated hardpan streambed materials are resisting the back cutting from the lowered downstream streambed reach. Because subsequent stormwater outfalls have been installed at the current lowered streambed level, restoring the streambed to its original, higher depth is not an option as this would bury the openings of outfall pipes. In order to reconnect the channel to its natural floodplain, restoration will need to focus on reshaping channel banks. Removing existing bank weirs would be a first step in this process.

Stream bank vegetation can provide a measure of bank stability based on factors including vegetation type, percent of bank cover and depth of roots into bank materials. The location

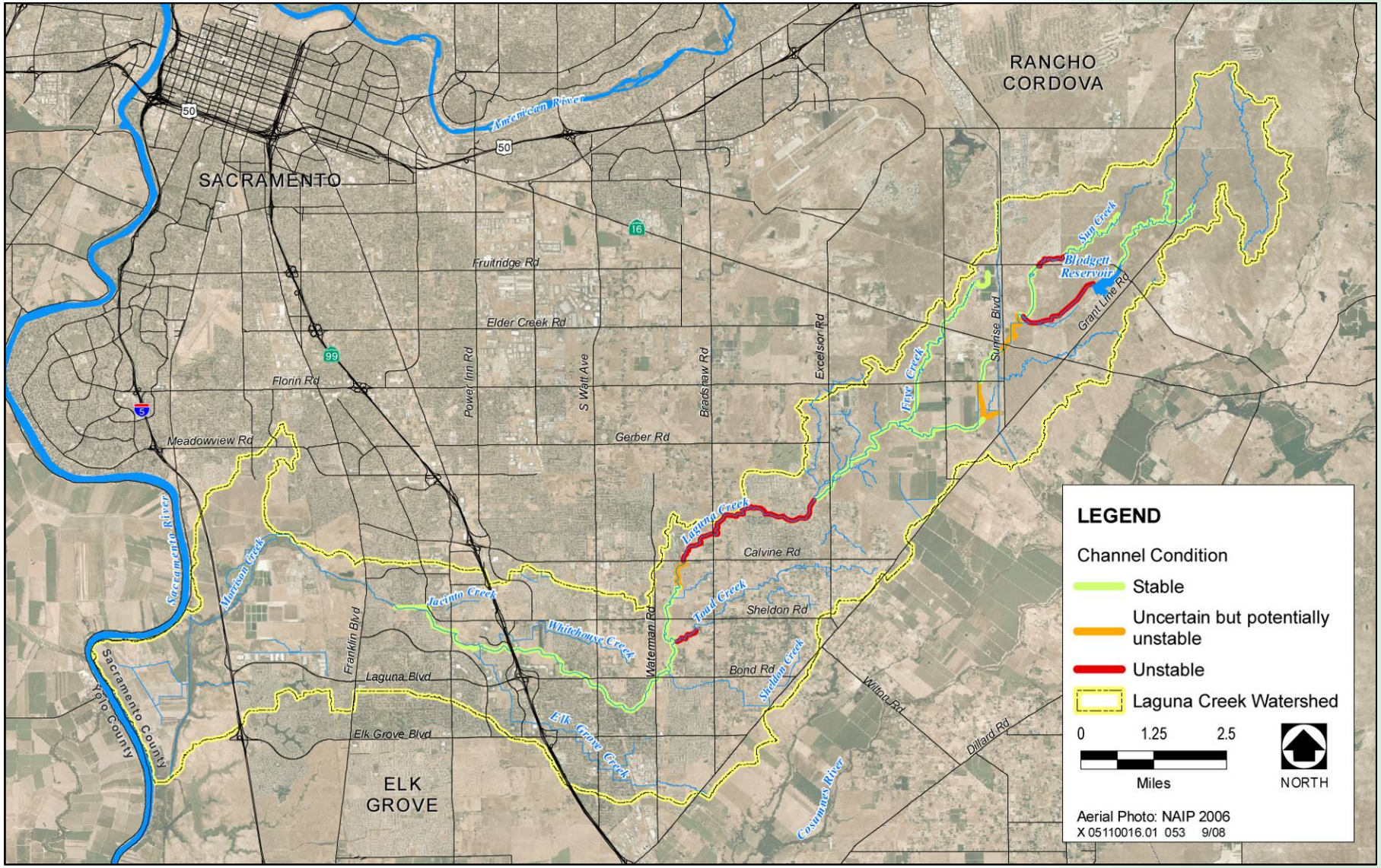


Figure 5-2 Observed Channel Stability Conditions in Laguna Creek

of stormwater outfalls between Vineyard Road and the California Central Traction Railroad (CCTR) overcrossing are such that they either are or have the potential to undermine the rare occurrences of riparian canopy cover along this reach. Current channel maintenance practices periodically cut and remove the larger vegetation from streambanks along this reach, presumably to reduce channel roughness. This practice reduces the ability of the natural vegetation to provide bank stability and should be reviewed as a best management practice for this reach.

