6/15/10 Board Meeting
2010 Integrated Report 303(d)
Deadline: 5/28/10 by 12 noon

COUNTY SANITATION DISTRICTS
OF LOS ANGELES COUNTY

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May 28, 2010
File No. 31-370.40.4A

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MAY 28 2010
SWRCB EXECUTIVE

Ms. Dorothy Rice, Executive Officer
State Water Resources Control Board
1001 I Street
Sacramento, CA 95814

Dear Ms. Rice:

Comments on the Proposed 2010 Integrated Report:
Clean Water Act Section 303(d) List of Water Quality Limited Segments
and Clean Water Act Section 305(b) Assessment of Surface Water Quality

The Sanitation Districts of Los Angeles County (Sanitation Districts) appreciate the opportunity to comment on the subject document. The Sanitation Districts are a consortium of 23 independent special districts serving the wastewater and solid waste management needs of over five million people and 3,300 industries in Los Angeles County, California. The Sanitation Districts currently operate and maintain over 1,400 miles of trunk sewers and 11 wastewater treatment plants that collectively treat over 450 million gallons per day of wastewater. Of the 11 wastewater treatment plants, nine are located in the Los Angeles Region. Seven of the these treatment plants discharge to inland surface waters in the San Gabriel River, Santa Clara River, and Rio Hondo watersheds; one discharges to the Pacific Ocean; and one does not discharge to surface waters but instead solely supplies recycled water for irrigation.

Although the Sanitation Districts support the overall methodology used by the Water Boards to produce the 303(d) List, including application of the State Water Board's Quality Control Policy for Developing California's Clean Water Action Section 303(d) List (Listing Policy), the Sanitation Districts do have serious concerns with several listings, especially the proposed new listings for Benthic Macroinvertebrate Bioassessments for Reaches 5 and 6 of the Santa Clara River. A summary of comments on this issue and several others are presented below; detailed comments are included in Attachment A.

First, the Water Boards have not yet established water quality objectives to evaluate benthic macroinvertebrate bioassessments for water quality standards attainment. Thus, at this point, there is no non-attainment of a water quality standard that could justify the impairment listings. The State Water Board is only now beginning to develop water quality objectives for benthic macroinvertebrates in streams, which underscores the fact that such standards do not exist and are needed before further regulatory decisions are made based on the bioassessments.

Second, State Water Board staff attempt to use a narrative toxicity objective to justify the benthic macroinvertebrate listing. The Sanitation Districts believe that the narrative toxicity standard can only be used to justify a toxicity listing and the use of this narrative standard to justify a listing for a parameter for which no standard exists is patently improper. This objective notwithstanding, the narrative toxicity objective requires that, "waters shall be maintained free of ***toxic substances in concentrations that are toxic*** to, or that produce detrimental physiological responses in, human, plant, animal, or aquatic life."

[Emphasis added.] No attempt has been made to establish a causal relationship between any toxic substances appearing as separate listings in the Santa Clara River and the bioassessment results. In support of the proposed bioassessment listing decisions, the Fact Sheets for the listings and the Staff Report for the 2010 Integrated Report (Staff Report) noted a co-occurrence of impairments for certain substances in Santa Clara Reaches 5 and 6. However, the data presented to support these listings are for non-toxic substances (indicator bacteria), for substances that do not occur in amounts toxic to aquatic life (chloride), nonrepresentative due to management actions that have been taken that reduce concentrations (chlorpyrifos and diazinon), inappropriately assessed (copper), or based on outdated standards for a pollutant that is only bioavailable at conditions not present in the river (iron).

Third, the proposed listings for Benthic Macroinvertebrate Bioassessments are based on application of the Southern California Coastal Index of Biological Integrity (SoCal IBI), which is calculated by scoring bioassessment results from a receiving water location. A lower score does not necessarily indicate impairment, because different types of streams are expected to support different types of invertebrate communities. In particular, the bottom of low gradient streams such as Santa Clara River Reaches 5 and 6 (less than 1% gradient) are typically composed of fines and sand, while the bottom of high gradient streams are typically composed of rocks and cobble. These are two very different habitats for benthic macroinvertebrates, which therefore support very different populations. While the scientists that developed the SoCal IBI attempted to incorporate reference conditions into the index itself, the streams used to develop the index did not include any low gradient/low elevation streams in Los Angeles County. In fact, subsequent work published by the lead scientist in development of the index acknowledges that the SoCal IBI does not adequately address reference conditions in low elevation sites. Other expert scientists in this field have weighed in on this issue as well and concur that reference conditions for low gradient streams in southern California have not been identified. Furthermore, a recent study that examined a wide range of low gradient streams in southern California, including multiple locations assumed to be representative of reference conditions, observed so-called "impaired" IBI scores at every location. The data from this study indicate that low gradient streams in southern California, even those expected to be reflective of reference conditions, often have IBI scores in the range considered "impaired" for the proposed bioassessment listings. Additionally, as part of the State Water Board process to develop water quality objectives for benthic macroinvertebrate communities based on IBI scores, a technical panel was convened to prepare a report on development of a network of adequate reference sites to support such objectives. In its report, the panel noted that adequate references sites have not been identified in southern California.

In addition, Santa Clara River Reach 6 should not be listed for benthic macroinvertebrate bioassessments because no data of any kind have been provided to support a listing. The single sampling location provided in the Fact Sheet for this listing is actually in Reach 5 of the river, not Reach 6. Furthermore, the SoCal IBI was developed for perennial streams and Reach 6 is not perennial as water is not present throughout the reach year-round. Reach 6 is typically dry upstream of the discharge from the Saugus Water Reclamation Plant and becomes dry again a short distance downstream of the discharge as the water infiltrates into the sandy riverbed.

Finally, notwithstanding the impropriety of listings for parameters without standards, the process used to categorize the proposed listings for bioassessments appears to be inconsistent among the various regions of the State. While the proposed 2010 Integrated Report contains new Category 5 303(d) listings for benthic community effects for a number of water bodies in Region 4 (Los Angeles), it states that such listings are not warranted for at least seven similar water bodies in Region 9 (San Diego). The San Diego water bodies have co-occurring impairments for constituents such as DDE, DDT, chlorpyrifos, copper, iron, and fecal indicator bacteria. The reason given for not listing the San Diego waterbodies in Category 5 was, "as required under section 3.9 of the Listing Policy, pollutant(s) could not be directly associated with benthic community effects" and "pursuant to section 3.11 of the Listing Policy, no additional data and information are available indicating that standards are not met." The Sanitation Districts believe that this reasoning applies to Santa Clara Reaches 5 and 6 as well.

Additionally, when the proposed 2010 Integrated Report was first released on April 19, 2010, it did not contain Category 5 303(d) listings for Benthic Macroinvertebrate Bioassessments for Santa Clara River Reaches 5 and 6. Instead, it placed the listings in Integrated Report Category 4c, which is the category to be used when a beneficial use may not be supported, but a TMDL is not needed because the impairment is not caused by a specific pollutant. This would be the correct category if a bioassessment indicated impaired scores relative to appropriate reference conditions, but evidence indicated that the impairment cause was not a specific pollutant but, instead, caused generally by "pollution," which, pursuant to USEPA guidance, includes man-made habitat alteration. However, sometime after the release of the 2010 Integrated Report, the report was amended to move the Santa Clara River Reach 5 and 6 bioassessments from Category 4c to Category 5, where Category 5 listings comprise the 303(d) list. No justification was provided for the reclassification, and the Santa Clara River Reach 6 Fact Sheet still includes mention of Category 4c.

In addition to our concerns regarding the proposed bioassessment listings, the Sanitation Districts have comments on several other listing decisions. The Sanitation Districts request that the State Water Board change the methodology used to evaluate the proposed new listing for copper in Santa Clara River Reach 6. For the purpose of determining whether this water body is impaired for copper, the Water Boards divided the copper data into two data sets, one consisting of dissolved copper data and one consisting of total copper data. The more appropriate, scientifically-based method for analyzing the data is to combine them into one data set, using a translator to transform total metals values to dissolved values. One larger data set provides a more reliable assessment of water quality that is more likely to be representative of water quality than several smaller data sets. For Santa Clara River Reach 6, when the data sets are considered individually, the dissolved data set triggers an impairment listing while the total data set does not. When the data sets are combined into one more robust and reliable data set, the data indicate that water quality standards are being attained.

In the case of listing decisions for chlorpyrifos and diazinon in Santa Clara Reach 6, the Water Boards relied substantially upon use of Surface Water Ambient Monitoring (SWAMP) data that was declared invalid by SWAMP due to failure of Quality Assurance/Quality Control (QA/QC) protocols. Although the LA Regional Board believes the data can be used to justify the listing because the QA/QC violations were sample holding time exceedances, there is no justification for using data that does not pass QA/QC for regulatory purposes. Use of invalid data casts doubt on the integrity of the entire listing process. The Water Board also used compromised data in the proposed listing decision for copper in the San Gabriel River estuary. In this case, the data were collected using USEPA Method 200.8, which is well documented to give results that are biased high for copper in estuarine samples, caused by a positive interference from sodium in the samples. The Sanitation Districts request that the invalid chlorpyrifos and diazinon data and the biased copper data not be used in making listing determinations.

For diazinon in Santa Clara River Reach 6, in addition to eliminating invalid data the Sanitation Districts request that the State Water Board base its listing decision on data collected after 2004. As of December 31, 2004, a USEPA ban eliminated sales of all indoor and outdoor non-agricultural uses of diazinon. Because Santa Clara River Reach 6 is an urbanized area with little agricultural activity, this ban is expected to have eliminated essentially all sources of diazinon to the reach once existing stocks of the pesticide were applied or discarded. The fact that there have been no exceedances of water quality thresholds in Santa Clara River Reach 6 since January 2006 indicate that the ban has successfully addressed the impairment.

Finally, the Sanitation Districts request that the proposed new listing for cyanide in Rio Hondo Reach 2 be reexamined. This listing was originally proposed by the LA Regional Board for Rio Hondo Reach 1, but upon State Water Board review it was correctly moved to Rio Hondo Reach 2. However, not all readily available cyanide data for Rio Hondo Reach 2 were evaluated by the State Water Board. The Sanitation Districts submitted cyanide data for this reach to the LA Regional Board in February 2007, and the Sanitation Districts' data should be included in the listing analysis.

If these concerns are not addressed, inappropriate impairment listings will be made which will in turn result in scarce resources being directed away from addressing actual water quality impairments. Given the limited resources available for the development and implementation of Total Maximum Daily Loads (TMDLs) to resolve impairments, the Sanitation Districts believe that it is important for the State Water Board to concentrate on those waters where impairments are properly established, based on solid evidence. If you have any questions, please contact Ken Hoffman at (562) 908-4288, extension 2445, or khoffman@lacsd.org.

Very truly yours,
Stephen R. Maguin

Philip L. Friess
Department Head
Technical Services

RT:KMH:lmb
Attachments

cc: Shakoora Azimi-Gaylon - State Water Board
Dr. Peter Kozelka - USEPA Region 9

Attachment A

Detailed Comments

1. Impairment Listings for "Benthic-Macroinvertebrate Bioassessments"

Background

Section 303(d) of the Clean Water Act requires States to "identify those waters within its boundaries for which the effluent limitations required by section 1311(b)(1)(A) and section 1311(b)(1)(B) are not stringent enough to implement any water quality standard applicable to such waters," referred to as the state's 303(d) List. *See* 33 U.S.C. §1313(d). The United States Environmental Protection Agency (USEPA) has promulgated implementing regulations for this listing aspect of section 303(d), which mirrors and expands the requirement of States to identify "water quality-limited segments" for which neither federal effluent limitations, more stringent state or local effluent limitations, nor any other existing federal, state or local pollution control requirements are stringent enough to implement water quality standards applicable to such waters. *See* 40 CFR § 130.7(b)(1)(i)-(iii). Those federal regulations place the following requirements upon State-generated 303(d) lists:

- The term "water quality standard applicable to such waters" and "applicable water quality standards" refer to those water quality standards established under section 303 of the Clean Water Act, including numeric criteria, narrative criteria, waterbody uses, and antidegradation requirements. (40 C.F.R. §130.7(b)(3))
- The list shall include a priority ranking for all listed water quality-limited segments still requiring TMDLs, taking into account the severity of the pollution and the uses to be made of such waters and *shall identify the pollutants causing or expected to cause violations of the applicable water quality standards*. (40 C.F.R. §130.7(b)(4))
- Each State shall assemble and evaluate *all existing and readily available water quality-related data and information* to develop the list. (40 C.F.R. §130.7(b)(5))
- As part of the documentation that must be submitted to USEPA by a State to justify its 303(d) List, the State must include a rationale for any decision to not use any existing and readily available data and information. (40 C.F.R. §130.7(b)(6)(iii))

A. The Finding of Impairment and Subsequent 303(d) Listing for Benthic Macroinvertebrate Bioassessments in Santa Clara River Reach 5 and 6 is Without Basis as the State Water Board Has Not Promulgated Biological Water Quality Objectives.