The upland floodplain through this reach is currently land of dedicated open space, or of development plans with dedicated open space buffer along the creek, or land where Sacramento County DWR has proposed to locate several stormwater management basins. Current and future planning efforts along this reach will need to consider factors related to stream bank stability, streambed back cutting, reconnecting flows to the floodplain for both flood energy reduction and upland habitat quality purposes when pursuing projects that will ultimately encroach on the channel and / or add to the volume, duration and frequency of flows through this highly unstable reach.

Toad Creek (a.k.a. Tributary #1). Near the confluence with Laguna Creek. Eucalyptus riparian canopy along this reach has led to loss of understory bank vegetation and associated root systems to help stabilize channel banks due to the xenophobic character of Eucalyptus. Bank material, bank angle, and bank vegetation combine to create unstable channel conditions from Sandage Road downstream to the confluence with Laguna Creek. Upstream conditions are unknown and a subwatershed assessment and planning effort is recommended for Toad Creek.

Uncertain, but Potentially Unstable Reaches

Other reaches appear unstable based on aerial and brief field reconnaissance, but field crews were unable to assess conditions fully due to access limitations. Potentially unstable reaches include:

Laguna Creek between Vulcan / Triangle mine and Eagles Nest Road.

Laguna Creek between Sun Creek and Sunrise Boulevard.

Laguna Creek through Lot P. This reach is currently stable but could be effected by continued incision of downstream channel.

Laguna Creek Jordan Ranch Reach. Currently stable but uncertainty exists regarding the design, performance, and potential future effects on channel stability of several constructed swales that outfall into Laguna Creek within this reach.

Meta-Stable Reaches

Some reaches of Laguna Creek have been relocated, straightened, or modified in some way but have since grown to support thick bank vegetation that provides both bank stability and habitat values. These are considered Meta-stable reaches. Restoring stream profile and planform would be less of a priority along these reaches as they have reached a post-modification equilibrium.

Laguna Creek from Eagles Nest Road to the Shehadeh reach. Thick growth of willows and other bank vegetation have provided bank stability and habitat along this reach. A recent fire (June 2008) burned streamside vegetation along a portion of this reach.

Water Quality

Water Quality Constituents

Water quality and BMI bioassessment sampling locations are shown in Figure 5-1 above. Existing water quality data for watershed streams are limited to four lower watershed locations

west of Hwy 99; three sites on Laguna Creek within the SRCSD Bufferlands, and one site on Elk Grove Creek at Laguna Boulevard. Water quality conditions of concern based on existing data from these four lower watershed sites include the following (for more details on sampling locations, times, and procedures refer to Chapter 3 of the Geosyntec Technical Report):

- Dissolved oxygen (DO) concentrations are less than 7.0 mg/L in 83% of wet weather samples, and in 85% of dry weather samples. Fluctuating and depressed DO is the most common water quality condition of concern in Laguna Creek. It can have the potential for the greatest ecological impact, since fish and other aquatic life depend on minimum concentrations of DO for survival. The cause is believed to be excessive plant growth (either algae or macrophytes – larger vascular aquatic plants that are commonly attached to the creek bottom) and associated photosynthesis and respiration processes. At night, plant respiration reduces DO and increases CO_2, which can result in a decrease in pH. The microbial decomposition of organic matter deposited in the creek bottom may also be contributing the lowered DO levels.
- Chlopyrifos concentrations exceed water quality objectives in 55% of wet weather samples, and 100% of dry weather examples.
- Diazinon samples exceed objectives in 58% of wet weather samples, and 79% of dry weather samples.
- Fecal coliform concentrations exceed 400 MPN/100 ml standard in 44% of wet weather samples, and 25% of dry weather samples.
- Dissolved arsenic concentrations exceed objectives in 10% of wet weather samples, and 5% of dry weather samples, with comparable results for total arsenic.
- Dissolved copper exceeds objectives in 29% of wet weather samples, and 9% of dry weather samples.
- Dissolved lead exceeds objectives in 12% of wet weather samples, and 11% of dry weather samples.
- Dissolved zinc exceeded objectives in 2% of samples.

Nonpoint source loadings that may contribute potential contaminants include agricultural activities in the upper watershed and urban stormwater runoff and discharge in both upper and lower watershed. Currently, the Sacramento River adjacent to the lower watershed, as well as Elk Grove Creek and Morrison Creek are listed water bodies on the California Clean Water Act Section 303(d) list due to containing specific pollutants.

Filamentous algal growth in an upper reach of Laguna Creek.

Emergent Vegetation Overgrowth

There is consensus among landowners, residents, and agency staff associated with both upper and lower watershed stream reaches that the growth of emergent vegetation in stream channels has increased dramatically over the past decade. Yellow primrose, cattails, bulrush, and floating mats of green algae have become impairments to both water quality and the stream channels' ability to convey high water flows. The City of Elk Grove has spent a significant amount of budget to address the permitting and maintenance requirements relating to emergent vegetation issues along urbanized stream reaches. A variety of conditions in Laguna Creek and its tributaries stimulate plant growth, including direct sunlight due to the absence of a tree canopy, elevated water temperatures, nutrient loading from urban and agricultural sources, and the creek's relatively low gradient which produces low flow rates and little natural aeration. Increased algal and emergent vegetation growth can produce low levels of dissolved oxygen from subsequent algal and plant decay. Preliminary data suggests that nutrient concentrations, particularly inorganic phosphate, are creating eutrophic conditions throughout the watershed.