At this point, there is no basis for the State Water Resources Control Board (State Water Board) to include on the 303(d) List any impairments based on benthic macroinvertebrate bioassessments. The State Water Board has not yet established water quality objectives for such bioassessments and therefore no quality standard is being violated that could justify the impairment listings. The State Water Board is just beginning to initiate the process to develop biological water quality objectives (Biological Objectives) for freshwater streams and rivers in California, which underscores the fact that such standards do not exist and are needed before regualtory decisions are made based on the bioassessments. The State Water Board has stated that "biological objectives will help improve water quality in our streams and rivers by providing the narrative or numeric benchmarks that describe conditions necessary to protect aquatic life beneficial uses." *See* http://www.swrcb.ca.gov/plans_policies/biological_objective.shtml.

At this point, three committees are being established as part of the Biological Objectives development project. A Stakeholder Committee has been formed to communicate the development of Biological Objectives project goals to other interested stakeholders. This committee will then carry overall stakeholder's comments back to the scientific and regulatory committees to ensure that overall stakeholder input is incorporated into the technical and policy elements throughout this process, empowering the Stakeholder Committee to play a key role in advising the State Water Board. *Id*. A Scientific Committee of external experts will provide review of the technical aspects of the project, and a Regulatory Oversight Committee will coordinate with staff in other State Water Board programs and at all Regional Water

Quality Control Boards (Regional Boards) to ensure that the Biological Objectives development project delivers the tools that regulators and managers need, and also to provide the needed outreach and training to ensure that these tools will be used correctly and equitably. *Id*.

On February 2, 2010, a notice was distributed for the initial Stakeholder Committee meetings, held in March 2010. Notably, in that notice, the following statements were made by the State Water Board:

> "Protecting the integrity of biological resources in streams and rivers is one of the primary goals of California's water quality regulatory efforts. Historically, the Water Boards [State Water Board and Regional Boards] focused their monitoring, assessment, and regulatory efforts almost exclusively on chemical and physical criteria. Recognizing the value of directly measuring biological integrity, several Water Board programs conduct bioassessment monitoring and some require bioassessments in permits. *However, State and Regional Water Board plans and policies <u>do not contain numeric objectives or guidance for using biological data in regulatory decision-making</u>. Therefore, biological objectives are needed to provide the narrative or numeric benchmarks that describe conditions necessary to protect aquatic life beneficial uses.* This initial effort will focus on wadeable perennial streams and rivers.
>
> The absence of biological objectives or the lack of guidance has limited the effectiveness of many Water Board programs, leading to:
>
> - The inability to objectively assess whether aquatic life beneficial uses are supported;
> - The inability to assess whether chemical and physical criteria are sufficient to protect aquatic life (i.e., whether permits relying on chemical and physical criteria alone are achieving healthy streams & rivers)
> - *Inconsistencies in identifying impaired waterbodies*
> - Costly development of biological targets on a project-by-project basis.
>
> … The State Water Board plans to develop biological objectives for all perennial, wadeable streams and rivers in California taking into account the range of natural variation and degree of development in the state. The objectives likely will be in the form of a narrative statement that will be applied statewide. This narrative objective will be accompanied by a detailed implementation plan that, where possible, sets regionally appropriate numeric targets. Where data are not sufficient to define numeric targets, the implementation plan will describe the process for developing them."

See February 2, 2010 State Water Board letter, "Development of Biological Objectives for California" enclosed as Attachment A – Exhibit 1 (emphasis added)

The USEPA has also addressed the promulgation and use of biological criteria. In the USEPA NPDES Permit Writers' Manual, USEPA acknowledges that before biological assessment data can be used for regulatory activities, biological water quality objectives (called "criteria" under federal law) must be incorporated into a State's water quality standards. *See* NPDES Permit Writers' Manual at pp 98-99. Subsequently, USEPA prepared a "frequently asked questions" webpage regarding the development of biological criteria. In response to the question, **"What are some concerns of dischargers?",** USEPA responded as follows: "Dischargers are concerned that biological criteria will identify impairments that may be erroneously attributed to a discharger who is not responsible. This is a legitimate concern that the discharger and State must address with careful evaluations and diagnosis of cause of impairment." *See* http://www.epa.gov/waterscience/biocriteria/faqs.html.

The State Water Board has already acknowledged during the recently commenced Biological Objective promulgation process that no applicable water quality standard yet exists for an appropriate determination of attainment or impairment based on bioassessment data, which is required by Section 303(d) of the Clean Water Act or 40 C.F.R. sections 130.7(b)(1), (3). The State Water Board should first complete its process to adopt water quality standards, and then, in a subsequent listing cycle, determine whether an impairment, in fact, exists that must, and can, be addressed by a TMDL. Since the listing process occurs every two years, the State Water Board will have ample opportunity in the near future to re-assess the listing if it is removed from the 2010 303(d) List. If the State Water Board approves of the newly proposed listings, the State Water Board will be acting contrary to the Clean Water Act and federal regulations, as well as failing to comply with Water Code sections 13000 (requiring reasonableness in all aspects of water quality regulation), 13370(c), and 13372 (California must adhere to the requirements of the Clean Water Act and its regulations when implementing programs there under).

B. The State Water Board's Use of a Narrative Water Quality Objective for Toxicity as a Basis for 303(d) Listings for Benthic Macroinvertebrate Bioassessments Is Improper.

Notwithstanding the absence of appropriate biological water quality standards, State Water Board staff included both Reaches 5 and 6 of the Santa Clara River on the 303(d) List (Category 5) as impaired for benthic macroinvertebrate bioassessments. *See* April 19, 2010 State Water Board Staff Report - 2010 Integrated Report; Draft 2010 Integrated Report at Decision Id. 17217 and 18003. These listings have several fundamental flaws with respect to the bases for the listings.

As noted in the preceding comments, no appropriate biological water quality standards exist for the purpose of assessing the meaning or consequence, if any, of the benthic-macroinvertebrate bioassessments conduced in Reaches 5 and 6 of the Santa Clara River. Without properly promulgated biological water quality standards, there is no mechanism for determining the regulatory consequence of any bioassessments conducted, and no appropriate manner to determine an impairment pursuant to Section 303(d) and 40 C.F.R. 130.7(b). Instead of deferring these listings until the biological standards-setting process is complete, State Water Board staff have proposed to improperly base the 303(d) listings on the inapplicable narrative water quality objective for toxicity (Toxicity Objective) set forth in the Water Quality Control Plan for the Los Angeles Region (Basin Plan), hoping the objective is broad enough to be a "catch-all" for any desired listing. However, based on the plain language of the Toxicity Objective, the Toxicity Objective is inapplicable and does not support the State Water Board staff's proposed listings. The Toxicity Objective states,

> "Toxicity is the adverse response of organisms to chemical or physical agents. When the adverse response is mortality, the result is termed acute toxicity. When the adverse response is not mortality but instead reduced growth in larval organisms or reduced reproduction in adult organisms (or other appropriate measurements), a critical life stage effect (chronic toxicity) has occurred. <u>*The use of aquatic bioassays (toxicity tests) is widely accepted as a valid approach to evaluating toxicity of waste and receiving waters*</u>.
>
> All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant, or animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the State or Regional Board.

> The survival of aquatic life in surface waters, subjected to a waste discharge or other controllable water quality factors, shall not be less than that for the same waterbody in areas unaffected by the waste discharge or, when necessary, other control water.
>
> There shall be no acute toxicity in ambient waters, including mixing zones. The acute toxicity objective for discharges dictates that the average survival in undiluted effluent for any three consecutive 96-hour static or continuous flow bioassay tests shall be at least 90%, with no single test having less than 70% survival when using an established USEPA, State Board, or other protocol authorized by the Regional Board.
>
> There shall be no chronic toxicity in ambient waters outside mixing zones. To determine compliance with this objective, critical life stage tests for at least three species with approved testing protocols shall be used to screen for the most sensitive species. The test species used for screening shall include a vertebrate, an invertebrate, and an aquatic plant. The most sensitive species shall then be used for routine monitoring. Typical endpoints for chronic toxicity tests include hatchability, gross morphological abnormalities, survival, growth, and reproduction.
>
> Effluent limits for specific toxicants can be established by the Regional Board to control toxicity identified under Toxicity Identification Evaluations (TIEs)."

See Basin Plan at 3-16 and 3-17 (emphasis added).

Evident from the plain language of the Toxicity Objective, the purpose of that objective is to identify water column toxicity, and to ensure the regulation of specific pollutants that are the cause. The Toxicity Objective sets forth detailed requirements regarding water column toxicity testing, and if such testing identifies toxicity, the Toxicity Objective then authorizes the Regional Water Board to take action to identify the specific pollutant(s) causing the toxicity and impose effluent limits. *See, accord*, Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (Listing Policy) at pp. 5-6 (setting forth criteria for 303(d) listing pursuant to narrative water quality objective for toxicity); State Water Board's Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (SIP) at pp. 28-30 (setting forth detailed instruction assessment and compliance with Basin Plan toxicity objectives); *see also* USEPA NPDES Permit Writers' Manual at 94-98 (setting forth similar detailed requirements). Alternatively, if the USEPA or other appropriate agency has already identified acute and chronic criteria (*e.g.*, 304(a) criteria promulgated by USEPA) for a toxic pollutant, the Toxicity Objective can be used in conjunction with those criteria to determine reasonable potential and, if appropriate, to calculate effluent limitations for those pollutants. *See* 40 C.F.R. §122.44(d)(1)(vi).

The Water Boards cannot create a new narrative water quality standard for biological integrity by simply reinterpreting the existing narrative Toxicity Objective. The purpose of the Toxicity Objective is to ensure that toxic substances are not discharged in toxic amounts, not to establish objectives for the health of the benthic macroinvertebrate community.

In this case, State Water Board staff has not identified current concentrations of specific pollutants that are at levels that might be toxic to, or produce detrimental physiological responses in, aquatic life as measured using benthic macroinvertebrate bioassessments. In fact, the data cited by the State Water Board are outdated and convey an inaccurate depiction of current receiving water conditions. Specifically, with respect to:

- Santa Clara River Reach 6:
  - Chloride

    - Although currently listed as impaired for chloride, all chloride measurements in Santa Clara River Reach 6 have and continue to meet the protective aquatic life threshold of 230 mg/L. The 100 mg/L chloride objective for this reach as listed in the Basin Plan was established solely for the protection of salt sensitive agriculture.
  - Chlorpyrifos
    - Although currently listed as impaired for chlorpyrifos, no exceedances of the protective aquatic life threshold for chlorpyrifos have been observed in Reach 6 for over eight years.
  - Coliform bacteria
    - Although currently listed as impaired for coliform bacteria, bacteria water quality objectives for bacteria are established for human health protection and would not impact benthic macroinvertebrates.
  - Diazinon
    - Although currently listed as impaired for diazinon, diazinon measurements collected after the January 1, 2005 USEPA phase out indicate water quality thresholds are being met and the reach should be removed from the 303(d) List.
  - Iron
    - Although there is a proposed impairment listing for iron for this reach, the 1.0 ppm iron criterion used as the basis for the proposed impairment is taken from the 1976 USEPA "Red Book" and was not developed or updated using the 1985 Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. The toxicity studies used for this criterion are based on studies from 1969 and are outdated. Furthermore, the bioavailable form of iron is ferrous iron, which only exists at low pH levels. The pH in Reach 6 averages 7.51 with a 5th percentile pH of 7.11. At this pH, the ferrous iron is rapidly oxidized to ferric ion that is insoluble in water and not biologically available. In fact, the Red Book[1] includes a disclaimer that "data obtained under laboratory conditions suggest a greater toxicity for iron than that obtained in natural ecosystems". In ambient waters with sufficient dissolved oxygen and a pH above 7.0l, iron will rapidly oxidize to a non-bioavailable form and would not be responsible for impacts to aquatic life.
  - Copper
    - Although currently listed as impaired for copper, the most recent copper water quality objective exceedance in Santa Clara River Reach 6 was over five years ago. Additionally, when dissolved copper data for this reach is considered along with total copper data for this reach (with an appropriate total-to-dissolved translator applied to the total metals data), the data indicate that there is no copper impairment in this reach.

- Santa Clara River Reach 5:
  - Chloride
    - Although currently listed as impaired for chloride, all chloride measurements in Santa Clara River Reach 5 have and continue to meet the protective aquatic life threshold of 230 mg/L. The 100 mg/L chloride objective in the Basin Plan was established solely for the protection of salt sensitive agriculture.
  - Coliform bacteria
    - Although currently listed as impaired for coliform bacteria, bacteria water quality objectives for bacteria are established for human health protection and would not impact benthic macroinvertebrates.
  - Iron
    - Although there is a proposed impairment listing for iron for this reach, the 1.0 ppm iron criterion used as the basis for the proposed impairment is taken from the 1976 USEPA "Red Book" and was not developed or updated using the 1985 Guidelines for Deriving

[1] Quality Criteria for Water, USEPA, PB-263 943, 1976.

Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. The toxicity studies used for this criterion are based on studies from 1969 and are outdated. Furthermore, the bioavailable form of iron is ferrous iron, which only exists at low pH levels. The pH in Reach 5 averages 7.89 with a 5th percentile pH of 7.47 At this pH, the ferrous iron is rapidly oxidized to ferric ion that is insoluble in water and not biologically available. In fact, the Red Book[2] includes a disclaimer that "data obtained under laboratory conditions suggest a greater toxicity for iron than that obtained in natural ecosystems". In ambient waters with sufficient dissolved oxygen and a pH above 7.0, iron will rapidly oxidize to a non-bioavailable form and would not be responsible for impacts to aquatic life.

Notwithstanding the fact that none of the pollutants identified as co-occurring in the Santa Clara River are present in amounts toxic to aquatic life, State Water Board staff has also made no attempt to establish a causal relationship between the pollutants and any impacts to the benthic macroinvertebrate community. Without establishment of relationship indicating that the presence of a particular pollutant is causing degradation of the benthic macroinvertebrate community, the State Water Board cannot make a determination that toxics are present in toxic amounts, as would be necessary to establish a violation of the Toxicity Objective. Lacking a basis for linking the bioassessment data to a particular pollutant(s) associated with aquatic toxicity, the Integrated Report improperly lists “Benthic-Macroinvertebrate Bioassessments” as the “Pollutant.” *See* Integrated Report, Decisions 18003 and 17217.

Finally, use of the Toxicity Objective as a basis for an impairment decision would require that the Water Boards establish that the survival of aquatic life in an areas subject to waste discharge is less than that for the same water body in areas unaffected by the waste discharge or a control water. As further discussed below in Section 1.C, the Water Boards have not made a demonstration that the benthic macroinvertebrate community in Santa Clara River Reaches 5 and 6 is degraded relative to reference conditions.

It appears in this circumstance that State Water Board staff simply wanted to include Reaches 5 and 6 of the Santa Clara River on the 303(d) list as impaired for benthic macroinvertebrates, and due to the absence of any applicable water quality standard, staff chose the Toxicity Objective because of its reference to “population density” as a measure during toxicity testing, as though that reference would be sufficient to justify the listing. This “means to an end” rationale should be rejected. The Toxicity Objective cannot be used as a generic “catch-all” objective, to authorize regulatory action that does not comport with the plain language of the objective.[3]

C. The 303(d) Listings for Benthic-Macroinvertebrates Are Inconsistent with State Water Board's Own Listing Policy

On September 30, 2004, the State Water Board adopted its Water Quality Control Policy for Developing California’s Clean Water Act Section 303(d) List (Listing Policy), to describe the process by which the State Water Board and Regional Water Boards will comply with the listing requirements of section 303(d) of the Clean Water Act. The objective of the Listing Policy was to establish a standardized approach for developing California’s 303(d) List. *See* Listing Policy at 1. In order to make decisions regarding attainment with water quality standards, the Listing Policy provides guidance for interpreting

[2] Quality Criteria for Water, USEPA, PB-263 943, 1976.

[3] If the Regional and State Water Boards take the position that the Toxicity Objective can be used as a basis to find impairment for benthic-macroinvertebrates based on bioassessment data, the Districts assert that the Regional and State Water Boards failed to comply with Water Code section 13240, *et seq.* when adopting, revising, and approving the Toxicity Objective, in that the Regional and State Water Boards did not set forth this type of activity as part of the Toxicity Objective, did not consider the factors set forth in Water Code section 13241, and did not set forth a program of implementation to achieve compliance pursuant to Water Code section 13242.

data and information as they are compared to beneficial uses, existing numeric and narrative water quality objectives, and anti-degradation considerations. *Id*.

Pursuant to the Listing Policy, "Waters shall be placed in this [water quality limited segments] category of the section 303(d) list if it is determined, in accordance with the California Listing Factors, that the *water quality standard is not attained; the standards nonattainment is due to toxicity, a pollutant, or pollutants;* and remediation of the standards attainment problem requires one or more TMDLs." *Id*. at 3 (emphasis added). Thus, in order for a waterbody to be placed on the portion of the 303(d) List that requires preparation of a TMDL (Category 5), the Listing Policy requires both a determination that a specific water quality standard is not being attained and a finding that non-attainment of the standard is due to toxicity, a pollutant, or pollutants.

Further, when evaluating data, the Listing Policy provides, "An assessment in favor of or against a list action for a water body-pollutant combination shall be presented in fact sheets … This assessment shall be made on *a pollutant-by-pollutant (including toxicity) basis*." *Id*. at 2 (emphasis added). This again affirms that the Regional and State Water Boards must be able to link an impairment to a specific pollutant or pollutants, or water column toxicity, before an impairment can warrant the preparation of a TMDL.

The Listing Policy sets forth eleven listing factors, several of which are relevant here, as follows:

> "**3.6. Water/Sediment Toxici**ty: A water segment shall be placed on the section 303(d) list if the water segment exhibits statistically significant water or sediment toxicity using the binomial distribution as described in section 3.1. The segment shall be listed if the observed toxicity is associated with a pollutant or pollutants. Waters may also be placed on the section 303(d) list for toxicity alone. If the pollutant causing or contributing to the toxicity is identified, the pollutant shall be included on the section 303(d) list as soon as possible (i.e., during the next listing cycle)…
>
> Association of pollutant concentrations with toxic or other biological effects should be determined by any one of the following:
>
> A. Sediment quality guidelines (satisfying the requirements of section 6.1.3) are exceeded using the binomial distribution as described in section 3.1 In addition, using rank correlation, the observed effects are correlated with measurements of chemical concentration in sediments. If these conditions are met, the pollutants shall be identified as "sediment pollutant(s)."
> B. For sediments, an evaluation of equilibrium partitioning or other type of toxicological response that identifies the pollutant that may cause the observed impact. Comparison to reference conditions within a watershed or ecoregion may be used to establish sediment impacts.
> C. Development of an evaluation (such as a toxicity identification evaluation) that identifies the pollutant that contributes to or causes the observed impact.
>
> **3.9. Degradation of Biological Populations and Communities**: A water segment shall be placed on the section 303(d) list if the water segment exhibits significant degradation in biological populations and/or communities <u>*as compared to reference site(s)* ***and*** *is associated with water or sediment concentrations of pollutants including but not limited to chemical concentrations, temperature, dissolved oxygen, and trash.*</u> …This analysis should rely on <u>*measurements from at least two stations*</u>. …

> Association of chemical concentrations, temperature, dissolved oxygen, trash, and other pollutants shall be determined using sections 23.1, 3.2, 3.6, 3.7, 6.1.5.9, other applicable sections….
>
> Bioassessment data used for listing decisions shall be consistent with section 6.1.5.8. For bioassessment, measurements at one stream reach may be sufficient to warrant listing provided that the impairment is associated with a pollutant(s) as described in this section.
>
> **3.11. Situation-Specific Weight of Evidence Listing Factor**: When all other Listing Factors do not result in the listing of a water segment but information indicates non-attainment of standards, a water segment shall be evaluated to determine whether the weight of evidence demonstrates that a water quality standard is not attained. If the weight of evidence indicates non-attainment, the water segment shall be placed on the section 303(d) list. When making a listing decision based on the situation-specific weight of evidence, the RWQCB must justify its recommendation by:
>
> - Providing any data or information including current conditions supporting the decision;
> - Describing in fact sheets how the data or information affords a substantial basis in fact from which the decision can be reasonably inferred;
> - Demonstrating that the weight of the evidence of the data and information indicate that the water quality standard is not attained; and
> - Demonstrating that the approach used is scientifically defensible and reproducible.

Id. at 5, 7, and 8

For Santa Clara River Reach 6, the Fact Sheet for the listing indicates that the listing is based on Listing Policy Section 3.9 while the Staff Report (at p. 9) indicates that the listing is based on a situation-specific weight of evidence approach, which would be Listing Policy Section 3.11. For Santa Clara River Reach 5, both the Fact Sheet and the Staff Report based the listing on Listing Policy Section 3.11. Nowhere is Listing Policy Section 3.6, pertaining to a listing based on water quality objectives for toxicity, referenced.

1. Inconsistency with the Listing Policy for Santa Clara River Reach 6 Proposed Listing

With respect to the proposed listing for Reach 6, if the Fact Sheet is correct and the basis for this listing is Listing Policy Section 3.9, the State Water Board must satisfy two demonstrations to justify the listing. The State Water Board must first demonstrate that the water segment exhibits significant degradation in biological populations and/or communities as compared to reference site(s) ***and*** the State Water Board must demonstrate that significant degradation is associated with water or sediment concentrations of pollutants including but not limited to chemical concentrations, temperature, dissolved oxygen, and trash. Failure to satisfy these two demonstrations is detailed below.

<u>a. Failure to Identify Appropriate Reference Conditions/Sites</u>

The proposed listing for Benthic-Macroinvertebrate Bioassessments is based on application of the Southern California Coastal Index of Biological Integrity (SoCal IBI). The SoCal IBI does not inherently account for appropriate reference conditions, and adequate consideration of reference sites is an essential component in application of the index. The SoCal IBI is calculated by scoring bioassessment results from a receiving water location, but a lower score does not necessarily indicate "impairment." Different types of streams would be expected to support different types of invertebrate communities. In low-gradient streams, bed substrate is typically composed of fines and sand, rather than the cobbles, boulders, or bedrock typically found in high-gradient streams. In high-gradient streams, sediments and leaf litter are typically removed with the increased flow velocities resulting in larger open spaces between rocks and cobble that provide different habitats for different types of invertebrates utilizing different feeding strategies (more predators and fewer detritus feeders). In the low-gradient streams, the sediment and leaf litter/detritus loads are naturally deposited in the channel, filling up the available spaces between rocks. These habitats support a much different population of invertebrates (more detritus feeders and fewer predators), not necessarily an "impaired" population.

While the scientists that developed the SoCal IBI attempted to incorporate reference conditions into the index itself, the reference conditions used to develop the SoCal IBI are not representative of low elevation/low gradient streams in the Los Angeles Region. In the study used to develop the index,[4] data was collected from 275 sites, ranging from Monterey County in the north to the Mexican border in the south, but not a single site was located in the low elevation areas of Los Angeles County. Additionally, low elevation/gradient streams representative of those in the Los Angeles Region were significantly under-represented in the study.[5] Santa Clara River Reaches 5 and 6 are extremely low gradient (less than 1%), low elevation coastal water bodies, and thus the SoCal IBI does not adequately account for reference conditions relative to these reaches.

The lead scientist for development of the SoCal IBI, Dr. Peter Ode, has even acknowledged the limitations on application of the SoCal IBI. In a recently published paper regarding a study examining the SoCal IBI relative to other benthic macroinvertebrate bioassessments, he concluded that the SoCal IBI did not adequately inherently address reference conditions in low elevation sites, stating that the SoCal IBI was "not completely effective at controlling for an elevation gradient."[6] Dr. Ode was also the co-author of a March 2009 report on recommendations for development and maintenance of a network of reference sites to support biological assessment of California's wadeable streams.[7] This report describes recommendations made by a technical panel of experts on bioassessment, including experts from California Department of Fish and Game, Southern California Coastal Water Research Project (SCCWRP), USEPA Region 9, and various universities. The technical panel laid out a number of steps that would be necessary to develop a network of adequate reference sites for implementation of criteria for bioassessments. They note that, "A crucial component to the development of assessment tools is understanding biological expectations at reference sites that consist of natural, undisturbed systems. These reference systems set the biological condition benchmarks for comparisons to the site(s) being evaluated." They also clearly note that adequate reference sites have not been identified in southern California, stating, "human-dominated landscapes can be so pervasive in locations such as urban southern California and the agriculturally dominated Central Valley that no undisturbed reference sites may currently exist in these regions. A statewide framework for consistent selection of reference sites must account for this complexity."

[4] Ode, P.R., A.C. Rehn, J.T. May. 2005. A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams. Environmental Management Vol. 35, No 4, pp. 494, Figure 1. Copy included in Attachment B - Appendix 1.

[5] Mazor, Raphael D.; Schiff, Kenneth; Ritter, Kerry; Rehn, Andy; and Ode, Peter; Bioassessment Tools in Novel Habitats: An Evaluation of Indices and Sampling Methods in Low-Gradient Streams in California, Environ. Monit. Assess., DOI 10.1007/s10661-009-1033-3. Copy included in Attachment C.

[6] Ode, P.R., C.P. Hawkins, R.D. Mazor, Comparability of Biological Assessments Derived from Predictive Models and Multimetric Indices of Increasing Geographic Scope, J. N. Am. Benthol. Soc., 2008, 27(4):967-985.p. 982. Copy included in Attachment B - Appendix 2.