Collecting benthic macroinvertebrates during low flows in upper Laguna Creek.

Benthic Macroinvertebrate Bioassessment

Due to the limited amount of water quality and pesticide data collected, it was not possible to definitively demonstrate any cause and effect relationships between BMI community structure and water quality or pesticide concentrations. However, the BMI metrics do indicate that the water bodies are impacted, and the water quality and physical habitat data suggest some potential reasons.

Determining stream water and habitat quality conditions using macroinvertebrate bioassessment as an assessment tool can be achieved by either comparing current conditions in Laguna Creek relative to other streams of the region, or by comparing current conditions to the same creek location over time to monitor trend analysis. Various metrics can be calculated from sampled BMI populations and used as a comparative tool for stream water quality analysis. One method of comparison of BMI metrics, the Composite Metric Score (CMS), calculates a mean value from a suite of indicator metrics for each sampling site and compares these means to determine which sites exhibit above or below average conditions (mean metric values) relative to each other (EDAW 2009).

Figure 5-3 plots Laguna Creek BMI composite metric scores relative to other Sacramento County valley floor stream BMI CMS values. Relative to other Sacramento County valley floor streams, Laguna Creek exhibits intermediate to poor quality conditions as measured using a CMS analysis.

Macroinvertebrate taxa sampled from downstream of Hwy 99 are more similar to assemblages that correlate more with lentic, slough habitat conditions than stream conditions (Ode et. al 2005), a finding to consider when deciding stream management goals for the lowest reaches of Laguna Creek.

The absence of the more sensitive Ephemeroptera (mayfly) larvae from all sampling sites for all sampling dates raises concern about the reason(s) for their absence and merits further study to explore possible explanations.

Biological Resources

Habitat

With much of the lower watershed built-out, concern for the loss of sensitive habitats has been focused on the upper watershed. Widely distributed vernal pool grasslands in the upper watershed are especially at risk of loss due to large-scale developments that are currently in various stages of the planning process.

Urban/developed areas are typically lacking in vegetation cover and associated habitat values. Urban areas tend to have little habitat value for wildlife species because the natural habitat has been greatly modified. These areas support many nonnative and common wildlife species.

For various reasons, the urbanized watershed of lower Laguna Creek has retained more of its riparian habitat values than any other stream in southern Sacramento County. For instance, in portions of its lower reach, a 600-foot-wide corridor was preserved for giant garter snake habitat. In addition, the Sacramento Regional Wastewater Treatment Plant (SRWTP) has invested heavily in enhancement of the riparian and wetland resource values of the terminal reach of Laguna Creek in its Bufferlands acreage. Moving upstream, the City of Sacramento created the North Laguna Creek Wildlife Area, complete with wide, densely-vegetated buffers, pedestrian bridge, and interpretive signage. Further upstream on Laguna Creek, the County and EGCSD (now CCSD) worked together to create several nice examples of protected creek habitat. These include the Lower Laguna Bypass (created to preserve valuable wetlands), Camden Lakes, and the Fallbrook and Silver Springs neighborhood natural floodplain and recreation areas.