[7] Ode, P.R., K. Schiff. Recommendations for the Development and Maintenance of a Reference Condition Management Program to Support Biological Assessment of California's Wadeable Streams: Report to the Surface Water Ambient Monitoring Program. Southern California Coastal Water Research Project, Technical Report 581. March 2009. Copy included in Attachment B - Appendix 3.

Furthermore, a memorandum recently prepared by Jerry Diamond of Tetra Tech, one of the leading national technical experts on bioassessments, confirms that adequate reference sites are not available to assess benthic macroinvertebrate populations for low gradient and low elevation streams in the LA Region.[8] Dr. Diamond is the author of several technical reports prepared for the LA Regional Board on tiered aquatic life uses (TALU) based on bioassessments.[9,10] Dr. Diamond states that there is "high uncertainty regarding appropriate reference conditions for low gradient and low elevation streams in this region [southern California]," and that "low elevation streams lacked a clear reference conditions in this region [southern California]." He further states that a technical advisory committee for a USEPA-funded project on TALU "identified a lack of appropriate reference sites for low elevation/low gradient streams as a critical data gap." The technical advisory committee consisted of regional experts from California Fish & Game, State Water Board, other Regional Boards, USEPA Region 9, and universities. Dr. Diamond also worked with SCCWRP and the LA Regional Board in facilitating two workshops on TALU for Southern California. Dr. Diamond states, "In the most recent stakeholder workshop… there was agreement that low gradient (rather than low elevation) was perhaps the most critical factor distinguishing stream biology in the region and that the reference condition for low gradient streams (many but not all of which occur at low elevation) is a critical data gap..."[9]

Other scientific experts concur with Dr. Diamond's conclusions. In a recent study that examined low gradient streams in California, including sites within Reach 6 of the Santa Clara River, Raphael D. Mazor of SCCWRP stated, "Several biomonitoring efforts in California specifically target low-gradient streams, as these habitats are subject to numerous impacts and alterations, … even though the applicability of assessment tools created and validated in high-gradient streams have not been tested."[5] The study found that, "As a consequence of these differences [substrate material, bed morphology, and distribution of microhabitats], traditional bioassessment approaches in California that were developed in high-gradient streams with diverse microhabitats have limited applications in low-gradient reaches,"[6] and, "Caution should be used when applying sampling methods for assessment tools that were calibrated for specific habitat types (e.g., high gradient streams) to new habitats (e.g., low gradient streams)."[6] The study also concluded, "….observation of the sites in this study suggests that the lack of stable microhabitats (e.g., riffles and vegetated margins) may account for the reduced number of macroinvertebrates, as few species are adapted to the shifting sandy substrate found in most low gradient streams in California."[6]

Additionally, this same study examined a wide range of low gradient streams in the South Coast area (southern California and San Diego areas) including multiple locations assumed to be representative of reference condition and observed "impaired" IBI scores at all locations. This study included 67 bioassessment measurements at ten low gradient streams in the South Coast area, several of which were expected to be reflective of reference condition. The median IBI score for every location was "poor" or "very poor" and the calculated IBI scores for 64 of the 67 measurements at these sites were also "poor" or "very poor." The three measurements with IBI scores above "poor" were only slightly above "poor", at the low end of the "fair" category. The three "fair" measurements were obtained from two locations; the remaining 13 bioassessment scores at the two locations were "poor" or "very poor." The data from this study indicate that low gradient streams in southern California, even those

[8] Diamond, Jerry. Reference Conditions and Bioassessments in Southern California Streams. July 31, 2009. Memorandum to Phil Markle of the Sanitation Districts. Copy included in Attachment B - Appendix 4.
[9] Schiff, K. and Diamond, J., Identifying Barriers to Tiered Aquatic Life Uses (TALU) in Southern California, Southern California Coastal Water Research Project, Technical Report 590. June 2009. Copy included in Attachment B - Appendix 6.
[10] Tetra Tech, Revised Analyses of Biological Data to Evaluate Tiered Aquatic Life Uses (TALU) for Southern California Coastal Streams. Prepared for EPA Region 9 and California Regional Water Quality Control Board, Los Angeles Region. 2006. Tetra Tech, Inc., Owings Mills, MD. Copy included in Attachment B - Appendix 5.

expected to be reflective of reference conditions, typically have IBI scores in the range considered "impaired" by the State Water Board ("poor " or "very poor").

Moreover, the State Water Board, Surface Water Ambient Monitoring Program, California Department of Fish and Game, and others recognize the limitations of the SoCal IBI regarding reference sites. They have identified application of a tiered aquatic life uses (TALU) approach and the selection of more representative/appropriate regional reference locations as being necessary components to the state's bioassessment program. [5, 6,7,11]

State Board staff have also recognized these and other limitations in the IBI and have recently initiated a program to develop Biological Objectives, as discussed in Section 1.A of this attachment. The development effort includes identification of appropriate reference conditions.

b. Failure to Demonstrate an Association with Concentrations of Pollutants

The second demonstration that must be made for a listing under Section 3.9 of the Listing Policy is a demonstration that significant degradation in biological populations and/or communities is associated with water or sediment concentrations of pollutants including but not limited to chemical concentrations, temperature, dissolved oxygen, and trash. The associations are to be determined using Listing Policy Sections 3.1, 3.2, 3.6, 3.7, 6.1.5.9, or other applicable sections. Among the referenced sections, the only one that is applicable and includes specific guidance on associating a toxicant with a biological impairment is Section 3.6 (water/sediment toxicity). Section 3.6 specifies that an association of pollutant concentration with toxic or biological effects can be demonstrated by three different methods, depending on the situation. The three methods rely on a proven correlation using rank correlation, evaluation of partitioning or toxicological response that identifies the pollutant causing an impact, or development of an evaluation that identifies the pollutant that contributes to or causes the observed impact. Based on the Fact Sheet for this proposed listing and the Staff Report, no such analysis was conducted for the Santa Clara River. In fact, as discussed in Section 1.B of this letter, State Water Board staff has made no attempt to demonstrate that any degradation actually observed is associated with specific water or sediment concentrations of pollutants; State Water Board staff only made generalized findings related to outdated and inapplicable data. An evaluation of currently listed chemical-specific impairments, as presented in Section 1.B of this attachment, indicates that no such association exists.

In addition to not satisfying either of the two demonstrations required for a listing under Section 3.9 of the Listing Policy, the proposed listing does not satisfy the element of Section 3.9 that requires that analysis of biological degradation be based on measurements from at least two stations. In fact, the State Water Board has not presented data from even a single station in Reach 6. The single location referenced by the State Water Board for Reach 6 is actually within Reach 5. The sampling location is described by the State Water Board as "One site in the Santa Clara was sampled, at the Old Road, the DPW mass emission site, at N 34˚ 25.843' W 118˚ 35.652'". This location is graphically depicted in Attachment A - Figure 1. It is located west of the Old Road bridge, on the downstream side of the bridge. Per the Basin Plan, Reach 6 of the Santa Clara River is described as "Between Bouquet Canyon Road Bridge and West Point Highway 99." (p. 2-24). Highway 99 is now know as the Old Road, and the western edge of this bridge represents the break between Reaches 5 and 6 of the Santa Clara River. Downstream and to the west of this point is Reach 5; upstream and to the east of this point is Reach 6. The Sanitation Districts verified the location of the bioassessment sampling by contacting the company that conducted the sampling, Weston Solutions. Bill Isham of Weston Solutions indicated that bioassessment sampling conducted at the DPW mass emissions station was conducted a significant distance downstream of the bridge[12]. Therefore, because

[11] Ken Schiff, Deputy Director of the Southern California Coastal Water Research Project. Personal communication. 7/14/2009.
[12] Personal Communication on May 11, 2010.

the State Water Board has not referenced any bioassessment data collected within Reach 6, the proposed benthic macroinvertebrate listing for this reach should be rejected. Even if data from one station was available, the Listing Policy calls for data from at least two stations in order to justify a listing under Section 3.9.

Furthermore, the SoCal IBI was developed for and is applicable only in perennial streams[13]. However, Santa Clara River Reach 6 is not perennial. A perennial stream is a stream that has water flow year round, but large portions of Santa Clara Reach 6 are dry except during wet weather. In particular, Reach 6 is typically dry upstream of the discharge from the Saugus Water Reclamation Plant (located downstream of the Bouquet Canyon Road bridge). The discharge from the Water Reclamation Plant flows a relatively short distance, approximately one mile, before subsiding completely into the sandy substrate. Non-perennial flow comprises approximately 40% of Santa Clara River Reach 6.

While the Fact Sheet for Santa Clara River Reach 6 indicates that the listing is justified using Listing Policy Section 3.9, the Staff Report indicates that State Water Board evaluated the listing using a situation-specific weight of evidence approach, which would be consistent with Listing Policy Section 3.11. The weight of evidence analysis was a simple restatement that the SoCal IBI indicated "poor" quality and that certain chemical concentrations were elevated,

> "State Water Board staff used a situation-specific weight of evidence approach to evaluate the Santa Clara River Reach 5 and Reach 6 Benthic Macroinvertebrate–Bioassessment listing decision made by the Los Angeles Water Board. State Water Board staff determined that water quality data, with multiple LOEs, show that benthic macroinvertebrate populations are impacted by a wide range of stressors. Using this approach, staff followed a two-step process for evaluation of all available water quality data including the chemistry and bioassessment data. State Water Board staff evaluated the bioassessment data using the Southern California Index of Biological Integrity (IBI). Staff reviewed the LOEs prepared by the Los Angeles Water Board. Benthic Macroinvertebrate, as measured by Southern California IBI, were poor indicating impairment of benthic community structure. In step 2, the chemistry data for Reach 5 for coliform, iron and chloride; and for Reach 6 for Chloride, Chlorpyrifos, Coliform, Copper, Diazinon, Iron, and Toxicity were evaluated. The LOEs for the data and information indicate that the beneficial use of the water is not supported. The water quality chemistry and bioassessment data provide a substantial basis that benthic macroinvertebrate populations are impacted by a wide range of stressors. Based on the available data and information, staff recommend to List for Benthic Macroinvertebrate-Bioassessment."

State Water Board staff did not present any evidence to indicate that the benthic macroinvertebrate populations are in fact impacted by "a wide range of stressors," but rather simply noted that concentrations of certain pollutants are elevated. Additionally, as previously detailed, the data cited for the specific pollutants are either for non-toxic substances (indicator bacteria), for substances that do not occur in amounts toxic to aquatic life (chloride), are outdated due to management actions that have been taken to reduce concentrations (chlorpyrifos and diazinon), inappropriately assessed (copper), for a pollutant with a water quality objectives based on outdated standards and that is only bioavailable at conditions not present in the river (iron), or are not for a pollutant (toxicity). Additionally, no evidence is provided to support the contention that elevated iron concentrations have anthropogenic origins. Thus, the data does not afford a substantial basis from which the decision to list can reasonably be inferred. Furthermore, as previously detailed, the State Water Board did not establish that the benthic community was actually impaired relative to reference conditions, and did not establish a causal relationship between

[13] Evaluation of California State Water Resource Control Board's Bioassessment Program, Final Report to USEPA OST and Region IX, May 2009. Page 2, "California's bioassessment program is currently capable of addressing wadeable perennial streams. Additional investment and technical development will be needed to address other waterbody types including large non-wadeable rivers, non-perennial streams, lakes, and wetlands."

the pollutants present and any impacts to the benthic macroinvertebrate community. The State Water Board has therefore not demonstrated that the approach used in this case is scientifically defensible.

In contrast, an appropriate situation-specific weight of evidence evaluation would establish that no listing should occur, based on no water quality standard being violated because none exists, no evidence of degradation relative to a reference community, no establishment of a specific pollutant as the cause of any degradation, no bioassessment data presented for the reach, and the fact that the method used for the bioassessments is for perennial streams when large sections of the reach are dry during the dry season. For these reasons, the proposed listing for Reach 6 does not comply with the Listing Policy.

2. Inconsistency with the Listing Policy for Santa Clara River Reach 5 Proposed Listing

With respect to the listing for Santa Clara River Reach 5, State Water Board staff used Listing Policy Section 3.11 to justify the listing, both in the Fact Sheet for the listing and in the Staff Report. In addition to the language quoted above from the Staff Report relating to both Reaches 5 and 6, the Fact Sheet for Reach 5 contains the following justification,

> "State Water Board staff determined that it is necessary to include these listings because additional data analyses and multiple line of evidence show that benthic macroinvertebrate populations are impacted by a wide range of stressors. Multiple lines of evidence are available in the administrative record to assess this indicator. The water quality chemistry data for iron and chlorides show that water quality standards are not being met. The water quality chemistry data and bioassessment data provide a substantial basis that the benthic macroinvertebrate populations are impacted by a wide range of anthropogenic stressors. The weight of evidence indicate that the beneficial use of the water is not supported. Based on the available data and information, staff recommend to list for benthic macroinvertebrate-bioassessment."

As with Reach 6, the situation-specific weight of evidence analysis consists simply of a simple restatement that the SoCal IBI indicated poor quality and that certain chemical concentrations were elevated. State Water Board staff did not present any evidence to indicate that the benthic macroinvertebrate populations are in fact impacted by "a wide range of anthropogenic stressors," but rather simply noted that concentration of certain pollutants are elevated. Additionally, as previously detailed, the data cited for chloride and iron do not satisfy a threshold finding that toxicity may be present in the receiving waters that is connected to bioassessment data. Chloride concentrations in the river are well above thresholds for protection of aquatic life; iron water quality standards are out-dated and do not consider bioavailability; and no evidence is provided to support the contention that elevated iron concentrations have anthropogenic origins. Thus, the data does not afford a substantial basis from which the decision to list can reasonably be inferred. Additionally, the State Water Board did not establish that the benthic community was actually impaired relative to reference conditions, and did not establish a causal relationship between the pollutants present and any impacts to the benthic macroinvertebrate community. The State Water Board has therefore not demonstrated that the approach used in this case is scientifically defensible.

In contrast, an appropriate situation-specific weight of evidence evaluation would establish that no listing should occur, based on no water quality standard being violated because none exists, no evidence of degradation relative to a reference community, and no establishment of a specific pollutant as the cause of any degradation. For these reasons, the proposed listing for Reach 5 does not comply with the Listing Policy.

Furthermore, while the State Water Board justification for listing of this segment uses Section 3.11 of the Listing Policy, the more appropriate section of the Listing Policy would have been Section 3.9, which specifically addresses degradation of biological populations and communities. Under Section 3.9, the State Water Board must make two demonstrations in order to use that section as the basis for the listing.

The State Water Board must first demonstrate that the water segment exhibits significant degradation in biological populations and/or communities compared to reference site(s) ***and*** the State Water Board must demonstrate that significant degradation is associated with water or sediment concentrations of pollutants including but not limited to chemical concentrations, temperature, dissolved oxygen, and trash. The discussion above regarding the failure of the State Water Board to make either of these demonstrations for Santa Clara River Reach 6 also applies to Santa Clara River Reach 5, with the exception of the discussions on Reach 6 relating to a lack of sampling locations and the non-perennial nature of the reach.

D. The Listing is Inconsistent with USEPA's 2006 303(d) Guidance

USEPA's most recent guidance for States preparing their section 303(d) lists is the *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act* (2006 Guidance). USEPA instructs States to prepare Integrated Reports that combine the state's section 303(d) list and section 305(b) report (biennial report on water quality). Pursuant to the 2006 Guidance, in preparing the section 303(d) list, States should assign all waters within their respective jurisdictions to one or more of the following five categories:

> Category 1: All designated uses are supported, no use is threatened;
>
> Category 2: Available data and/or information indicate that some, but not all of the designated uses are supported;
>
> Category 3: There is insufficient available data and/or information to make a use support determination;
>
> Category 4: Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed for one of the following reasons;
>
> > (a) TMDL has been completed;
> >
> > (b) Other pollution control measures are reasonably expected to result in the attainment of the water quality standard in the near future;
> >
> > (c) Impairment is not caused by a pollutant.
>
> Category 5 (§ 303(d) list): Available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed.

See 2006 Guidance, pp. 47, 53-54.

Category 5 constitutes the state's 303(d) list that USEPA will review and approve or disapprove pursuant to 40 C.F.R. 130.7, and are the waterbodies for which TMDLs must be developed. *Id*. at 57. The standard for inclusion in Category 5 is met when, based on existing and readily available data and/or information, technology-based effluent limitations required by the Act, more stringent effluent limitations and other pollutant control requirements are not sufficient to implement an applicable water quality standard and a TMDL is needed. *Id*., citing 40 C.F.R. 130.7(b)(1). Category 4c is an equally important listing category, in cases where an impairment may be identified, but the impairment is not necessarily caused by a specific or identifiable pollutant. The 2006 Guidance states, in part,

> "Segments should be placed in Category 4c when the state demonstrates that the failure to meet and an applicable water quality standard is not caused by a pollutant, but instead

> is cause by other types of pollution. Segments placed in Category 4c do not require the development of a TMDL. Pollution, as defined by the CWA is 'the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water' (section 502(19)). … States should schedule these segments for monitoring to confirm that there continues to be no pollutant associated with the failure to meet the water quality standard and to support water quality management actions necessary to address the cause(s) of the impairment."

See 2006 Guidance at p. 56.

The 2006 Guidance also addresses the use of community-level bioassessment data in the 303(d) listing process. While bioassessment data is included as part of the data and information assembled to develop an Integrated Report, USEPA recommends that "Threshold values for segment impairment determinations as well as quality assurance should be addressed in the state's methodology" and that "States using biological assessments to make reporting determinations should also consider other types of data and information (i.e., chemical and physical)." *See* 2006 Guidance at pp 41-42. Further, while the 2006 Guidance recognizes bioassessments as a permissible basis for including a water on the 303(d) List as "impaired," those impairments should not be included in Category 5 (and, instead, Category 4c) *if the State demonstrates that a pollutant is not causing the impairment*. *Id*. at 63.

In this case, and as discussed in comments herein, the Sanitation Districts do not believe a proper finding of impairment can occur, because no applicable water quality standard exists as required under the Clean Water Act and federal regulations, the State Water Board has failed to demonstrate degradation of biological communities/populations relative to an appropriate low gradient reference location, and failed to consider that no specific water or sediment concentrations of pollutants have been associated with the bioassessment data in accordance with the state's methodology, the Listing Policy.

However, should information addressing these shortcomings be developed or obtained, Reaches 5 and 6 of the Santa Clara River should be included on the State's 303(d) List as Category 4c impairments in accordance with the 2006 Guidance if bioassessments indicate impaired scores relative to reference conditions but evidence indicates that the impairment cause is not a pollutant but instead "pollution," where the term "pollution" includes man-made habitat alteration. In this case, no TMDL should be developed until or unless the listing is shifted to Category 5 due to a newly identified association between specific pollutant concentrations in the receiving waters and the bioassessment data results.

Originally, the State Water Board proposed to categorized Santa Clara River Reaches 5 and 6 Benthic Macroinvertebrate bioassessments under Category 4c. In the original Integrated Report posted on the State Water Board's website April 19, 2010, the State Water Board made the following recommendation for Santa Clara River Reach 5:

> "Pollutant: Benthic-Macroinvertebrate Bioassessments
> Final Listing Decision: Do Not List on 303(d) list (TMDL required list)
>
> SWRCB Board Staff Recommendation: This water body will be in Category 4c (for water bodies impaired by pollution, not a pollutant). However, if this water body is also impaired by a pollutant, it will be in Category 5 A – 303(d) list, instead of Category 4c."

See April 19, 2010 Integrated Report at Decision Id. 18003, enclosed as Attachment A - Exhibit 2.

The "Map" portion of the website was consistent with this determination, indicating a "Do Not List on 303(d) list (TMDL required list)" determination for Benthic-Macroinvertebrate Bioassessments for Santa Clara River Reaches 5 and 6.

However, shortly after this version of the Integrated Report was posted on the State Water Board's website, a new version of the Integrated Report was posted (the current version that these comments are directed towards), which suddenly recommended Reach 5 be included in Category 5 in stead of Category 4c. It should be noted that the Map portion of the website, as of May 20, 2010, continued to display a "Do Not List on 303(d) list (TMDL required list)" determination for Benthic-Macroinvertebrate Bioassessments for Santa Clara River Reaches 5 and 6. Screen shots of the Map are enclosed as Attachment A - Exhibit 3.

At the same time the listing determinations were suddenly changed from Category 4c to Category 5, the State Water Board's website appears to have removed Category 4c from the list of 303(d) listing categories, and currently states,

> "Integrated Report Categories
> The 2010 Integrated Report places each assessed water segment into one of the five non-overlapping USEPA categories based on the overall beneficial use support of the water segment. In California, the 303(d) list is made up of three of the Integrated Report categories, 5, 4A, and 4B. These categories contain water segments that are not meeting water quality standards or not expected to meet water quality standards.
> Category 5 - 303(d) list requiring the development of a TMDL
> Category 4A - 303(d) list being addressed by USEPA approved TMDL
> Category 4B - 303(d) list being addressed by an action other than a TMDL
> Category 3
> Category 2
> Category 1"

See http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml.

While the evidence does not support a finding that the benthic macroinvertebrate community is impaired relative to reference conditions, should the State Water Board nevertheless make this determination, then the Sanitation Districts request that Reaches 5 and 6 of the Santa Clara River be placed in Category 4c unless or until the State Water Board makes a specific association between any impairment and a specific pollutant.

E. The Listing is Inconsistent with other Listing Decisions Made by the State Water Board

In the 2010 Integrated Report, the State Water Board concluded that bioassessment listings (listed as "Benthic Community Effects" but based on benthic macroinvertebrate bioassessment) for the California Regional Water Quality Control Board, San Diego Region (Region 9) with similar pollutant association evaluations were "insufficient to determine with the confidence and power required by the Listing Policy since this data is not associated with water or sediment concentrations of pollutants (Policy Section 3.9)". Potential listings for benthic community effects based on application of the IBI were evaluated for, at minimum, Agua Hedonia (Decision ID 17880), Escondido Creek (Decision ID 17894), Temecula Creek (Decision ID 17915), Rainbow Creek (Decision ID 17903), Buena Vista Creek (Decision ID 17885), San Marcos Creek (Decision ID 17909), and Loma Ata Creek (Decision ID 17898). For all of these water bodies, the decision was made not to include them on the 303(d) List, despite concurrent listed impairments for constituents such as DDE, DDT, chlorpyrifos, copper, TDS, iron, sulfates, fecal bacteria, manganese, phosphorus, selenium, total nitrogen, and toxicity. The reasoning for not listing the water bodies for benthic community impairments was that, "*as required under section 3.9 of the Listing Policy, pollutant(s) could not be directly associated with the benthic community effects*" and "*pursuant to section 3.11 of the Listing Policy, no additional data and information are available indicating that standards are not met.*"

The State Board did not provided any reasoning as to why the lack of association between co-occurring chemical 303(d) listings was used to reject potential benthic macroinvertebrate listings in San Diego area waterbodies, but not in Los Angeles area waterbodies. Without such evidence, decisions regarding impairment listings based on bioassessments appear to be arbitrary.

F. The State Water Board lacks Evidence to Support the Listings, or the Findings Made Are Not Supported by Evidence in the Administrative Record.

Decisions made by the State Water Board and the California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) that are not supported by findings, or findings not supported by the evidence in the administrative record, constitute an abuse of discretion. *Topanga Association for a Scenic Community v. County of Los Angeles*, 11 Cal.3d 506, 515; *California Edison v. SWRCB*, 116 Cal. App.3d 751, 761 (4th Dt. 1981); *see also In the Matter of the Petition of City and County of San Francisco, et al.*, State Board Order No. WQ-95-4 at 10 (Sept. 21, 1995). As detailed herein, because the proposed decision to include on the 303(d) List Benthic Macroinvertebrate Bioassessments for Santa Clara River Reaches 5 and 6 is not supported by evidence and is inconsistent with other listing decisions made by the State Water Board, it would be an abuse of the State Water Board's discretion to include the Santa Clara River Reaches 5 and 6 Benthic Macroinvertebrate Bioassessments on the 303(d) List.

Furthermore, the California Legislature has found and declared that activities affecting water quality "shall be regulated to attain the highest water quality which is *reasonable*, considering all demands being made and to be made on those waters and the total values involved, beneficial and detrimental, economic and social, tangible and intangible." *See* Water Code §13000 (emphasis added). This section sets state policy and imposes an overriding requirement on the State Water Board that all orders be reasonable considering all circumstances. As detailed herein, due to a lack of evidence to support 303(d) listings for Santa Clara River Reaches 5 and 6 Benthic Macroinvertebrate Bioassessments, it would not be reasonable to approve these listings.