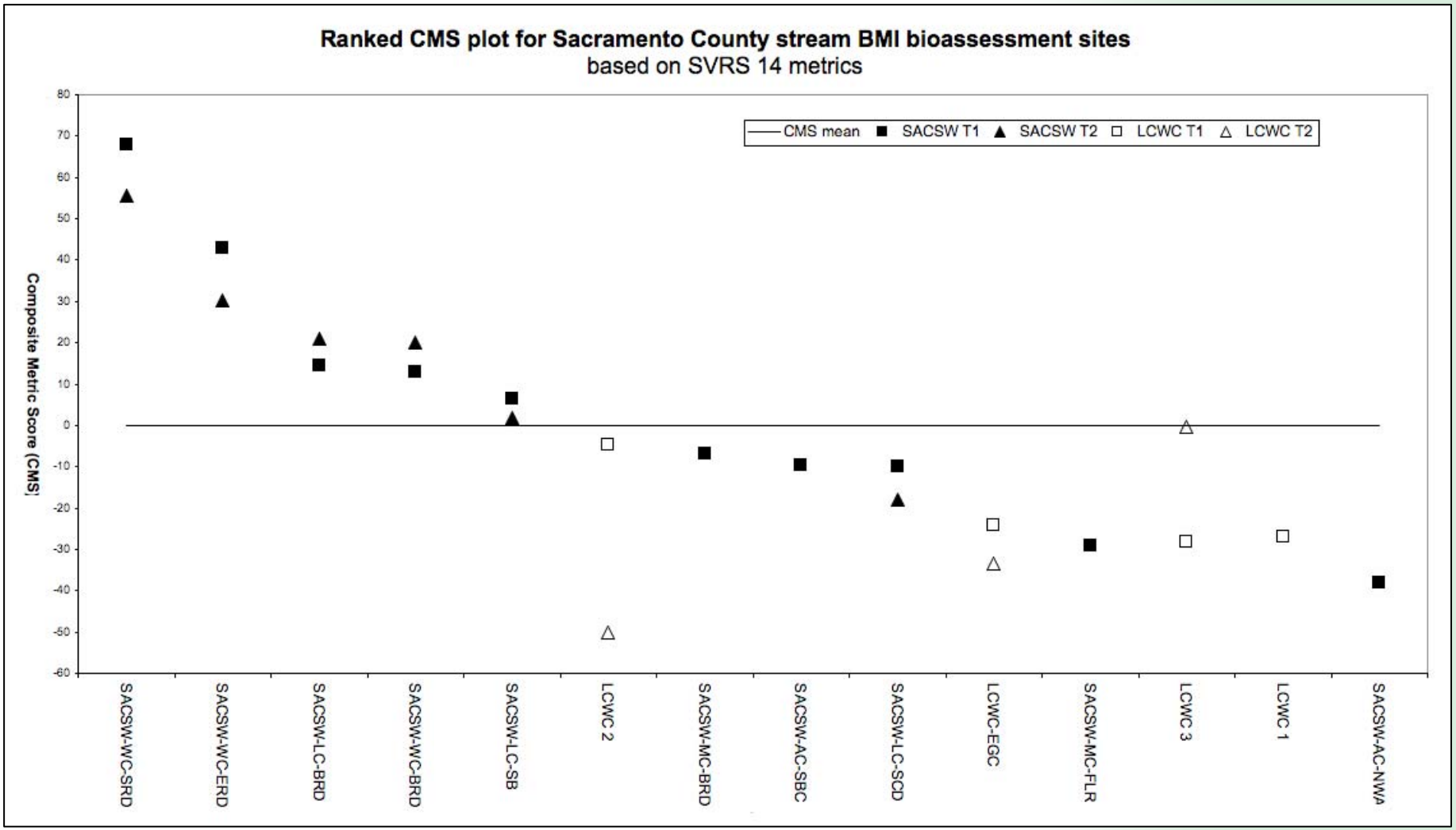
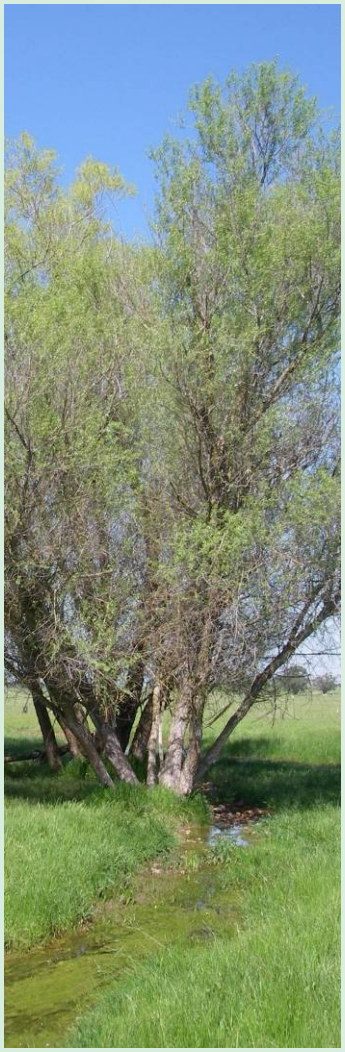


Figure 5-3 Laguna Creek BMI composite metric scores relative to other Sacramento County valley floor stream BMI



Opportunities still exist in the upper watershed to maintain and enhance water quality and habitat values, building on these previous investments.

Riparian scrub and tree species are scattered and uncommon along Laguna Creek and tributary streams. Aquatic vegetation is commonly found within the perennial segment of Laguna Creek and its tributaries and species include cattail, bulrush, and water primrose in the upper watershed; and cattail, bulrush, water primrose, and water hyacinth in the lower watershed. These emergent aquatic species form dense stands that impede the flow of water and create adverse water quality conditions and flood risks when occurring in urban settings.

Invasive weeds are widely distributed throughout the riparian corridor of Laguna Creek, especially along riparian buffer zones in the lower watershed. Infestations are along all reaches and across all geomorphic surfaces (e.g., at creek bottom, on the top of bank, and terrace) of the channel. Invasive weeds not only compete with native species, but alter riparian ecosystem functions such as conveyance of floodwaters, transport and storage of sediment, geomorphic processes that sustain channel and floodplain landforms, nutrient cycling, and provision of wildlife habitat. Weed mapping surveys indicate that relatively small growths of water hyacinth, tamarisk, arundo, Chinese tallow, and pampas grass occur in and along stream channels in the lower watershed, and yellow primrose occurs in stream channels throughout both the upper and lower watershed.