2. Assessment of Data for Metals Listings

In a comment letter submitted to the LA Regional Board on June 17, 2009 regarding the proposed 303d List, the Sanitation Districts expressed several concerns regarding the method by which metals data are analyzed to determine whether a water body is impaired. In its Response to Comments on the Draft 2008 303(d) List Comment due date: June 17, 2009 (Response to Comments) Response 9.12, the LA Regional Board provided some clarity regarding the methodology used to analyze metals data, stating,

> "Regarding the use of dissolved and total fraction metals data, Regional Board staff has been consistent with US EPA guidance on the use of translators to compare data reported as the total metals fraction to criteria expressed as the dissolved metals fraction. US EPA supports the use of translators (see US EPA's January 27, 2006 comment letter on the 2006 303(d) list) and added waters to the list based on the use of translators (June 28, 2007 final decision on waters added to the 2006 303(d) list). Staff believes that the use of translators to compare total metals data to dissolved criteria is appropriate because the CTR [California Toxics Rule] criteria are calculated based on total metals data. The criteria are calculated by multiplying the total metals criteria values (from the US EPA national section 304(a) criteria guidance) by conversion factors to obtain dissolved criteria (FR Vol. 65, No. 97, page 31690). The use of translators to compare total metals data to the dissolved criteria is, in essence, the same as reversing the last step in the CTR criteria calculations, which results in comparing like data to like criteria. Therefore, translators can and should be used to assess data when only total metals data are available."

While this response addressed some of the Sanitation Districts' concerns regarding assessment of data for metals listings, in its June 17, 2009 letter the Sanitation Districts additionally expressed concerns regarding the LA Regional Board practice of considering of total metals data sets and dissolved metals data sets as independent sets of evidence. Combining dissolved and total metals data into one data set is the most valid and unbiased approach for listing assessments. Separating the data sets results in an inappropriate listing for copper in Santa Clara Reach 6, as well as several other water body/pollutant combinations. It contradicts the LA Regional Board's statement that conversion of data "results in comparing like data to like criteria." Separating total metals data sets and dissolved metals sets into separate lines of evidence is inconsistent with Section 6.1.5.6 of the Listing Policy, which states that data should first be subject to any necessary mathematical transformation prior to conducting any statistical analysis for placement on the 303(d) list. In this case, the necessary mathematical transformation would be conversion of total metals data to dissolved metals data using a translator. In addition, separate analysis of total and dissolved metals data sets does not allow for appropriate consideration of averaging periods, as required under Section 6.1.5.6 of the Listing Policy. Furthermore, separate analysis of total and dissolved metals datasets may in some cases not be fully protective. It could result in a non-impairment decision when an impairment decision is more appropriate. For example, if two datasets each have one exceedance out of two samples, neither dataset alone would generate a listing decision. However, if the two datasets were combined, then the combined dataset would show two exceedances out of four samples and would support a listing decision.

The LA Regional Board Response to Comments regarding these concerns states, "Total and dissolved fraction data was evaluated, but in separate lines of evidence" (Response 9.27) and "… the data sets were kept as separate lines of evidence and not combined due to the different fraction analyzed." (Response 9.28). No justification was provided as to why this practice was used, when it is more scientifically sound to translate the total metals data into dissolved data and analyze it with the dissolved data available. One larger data set provides a more reliable assessment of water quality that is more likely to be representative of water quality than several smaller data sets.

For copper in Santa Clara Reach 6, the State Water Board Review and Conclusion in the Fact Sheet for this listing states, "State Board staff concurs with the Regional Board that the copper dissolved fraction data are more temporally representative of conditions in the water body and more reliable than the total fraction data. No change to the decision is being recommended." It is not clear as to why the dissolved data is considered by the Water Boards to be more temporally representative. Both the dissolved and total metals data were collected over the same overall time periods. The primary difference between the data sets is that the dissolved data metals data were collected primarily during wet weather and the total metals data were collected monthly throughout the year but only during dry weather. While the LA Regional Board Response to Comments states that dry weather data sets and wet weather data sets were not considered separately, it appears that separating the dissolved metals data set from the total metals data set is meant to accomplish such a separation of the data. To obtain the most temporally representative data set, the dissolved metals data should be combined with the totals metals data so that the data set is representative of both wet and dry weather. As to the data sets being "reliable", both data sets met necessary QA/QC requirements and thus can be considered reliable. Therefore, the Sanitation Districts request that dissolved metals data and total metals data translated to dissolved data be combined and considered as one line of evidence when assessing metals listings.

A complete summary of the Santa Clara River Reach 6 copper and hardness data along with the CTR hardness-dependent objective calculations are attached as Attachment A - Table 1. These combined data indicate two exceedances of the copper Criterion Maximum Concentration (CMC) out of sample size of 71 and three exceedances of the copper Criterion Continuous Concentration (CCC) out of sample size of 69. For a sample size of 60 to 71, Table 3.1 of the Listing Policy specifies listing a pollutant/water body combination only if the number of exceedances is equal or greater than six. Therefore, copper in Reach 6 of Santa Clara River should not be listed.

3. Consideration of Analytical Method Data Quality

The copper impairment for the San Gabriel River Estuary was inappropriately assessed using copper data analyzed with USEPA Method 200.8. This is in conflict with Section 6.1.4 of the Listing Policy, which states that data used must be of "sufficient high quality" to make determinations of water quality impairments. In the case of saline/estuarine samples, USEPA Method 200.8 is susceptible to positive interferences from the salt present in the water. The interference is caused by sodium in the sample combining with argon used in the instrumentation to form a complex that has the same molecular weight as copper, resulting in an overestimation of the actual copper concentration. Although this interference can be partially minimized with varying success by using collision cell techniques and sample dilution, the potential for a significant over-estimation of the actual copper concentrations remains. The Sanitation Districts consulted with Dr. Peter Kozelka of USEPA Region 9, who recommended the use of USEPA Method 1640 for all estuarine receiving water copper measurements.[14] In 1997, to address the shortcomings of EPA Method 200.8, the USEPA developed and subsequently approved USEPA Method 1640 for the quantification of trace metals.[15] USEPA Method 1640 directly addresses the sodium/argon interference by incorporating a chelation preparation step that removes the metal from the matrix.

To verify whether interference was occurring in San Gabriel River Estuary copper analyses when USEPA Method 200.8 is used, data collected during studies conducted by the Sanitation Districts, as well as data collected by two power plants discharging to the estuary were examined. The data demonstrate an over-estimation for copper in the estuarine samples using USEPA Method 200.8 that is statistically significant, with 99% certainty, when compared to measurements using USEPA Method 1640.[16] LA Regional Board staff agreed that interferences occur when using USEPA Method 200.8 for estuarine copper samples, stating, "Regional Board staff consulted with State Board staff and carefully reviewed analytical method comparison data (Method 1640 vs. Method 200.8) from the aforementioned studies and agree with your finding that using USEPA Method 200.8 with collision cell technology for copper analysis of estuarine water samples may significantly overestimate the actual copper concentration."[17] Despite agreement from Water Board staff that results from estuarine copper samples analyzed using USEPA Method 200.8 are not accurate, the USEPA Method 200.8 estuarine copper data is included in the analysis to support a copper impairment determination for the San Gabriel River Estuary. In order to provide an accurate determination of impairment for copper in the San Gabriel River Estuary, the Sanitation Districts therefore request that copper concentration data obtained using USEPA Method 200.8 be excluded from the impairment determination.

It should be noted that the Sanitation Districts provided comments on this issue to the LA Regional Board in a June 17, 2009 comment letter. In its Response to Comments, the LA Regional Board did not respond to this concern.

[14] Peter Kozelka, EPA Region 9. Personal communications, June 2008.
[15] USEPA. 1997. Method 1640 – Determination of trace elements in water by preconcentration and inductively coupled plasma-mass spectroscopy. USEAP Office of Water, Washington D.C.
[16] Email from Phil Markle, Sanitation Districts, to C.P. Lai, LA Regional Board, "SGR Estuary Copper Study Update," dated June 16, 2008. Copy included in Attachment B - Appendix 8.
[17] Letter from Tracy J. Egoscue, LA Regional Board Executive Officer, to Stephen R. Maguin, Sanitation Districts Chief Engineer and General Manager, "Response to Request for Amendments to Copper Monitoring Requirements for Estuarine Receiving Waters Under the Long Beach Water Reclamation Plant Monitoring and Reporting Program – Joint Outfall System, Long Beach Water Reclamation Plant (NPDES No. CA0054119, Order No. R4-2007-0047, CI No. 5662)," dated August 15, 2008. Copy included in Attachment B - Appendix 9.

4. Use of Invalid Data to Make Listing Decisions

The listing decisions for chlorpyrifos and diazinon in Santa Clara River Reach 6 are based substantially upon use of Surface Water Ambient Monitoring Program (SWAMP) data that was declared by SWAMP to be invalid due to failure of Quality Assurance/Quality Control (QA/QC) protocols. In accordance with Section 6.1.4 of the Listing Policy, data which have been declared invalid by the entity providing the data should not be used for listing decisions.

The Sanitation Districts commented on the inadequacy of the data in a June 17, 2009 comment letter to the LA Regional Board. In its Response to Comments, regarding the Santa Clara Reach 6 chlorpyrifos data the LA Regional Board simply expressed disagreement with excluding the invalid data without giving any justification stating, “Staff disagrees that only two of the SWAMP [samples] were valid.” In its Response to Comments regarding the Santa Clara Reach 6 diazinon data, the LA Regional Board stated, “Staff disagrees with rejecting the data due to ‘holding time violation’. Concentrations of chlorpyrifos [sic] in samples can only decrease with time. These data should still be considered for listing since chlorpyrifos [sic] was detected in most of the samples even if the holding time passed.”

Notwithstanding the fact that no evidence has been presented by the Water Boards to indicate that the QA/QC failure was due solely to a holding time violation, the Sanitation Districts strongly disagree with the Water Boards’ position that it is acceptable to use data that has failed QA/QC due to a holding time exceedance. There is no justification for using data that does not pass QA/QC for regulatory purposes. Use of invalid data casts doubt on the integrity of the entire listing processes.

A complete summary of the Santa Clara River Reach 6 chlorpyrifos data along with the water quality objective is attached as Attachment A - Table 2. Considering only valid data, the table indicates two exceedances of the water quality objective. For a sample size of 28 to 36, Table 4.1 of the Listing Policy specifies delisting a pollutant/water body combination if the number of exceedances is equal or less than two. Therefore, chlorpyrifos in Reach 6 of Santa Clara River should be delisted.

5. USEPA Diazinon Phase-out

The proposed 303d List includes a listing for diazinon in Santa Clara Reach 6. In its June 17, 2009 comment letter to the LA Regional Board, the Sanitation Districts requested that only recent data be used to reassess this listing, because the USEPA has implemented a management practice that resulted in a change in the quality of the water quality of the segment. Section 6.1.5.3 of the Listing Policy states, “If the implementation of a management practice(s) has resulted in a change in the water body segment, only recently collected data (since the implementation of the management measures(s)) should be considered.” For diazinon, by December 31, 2004 a USEPA ban on sales of all indoor and outdoor non-agricultural products containing diazinon took effect. Because Santa Clara River Reach 6 is in an urbanized area with little agricultural activity, this ban is expected to have eliminated essentially all sources of diazinon to this water body.

The Sanitation Districts requested that only recent data be considered in reassessing this listing in its June 17, 2009 letter to the LA Regional Board. In its Response to Comments, the LA Regional Board stated,

> “Looking at data collected through the end of the solicitation period, exceedances were still observed postban. In addition, it would be premature to state that the impairment is being addressed by other actions, especially given that there are enough exceedances to warrant not delisting (as per the Listing Policy). The 2004 USEPA diazinon and chlorpyrifos phase-out restricted the sale of products containing diazinon and chlorpyrifos, *not the use of such products currently in circulation*. The continued use of products purchased prior to the ban may occur for some time and the ban did not include specific dates of water quality attainment.”

The Sanitation Districts agree that the 2004 USEPA diazinon phase-out only restricted the sale of the products and not the use. However, the Sanitation Districts believe the final sales ban for diazinon on December 31, 2004 constitutes an implementation of a management practice that has resulted in changes in the water body segments. In particular, when data considered after the bans took effect are considered, only two four-day average diazinon results exceeded the CCC threshold out of 29 samples for Santa Clara River Reach 6. A delisting requires two or less exceedances.

Although concentrations of diazinon continued to be occasionally elevated for one to two years after the bans took effect, these data do not indicate that the ban was not successful. The ban was placed on sales of diazinon, not use, and stocks of previously purchased diazinon would be expected to be used up in the time period immediately following the bans taking effect. The fact that there have been no detections and no exceedances of diazinon in Santa Clara River Reach 6 since January 2006 indicates that the ban has successfully addressed the impairments. The Sanitation Districts therefore request that the State Water Board only consider diazinon data since the sales ban took effect when assessing this impairment. This dataset is attached as Attachment A - Table 3. For a sample size of 28 to 36, Table 4.1 of the Listing Policy recommends delisting a pollutant/water body combination if the number of exceedances is equal or less than two. Therefore, diazinon in Reach 6 of Santa Clara River should be delisted. Notwithstanding that the water quality objectives are being achieved and no impairment is present, if the State Water Board does not delist Santa Clara Reach 6 for diazinon, it would be fully conservative for the State Water Board to move the listing to the "Water Quality Limited Segments Being Addressed by Actions Other Than a TMDL" category until the next listing cycle when the listing can be reevaluated with additional data.

6. Support Proposed Delistings for Certain Water body/Pollutant Combinations

The State Water Board is currently proposing that a new listing for cyanide be made to the 303(d) List in Rio Hondo Reach 2. The fact sheet for cyanide in Rio Hondo Reach 2 states: "three of six samples exceeded the California Toxics Rule (CTR) Criterion Continuous Concentration (CCC) for cyanide" and "one of six samples exceeded the CTR Criterion Maximum Concentration (CMC) for cyanide." Originally this listing was proposed for Rio Hondo Reach 1 and upon State Water Board review the State Water Board has correctly moved this proposed listing to Rio Hondo Reach 2. However, State Water Board staff failed to assess all readily available data regarding this listing. The Sanitation Districts submitted relevant data to the LA Regional Board on February 28, 2007. The data submitted included cyanide data collected at receiving water monitoring stations RD and RD1, which are located in Rio Hondo Reach 2. Data from these receiving water stations were used in other Rio Hondo Reach 2 impairment assessments. A complete summary of the cyanide data along with the CTR water objective are attached as Attachment A - Table 4. These combined data indicate one exceedance of the cyanide Criterion Maximum Concentration (CMC) out of a sample size of 85 and four exceedances of the cyanide Criterion Continuous Concentration (CCC) out of sample size of 82. For a sample size of 72 to 82, Table 3.1 of the Listing Policy specifies listing a pollutant/water body combination only if the number of exceedances is equal or greater than seven. Therefore, cyanide in Rio Hondo Reach 2 should not be listed.

7. Support Proposed Delistings for Certain Water body/Pollutant Combinations

The Sanitation Districts have reviewed the proposed listing decisions for the water body/pollutant combinations listed below. The Sanitation Districts believe the decisions are correct and support removal of these water body/pollutant combinations from the 303(d) List:

- Ballona Creek - Silver
- Coyote Creek - Zinc
- Los Angeles River Estuary - Lead (sediment) and zinc (sediment)

- Rio Hondo Reach 2 - Ammonia
- San Jose Creek - Selenium
- Santa Clara River Reach 5 - Ammonia and Nitrate and Nitrite
- Santa Clara River Reach 6 - Ammonia
- Wilmington Drain - Ammonia
- Walnut Creek Wash - Toxicity

8. Administrative Record

The Sanitation Districts have checked the State Water Board's official administrative record and three letters submitted by the Sanitation Districts have been omitted. In a letter dated July 13, 2009 the Sanitation Districts requested postponement of the July 16, 2009 LA Regional Board hearing on the 303(d) List, because substantive revisions had been made to the list, including addition the listings for benthic macroinvertebrate bioassessment, only three days before the LA Regional Board hearing. This letter also requested an opportunity to submit written comments on the last minute revisions to the 303(d) List. Although the LA Regional Board did not respond to this letter, the Sanitation Districts prepared a letter containing written comments and submitted it to the LA Regional Board at the July 16, 2009 hearing. Additionally, in accordance with the Section 6.3 of the Listing Policy, the Sanitation Districts submitted a request for the State Water Board to review of specific listing decisions on August 14, 2009. All three of these letters should be added to the administrative record and copies are enclosed as Attachments D, E, and B, respectively.

State Water Resources Control Board

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Linda S. Adams
Secretary for Environmental Protection

Arnold Schwarzenegger
Governor

2 February 2010

Dear Water Quality Stakeholders:

DEVELOPMENT OF BIOLOGICAL OBJECTIVES FOR CALIFORNIA

The State Water Board is initiating the process to develop biological objectives for freshwater streams and rivers in California. You are invited to participate in the project kickoff meetings on 8 and 11 March 2010.

8 March 2010, 1:00 – 4:00 p.m.
Cal EPA Building
1001 I Street, Sacramento

11 March 2010, 9:00 a.m. – 12:00 p.m.
SCCWRP
3535 Harbor Blvd., Suite 110, Costa Mesa

The purpose of these meetings is to educate stakeholders on the project and initiate the process of assembling the stakeholder, regulatory, and scientific committees that will help guide the effort. A brief discussion of the purpose and background of the project is provided below.

Protecting the integrity of biological resources in streams and rivers is one of the primary goals of California's water quality regulatory efforts. Historically, the Water Boards focused their monitoring, assessment, and regulatory efforts almost exclusively on chemical and physical criteria. Recognizing the value of directly measuring biological integrity, several Water Board programs conduct bioassessment monitoring and some require bioassessment in permits. However, State and Regional Water Board plans and policies do not contain numeric objectives or guidance for using biological data in regulatory decision-making. Therefore, biological objectives are needed to provide the narrative or numeric benchmarks that describe conditions necessary to protect aquatic life beneficial uses. This initial effort will focus on wadeable perennial streams and rivers.

The absence of biological objectives or the lack of guidance has limited the effectiveness of many Water Board programs, leading to:

- the inability to objectively assess whether aquatic life beneficial uses are supported;
- the inability to assess whether chemical and physical criteria are sufficient to protect aquatic life (i.e., whether permits relying on chemical and physical criteria alone are achieving healthy streams & rivers);
- inconsistencies in identifying impaired waterbodies;
- costly development of biological targets on a project-by-project basis.

These problems can be resolved by employing modern tools for directly measuring and protecting aquatic life and developing thresholds and guidance for assessing the data.

State Water Board managers are committed to developing biological objectives for assessing the health of streams statewide.

The state has invested significant resources to develop the technical tools needed to directly measure biological condition (assessing the organisms living in streams) laying the groundwork for using these tools in regulatory programs. The State Water Board plans to develop biological objectives for all perennial, wadeable streams and rivers in California taking into account the range of natural variation and degree of development in the state. The objectives likely will be in the form of a narrative statement that will be applied statewide. This narrative objective will be accompanied by a detailed implementation plan that, where possible, sets regionally appropriate numeric targets. Where data are not sufficient to define numeric targets, the implementation plan will describe the process for developing them.

Three oversight committees will be established for the development and public vetting of the regulatory and technical policy statements: 1) a **Stakeholder Committee** that will communicate the project goals to interested stakeholders and carry their input back to the scientific and regulatory committees to ensure that stakeholder input is incorporated into the technical and policy elements throughout the process, and play a key role in advising the State Water Board; 2) a **Scientific Steering Committee** of external experts that will provide review of the technical aspects of the project; and 3) a **Regulatory Oversight Committee** that will coordinate with staff in other State Water Board programs and at all Regional Water Boards to ensure that the project delivers the tools that regulators and managers need, and to provide outreach and training to ensure that the tools are used correctly and equitably.

We look forward to working with you and encourage you to forward this letter to those we may have missed. Your participation at this early stage in the project is critical to ensure that the range of public interests is represented throughout the process. Thank you in advance for your participation in this important effort. We look forward to seeing you in March. If you have any questions or would like additional information regarding this matter please contact Karen Larsen at (916) 319-9769 or klarsen@waterboards.ca.gov.

Sincerely,

Valerie M Connor

Valerie M. Connor, PhD, Director
OFFICE OF INFORMATION MANAGEMENT AND ANALYSIS

DECISION ID 18003 Region 4

Santa Clara River Reach 5 (Blue Cut gaging station to West Pier Hwy 99 Bridge) (was named Santa Clara River Reach 7 on 2002 303(d) list)

Pollutant:	**Benthic-Macroinvertebrate Bioassessments**
Final Listing Decision:	**Do Not List on 303(d) list (TMDL required list)**
Last Listing Cycle's Final Listing Decision:	New Decision
Revision Status	Revised
Impairment from Pollutant or Pollution:	Pollutant

Conclusion:

State Water Board staff used Section 3.11 situation-specific weight of evidence approach to evaluate the Los Angeles Water Board benthic macroinvertebrateÂ–bioassessment listing. State Water Board staff determined that it is necessary to include these listings because additional data analyses and multiple line of evidence show that benthic macroinvertebrate populations are impacted by a wide range of stressors.

Multiple lines of evidence are available in the administrative record to assess this indicator. The water quality chemistry data for iron and chlorides show that water quality standards are not being met.

The water quality chemistry and bioassessment data provide a substantial basis that benthic macroinvertebrate populations are impacted by a wide range of anthropogenic stressors. The weight of evidence indicate that the beneficial use of the water is not supported. Based on the available data and information, staff recommend to list for benthic macroinvertebrate-bioassessment.

RWQCB Board Staff Recommendation:

SWRCB Board Staff Recommendation:

This water body will be in Category 4c (for water bodies impaired by pollution, not a pollutant). However, if this water body is also impaired by a pollutant, it will be in Category 5 Â– 303(d) list, instead of Category 4c.

USEPA Decision:

Line of Evidence (LOE) for Decision ID 18003, Benthic-Macroinvertebrate Bioassessments Region 4

Santa Clara River Reach 5 (Blue Cut gaging station to West Pier Hwy 99 Bridge) (was named Santa Clara River Reach 7 on 2002 303(d) list)

LOE ID:	31432
Pollutant:	Benthic-Macroinvertebrate Bioassessments
LOE Subgroup:	Population/Community Degradation
Matrix:	Water
Fraction:	None

4/19/10

Beneficial Use:	Warm Freshwater Habitat
Number of Samples:	4
Number of Exceedances:	4
Data and Information Type:	Benthic macroinvertebrate surveys
Data Used to Assess Water Quality:	Four out of 4 samples had IBI scores ranked in the "poor" or "very poor" range during the fall seasons of 2001, 2003, and 2004.
Data Reference:	A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams. Appendix 7-B Environmental Management Vol. 35, No. 4, pp. 493-504.
Water Quality Objective/Criterion:	Los Angeles RWQCB Basin Plan Objectives for Toxicity which states Â“All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in, human, plant or animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration or other appropraite methods as specified by the State or Regional Board."
Objective/Criterion Reference:	Basin Plan Amendments to the Water Quality Control Plan Los Angeles Region R4 Basin Plan 1997-2009.
Evaluation Guideline:	The IBI is a multi-metric assessment that employs biological metrics that respond to a habitat or water quality impairment. Each of the biological metrics measured at a site are converted to an IBI score then summed. These cumulative scores are then ranked according to very good (80-56), good (41-55), fair (27-40), poor (14-39) and very poor (0-13) habitat conditions. Sites with scores below 26 are considered to have impaired conditions.
Guideline Reference:	A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams. Appendix 7-B Environmental Management Vol. 35, No. 4, pp. 493-504.
Spatial Representation:	Three sites were used to collect samples: Station 1 - SCR Unlined Channel @ Old Rd., SCR-BC, and SCR-004
Temporal Representation:	Samples were collected during the fall seasons of 2001, 2003, and 2004.
Environmental Conditions:	
QAPP Information:	Data was collected in compliance with California Stream Bioassessment Procedure.
QAPP Information Reference(s):	

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http://www.swrcb.ca.gov/water_issues/programs/tmdl/integrated2010.shtml

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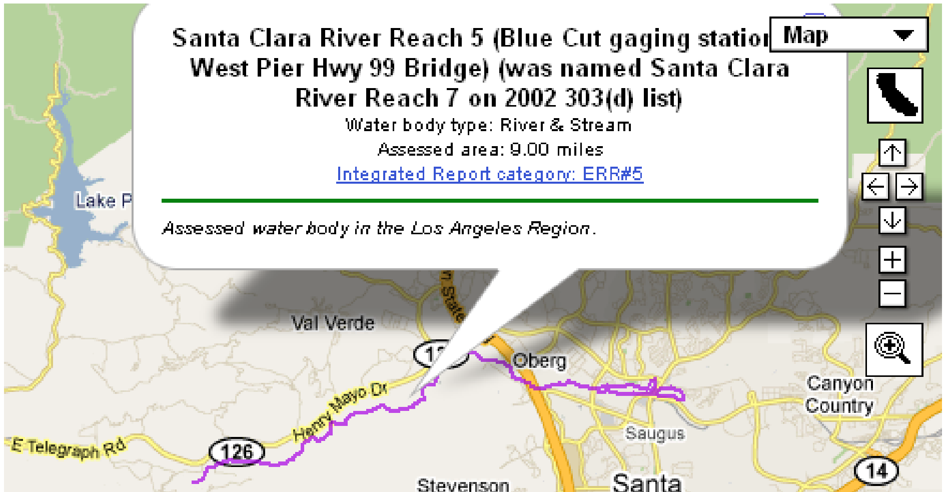

Show all assessed waters

Show only impaired ("303(d)-listed") waters

Show water bodies by pollutant:

Pollutant category: *All*

All

Pollutant: *Benthic-Macroinvertebrate*

Pollutant assessments for Santa Clara River Reach 5 (Blue Cut gaging station to West Pier Hwy 99 Bridge) (was named Santa Clara River Reach 7 on 2002 303(d) list)