Summary of Findings

The assessment identifies several stresses relating to stream channel conditions, water quality, and riparian/upland habitat quality throughout the Laguna Creek Watershed that include:

- low dissolved oxygen levels throughout Laguna Creek and tributaries;
- elevated water temperatures throughout Laguna Creek and tributaries;
- elevated fecal coliform counts in the lower reaches of Laguna Creek;
- impaired benthic macroinvertebrate populations relative to other Sacramento Valley floor streams;
- unchecked and overpopulated beaver populations and activity in the lower, urbanized watershed with populations occurring also in less-developed upper watershed reaches;
- excessive aquatic macrophyte growth (filamentous green algae and yellow primrose);
- excessive bulrush and cattail growth across midchannel locations of Laguna Creek and some tributaries causing a barrier to the free flow of midchannel water;
- entrenched and unstable channel conditions in some reaches of upper Laguna Creek and tributaries;
- channel bank and toe erosion exceeding background conditions in some reaches of upper Laguna Creek, and
- aggressive, invasive non-native weed species occur in the lower watershed but currently at relatively low amounts.

5.4 Watershed Assessment Conceptual Model

Conceptual models present logically arranged diagrams to summarize relational information graphically. When constructed at the beginning of a watershed assessment process, conceptual models can guide assessment planning by uncovering potential relationships between watershed stressors and their effects on resources and identifying data needs. A description of the use of conceptual models in watershed

management planning is presented in the California Watershed Assessment Manual (Shilling et al. 2005).

Figure 5-4 illustrates the conceptual model for describing impacts to Laguna Creek. The diagram summarizes actual and hypothesized cause-and-effect relationships between watershed conditions of concern and their observed and/or hypothesized sources of stress. The model represents both a summary of findings as well as a guide for further work needed to manage the watershed's resources. Appendix D presents general information about conceptual models and a description of the process used to develop the model for this watershed.

5.5 Recommendations

The following recommendations are based on watershed assessment findings. A list of related recommended action numbers appear at the end of each section. These numbers identify specific actions presented in Chapter 6 of this Plan.

Climate, Geology, and Soils

Climate Change Mitigation and Adaptation

While many uncertainties exist regarding local emission contributions and hydrologic effects, all future land planning activities in the watershed should consider the potential risks associated with climate change. Specifically, strategies should be developed to mitigate against existing and future greenhouse gas emission impacts, and adapt to increased hydrologic variability and temperature shifts.

Groundwater Recharge Area Mapping and Protection

Additional work should be conducted to determine areas within the watershed with high groundwater recharge potential and efforts should be made to protect and preserve these areas as native open spaces. Water use efficiency efforts must integrate ecological considerations with conjunctive use planning, particularly as groundwater recharge within the Laguna Creek watershed effects baseflows in neighboring Deer Creek and Cosumnes River channels.

Soil Conservation

Substantial soil conservation practices should be developed and implemented for all projects that may cause soil disturbance. Additionally, creek corridors should be protected and maintained to provide buffers between the creek channel and surrounding land use actions and activities.

Related Recommended Actions:
40, 41

Hydrology and Geomorphology

Adopting an Interdisciplinary Watershed Approach to Water Resource Projects

Awareness of the need to integrate ecology and fluvial geomorphology with traditional hydraulic and hydrologic engineering during the planning and design of water resource projects has increased in this watershed. To meet engineering demands and the scrutiny of the public, water resource engineers and city and county planning staff should work together with a multi-disciplinary team that includes valley stream ecologists, limnologists, and fluvial geomorphologists during planning, design, and performance phases of water resource projects. Watershed groups like the Laguna Creek Watershed Council represent an information network for engineers and planners when a broader perspective is required in order to adopt a watershed approach to water resource management. A watershed approach requires an understanding of the interdisciplinary relationships essential to the planning, design, and implementation of projects.

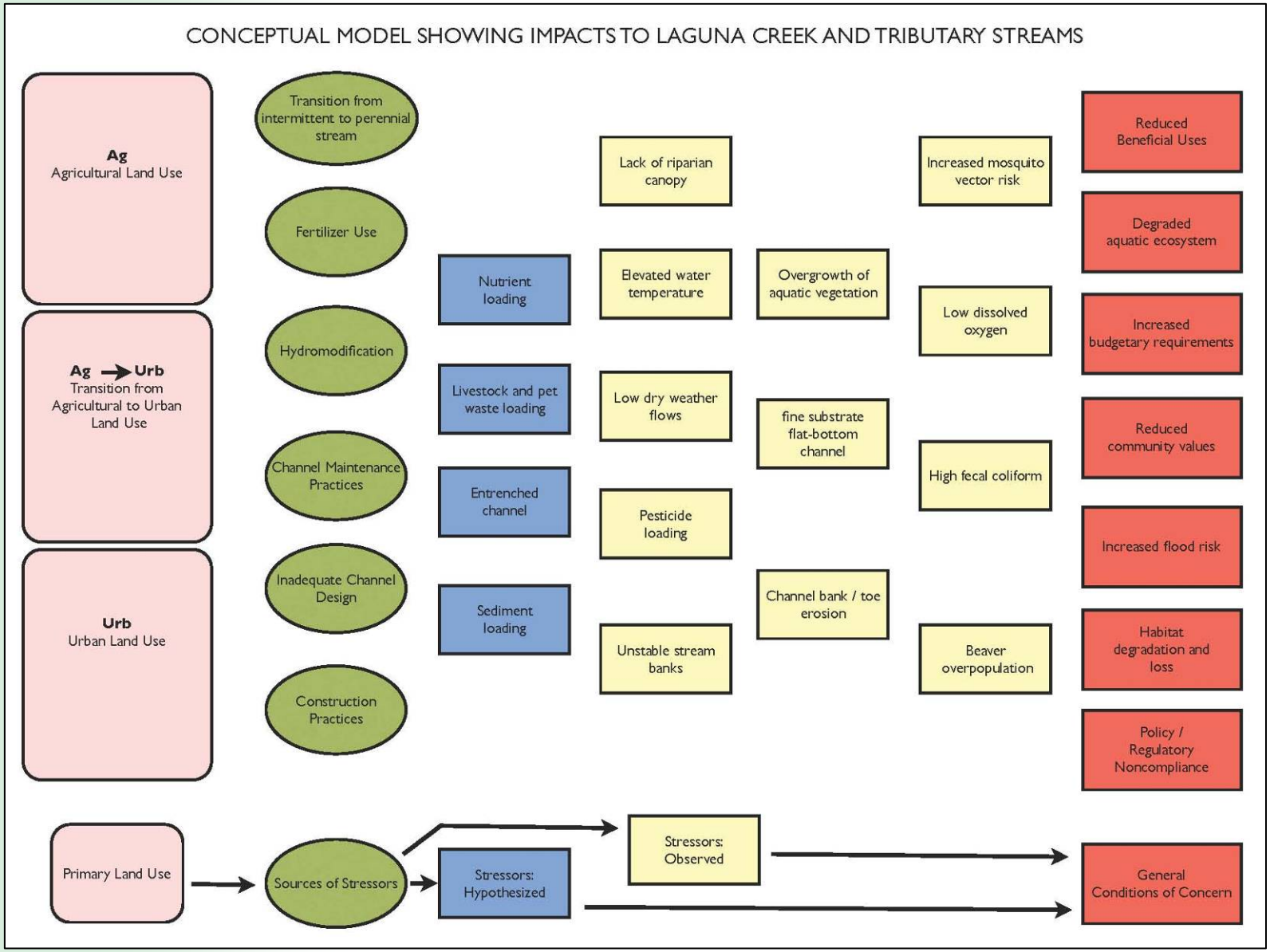


Figure 5-4 Conceptual Model Showing Impacts to Laguna Creek and Tributaries

Examples of adopting the watershed approach to water resource projects in the Laguna Creek Watershed include the Upper Laguna Creek Collaborative process (see Chapter 3), and a workshop hosted by the City of Elk Grove to study multi-objective solutions to the management of Elk Grove Creek. This approach is applicable to all new development projects, and to modifications of existing water resource management features throughout the watershed.

Related Recommended Actions:

1-6, 10, 12-14, 17-20, 25-27, 31, 41,42

Stream Restoration

Figure 5-2 illustrates relative channel stability for segments of upper Laguna Creek. The stable segments of Laguna Creek and its tributaries are the least likely to require restoration. The exceptions are currently stable segments of Elk Grove Creek, where stream restoration may be a solution to multiple issues confounding management solutions along this channel in the City of Elk Grove.

Those segments identified as meta-stable might have ecological value, despite their previous degraded state. Therefore, restoration potential should be evaluated on the basis of ecological conditions as well as geomorphic status.

Creek segments that have historically been dredged or channelized will likely require excavation of new floodplains, since the base level of their current creek beds cannot be raised above current stormwater outfall invert elevations.

The Geosyntec report can help future and near-term projects proposed for upper Laguna Creek address the restoration and preservation needs of the creek, and its findings may also be useful in researching ways to ameliorate hydrologic and hydraulic issues in Elk Grove Creek in the lower watershed.

Related Recommended Actions:

3, 4, 12, 18, 31

Integrate Flow Duration Control Models and LID into Planning

In the absence of controls, hydromodification from future urbanization is apt to exceed thresholds of stability in stream channels. Recommended management strategies to protect Laguna Creek from the impacts of anticipated urban growth will require a mix of flow and volume control alternatives, including Low Impact Development (LID) designs, Flow Duration Control (FDC), and appropriate in-stream modification design strategies.

- LID designs are a popular management strategy that can provide positive benefits and are applicable to projects throughout the watershed. However, it is unlikely that LID alone can reduce future runoff volumes to the extent necessary to reverse the effects of hydromodification.
- FDC is a strategy for sizing and designing stormwater detention/retention basins that is meant to maintain the channel integrity of receiving streams by basing designs on the full range of flows versus one or some set of discrete events (e.g. bankfull, 2-year, 10-year storm event flows), and by ensuring that basin discharges are released at a fraction of the receiving channel's threshold for bank erosion. The FDC basin discharge criterion defined for Laguna Creek is 25 percent of the 2-year (undeveloped) peak flow as computed using a continuous simulation model.
- In-stream solutions involve modification of the receiving stream channel and should be reserved for restoration projects meant to stabilize a channel that is already degraded. Reshaping a stream channel to convey new urban flows, reduce the potential for erosion, aggradation, and damage to habitat can improve channel stability and prevent erosion. However, the channel modification must be carried far

enough downstream to a point where the effect of development is insignificant.

By approximately August 2010, the Sacramento County MS4 co-permittees will need to have completed and approved a Hydromodification Management Plan (HMP) as per the requirements of their NPDES permit. The Laguna Creek Watershed Council will continue to work with the ULCC group and co-permittee agency staff to promote the recommendations for the Laguna Creek Watershed as part of the HMP development process.

Related Recommended Action:
1-6, 10, 12-14, 17-20, 25-27, 31

Monitor Stream Channel Profiles

Accurately surveyed stream channel profiles can be a tool used to track any changes in channel morphology over time. Field assessments by both WLA and Geosyntec (2005 and 2006, respectively) generated 30 channel profiles in the upper watershed, and channel profiles exist for lower watershed stream locations at bridge crossings. Existing cross sections represent baseline profile data for sites throughout the watershed. Future stream profile measurements taken at baseline sites would provide data necessary to track changes in channel morphology (bank erosion, bed incision, sedimentation leading to channel aggradation, etc.) over time that may result from changes in upland land use and could be performed by properly trained volunteer citizens.

Related Recommended Actions:
11, 12, 15, 18, 19, 25, 31, 35, 39

Water Quality

Control Emergent Vegetation Growth

Bulrush, cattails, algal mats, and some species of yellow primrose are all plants that are native to California's Central Valley and the Laguna Creek Watershed. Laguna Creek and its tributaries historically were dry during summer months, limiting the temporal and spatial extent to which these aquatic plants could have survived in the past. Inputs of agricultural and urban runoff now provide perennial water flow in Laguna Creek and several tributaries, providing conditions for aquatic plant growth during dry weather flows. A combination of factors are most likely contributing to the overgrowth of aquatic vegetation, including; flow regime, channel morphology, water temperature, nutrient loading, available sunlight, and sedimentation. It will require efforts on multiple fronts to reduce the overgrowth of emergent aquatic vegetation within channels, which could include: outreach and education of watershed residents, water quality monitoring, riparian shade tree planting, channel modification, modified summer grazing practices, plant removal, and others.

Related Recommended Actions:
31, 32, 33, 35, 39, 40

Identify and Reduce Nutrient, Bacterial, and Pesticide Inputs

Little water quality data exist for the Laguna Creek Watershed. In order to develop a better sense of water quality conditions throughout the watershed, the following recommendations should be considered.

Monitor continuous samplings of DO, pH, and temperature to describe the diurnal patterns of these common constituents at an upper and lower watershed location during dry and wet seasons. Subsequent instantaneous data could then be analyzed within a clearer context of known diurnal patterns for these parameters.

Monitor inorganic nitrogen and phosphorous concentrations, and fecal coliform bacteria concentrations throughout the watershed at strategic locations to determine baseline values of these constituents as well as potential input locations and upland sources. Monitor during wet and dry seasons to determine characteristic concentrations during different climate

conditions. Once major source locations have been identified, initiate continuous monitoring of these constituents to determine characteristic concentrations during an annual wet / dry season time frame.

Monitoring sites should be located downstream of areas where there are notable changes in upland land use conditions (irrigated crop fields, grazed pastureland, open space conservation areas, existing large development projects, etc.). These locations represent geographic nodes where contributions to water quality improvements or impairments associated with landscape-scale changes in upstream upland land uses might be detected over time. Additional sites should be identified at locations where water samples could most easily be obtained from creeks where no water quality information currently exists (e.g., locations along Toad Creek, Sheldon Creek, Whitehouse Creek, and Jacinto Creek). These types of site locations represent opportunities to fill data gaps in subwatersheds where no data exists. A map of potential monitoring sites is presented in the Appendix.

Regular monitoring at some or all of the recommended sites would provide data necessary to help determine sources of the water quality conditions of concern identified from the existing water quality data, and help determine the efficacy of future BMPs implemented to address them. Not all pollutant sources are identifiable. Identifying a pollutant does not imply that an effective control can be found and/or implemented.

Volunteer citizen monitoring efforts, with proper training, coordination, and quality controls, could measure many water quality parameters using equipment and supplies available through the Laguna Creek Watershed Council, Sacramento Splash, and other local agencies and organizations. Types of available equipment include instantaneous probes to measure pH, temperature, dissolved oxygen, and electrical conductivity; colorimeters to measure levels of nitrates, phosphates, and some metals; and flow meters, stadia rods, and reel tapes to measure stream channel profiles and flow conditions.

Some water quality tests will require analyses to be performed by professional laboratories. The collection of samples in certified collection containers could be accomplished using citizen monitors to reduce the cost of professional laboratory analysis.

Related Recommended Actions:

35, 39

Biological Resources

Habitat loss due to agricultural land use and encroachment of urban areas is the primary stressor to biological resources in the watershed. Preservation of remaining open space areas along the Laguna Creek corridor, and remaining areas of sensitive habitat including vernal pool grassland prairie is a priority watershed management issue. Education and stewardship programs connect residents to the watershed's biological resources and help sustain existing habitat quality over the long-term.

Collaborative Laguna Creek Corridor Planning Effort

Creek corridor and open space preservation should be made a priority in areas that are currently undergoing development and other areas (e.g., already developed) where opportunities may exist. Creek corridors could be preserved through the creation of setback buffers to provide multiple functions (e.g., active floodplain, riparian habitat, flood flow conveyance, trails, etc.). The width of the buffers and uses allowed within buffers (e.g., natural state, recreation, landscaping, utilities, stormwater management) should be developed based on:

- landowner interests;

- preservation objectives (e.g., water quality maintenance, wildlife movement, biodiversity, aesthetics);
- habitat functions and values;
- topography;
- soils and geology;
- flood frequency and magnitude; and
- existing and future adjacent land uses, including infrastructural needs.

Open space preservation strategies should be developed and implemented in coordination with regional efforts such as the Upper Laguna Creek Collaborative, the Sacramento Valley Conservancy's 2020 Vision, and the South Sacramento County Habitat Conservation Plan, with the objectives of protecting sensitive resources and maximizing connectivity between habitats and other open space areas.

Collaborative planning efforts like the ULCC process in the upper watershed are translatable to undeveloped lower watershed reaches along Laguna, Elk Grove, and Whitehouse Creeks.

Related Recommended Actions:
1-20, 25, 26, 31, 42, 43

Watershed Education and Stewardship

Watershed stewardship and education can improve the land use practices of watershed residents and reduce the impacts of urban landscapes on the watershed's biological resources. Several local agencies conduct watershed stewardship-related programs that represent partnership opportunities for LCWC Watershed Education and Stream Stewardship Programs as described in section 3.6. The LCWC Stream Stewards Program should expand in focus to include stewardship of areas of the watershed; an expanded Watershed Stewards Program is recommended in Chapter 6. Maintaining partnerships, establishing new ones, and securing funding for project coordination will be necessary to maintain current programs and to develop recommended new programs.

Related Recommended Actions:
28, 30, 32, 33, 35-37, 39-41

Invasive Weed Monitoring and Removal

Citizen stewards can be trained to identify and report occurrences of major weed species, and assist in the removal of some weed types (e.g., yellow star thistle, cocklebur, Chinese tallow). Other species that are more difficult to remove (e.g., tamarisk, pampas grass, water hyacinth, blackberry, arundo) may need to be removed by professional maintenance crews.

A GIS database of invasive weed locations and management status would be the most effective means of monitoring the efficacy of weed management practices. Volunteers could be recruited to assist in these efforts.

Related Recommended Action Projects:
32, 35, 36, 40

Beaver Management

Beaver populations can create new habitat conditions along riparian corridors. Their presence causes persistent challenges to flood risk management planning and maintenance. A beaver management plan that identifies active, suitable but not active, and unsuitable beaver habitat by stream reach has been completed for the upper watershed stream channels. This assessment, completed as part of the ULCC's Upper Laguna Creek Corridor Master Plan report scheduled for review in 2009, is useful for water resource management planning of future development along these upper stream reaches where beaver activity will need to be accounted for in planting and maintenance plans.

Beaver population control has become a pragmatic management solution in the lower watershed where perennial flows, abundant aquatic vegetation food sources, and a nearly

complete lack of natural predators have allowed beaver populations to increase unchecked throughout the lower watershed.

A beaver management plan is needed for lower watershed stream channels that identifies a suite of beaver management practices to employ in response to persistent beaver populations. The plan should also qualify the need for depredation and identify reaches where public safety concerns (flooding), maintenance costs, and other factors take priority and have a lower beaver population capacity than reaches identified as more "beaver-friendly", where reaches associated with wider riparian buffers could accommodate beaver dams of a given size (e.g., susceptible to flushing flows).

Citizen volunteers could be trained to assist in beaver surveys. An established beaver management plan would help articulate a reasoned approach to beaver depredation to members of the community who do not favor this type of management practice.

Related Recommended Action Projects:
18, 19, 25, 31, 35, 38

Summary of Recommendations

General recommendations to address watershed conditions of concern in order to achieve desired stream conditions include:

- continue collaborative approach to upper watershed planning and promote similar strategy for subwatershed planning;
- extend existing multi-use riparian buffer Parkway to upper watershed;
- collect additional data necessary to characterize the temporal and geographic nature of bacterial, nutrient, and pesticide loading in Laguna Creek and tributaries;
- continue and expand campaigns to reduce bacterial, nutrient, and pesticide loading into streams;
- modify bank and/or channel morphology where necessary to achieve stable channel conditions and to prevent mid-channel emergent vegetation growth;
- ensure the design of stormwater quality and flood management best management practices to address hydromodification using tools that include but are not limited to low impact development practices, and the hydrogeomorphic model developed as part of this Watershed Assessment;
- plant more native riparian trees and shrubs along channel banks where appropriate to improve riparian habitat and shade; and
- extend existing beaver management planning effort to lower watershed reaches.

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