Close

Pollutants	Listing Decision / *Comments*	Detailed Report	Potential Sources	Schedule
Aluminum	Do Not List on 303(d) list (TMDL required list)	5385	n/a	
Ammonia	Delist from 303(d) list (being addressed by USEPA approved TMDL)	7166	n/a	USEPA TMDL approval: 2004
Benthic-Macroinvertebrate Bioassessments	Do Not List on 303(d) list (TMDL required list)	18003	n/a	

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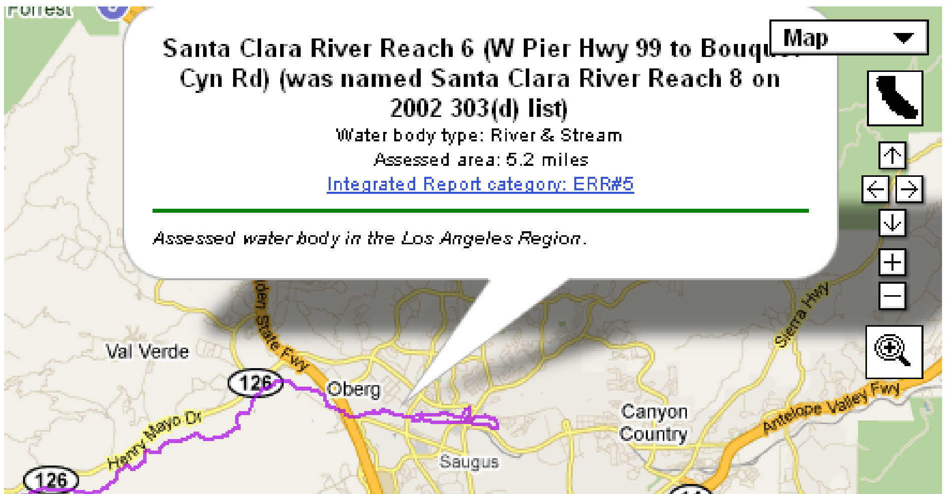

- Show all assessed waters
- Show only impaired ("303(d)-listed") waters

Show water bodies by pollutant:

Pollutant category:
All

All

Pollutant:
Benthic-Macroinvertebrate

Pollutant assessments for Santa Clara River Reach 6 (W Pier Hwy 99 to Bouquet Cyn Rd) (was named Santa Clara River Reach 8 on 2002 303(d) list) Close

Pollutants	Listing Decision / *Comments*	Detailed Report	Potential Sources	Schedule
Ammonia	Delist from 303(d) list (being addressed by USEPA approved TMDL)	4205	n/a	USEPA TMDL approval: 2004
Benthic-Macroinvertebrate Bioassessments	Do Not List on 303(d) list (TMDL required list)	17217	n/a	
Bis(2ethylhexyl)phthalate (DEHP)	Do Not List on 303(d) list (TMDL required list)	9451	n/a	

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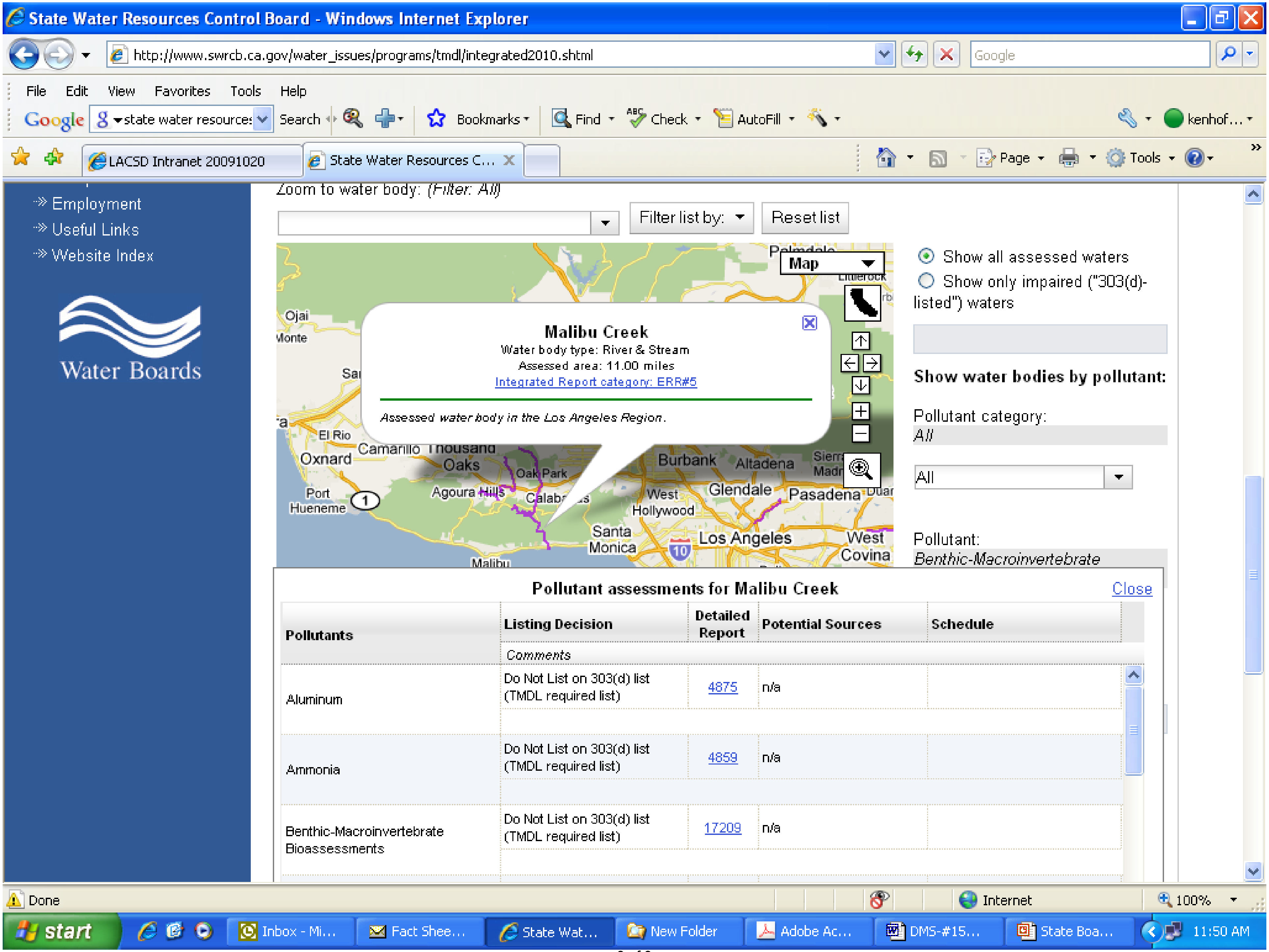
ATTACHMENT A - EXHIBIT 3



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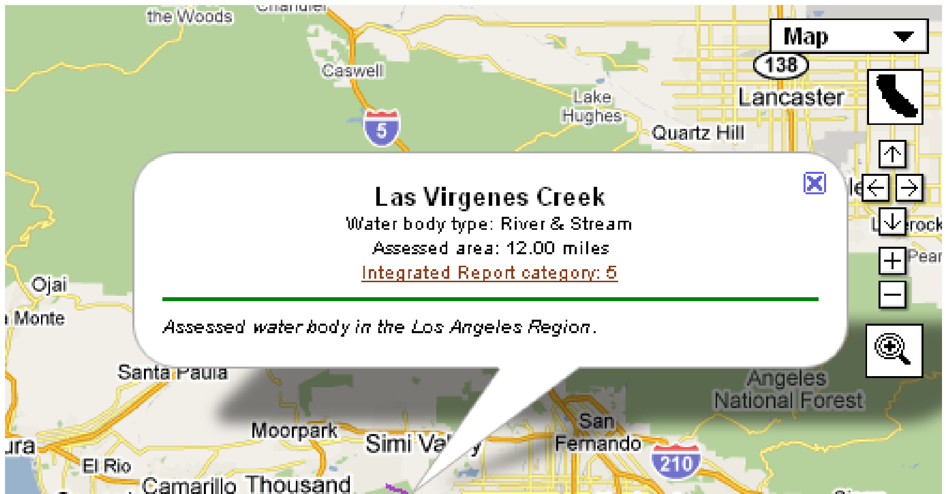

Show all assessed waters

Show only impaired ("303(d)-listed") waters

Show water bodies by pollutant:

Pollutant category:

All

All

Pollutant:

Benthic-Macroinvertebrate

Pollutant assessments for Las Virgenes Creek Close

Pollutants	**Listing Decision** / *Comments*	**Detailed Report**	**Potential Sources**	**Schedule**
Benthic-Macroinvertebrate Bioassessments	Do Not List on 303(d) list (TMDL required list)	17207	n/a	
Coliform Bacteria	List on 303(d) list (being addressed by USEPA approved TMDL)	6156	Nonpoint Source	USEPA TMDL approval: 2005
Invasive Species	List on 303(d) list (TMDL required list)	16621	Nonpoint Source, Point Source	Est. TMDL completion: 2021
			Agriculture-animal, Atmospheric Deposition, Golf course activities, Groundwater Loadings,	

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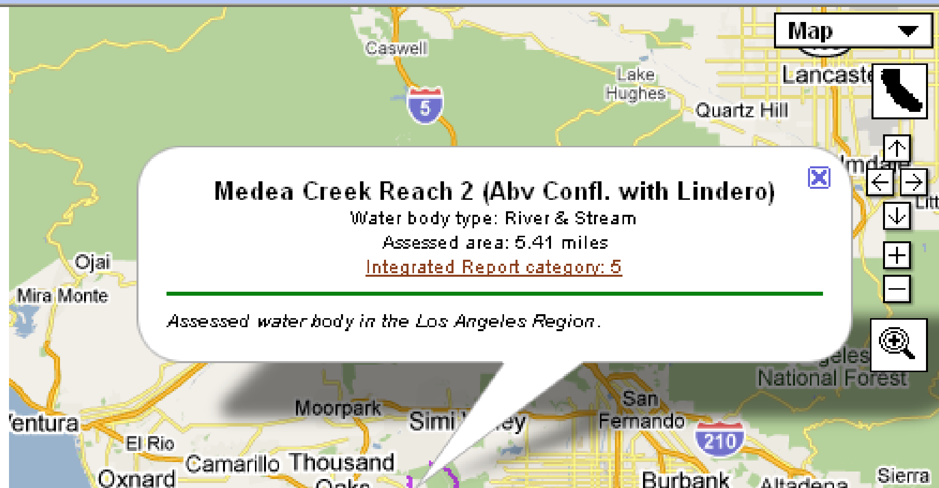

Show all assessed waters

Show only impaired ("303(d)-listed") waters

Show water bodies by pollutant:

Pollutant category:

All

All

Pollutant:

Benthic-Macroinvertebrate

Pollutant assessments for Medea Creek Reach 2 (Abv Confl. with Lindero) Close

Pollutants	Listing Decision / *Comments*	Detailed Report	Potential Sources	Schedule
Algae	List on 303(d) list (being addressed by USEPA approved TMDL)	7344	Atmospheric Deposition, Golf course activities, Groundwater Loadings, Irrigated Crop Production, Major Municipal Point Source-dry and/or wet weather discharge, Onsite Wastewater Systems (Septic Tanks), Urban Runoff/Storm Sewers	USEPA TMDL approval: 2003
Benthic-Macroinvertebrate Bioassessments	Do Not List on 303(d) list (TMDL required list)	17210	n/a	

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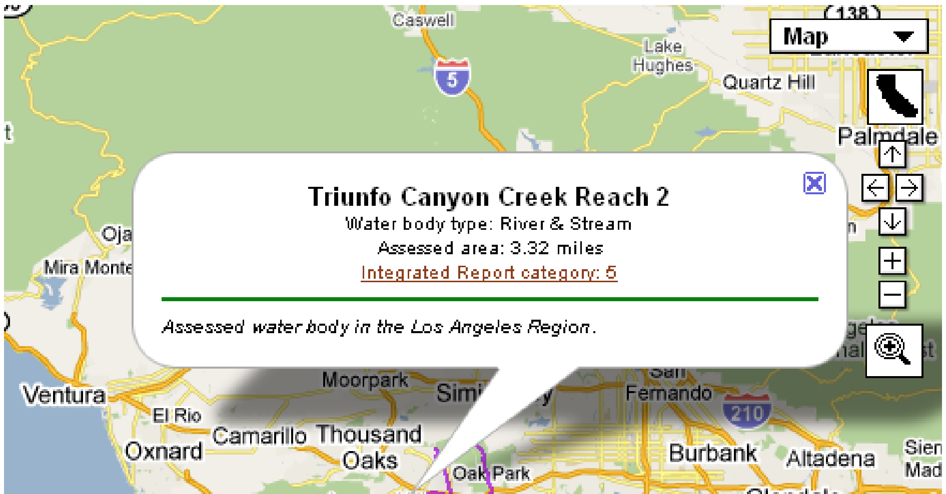

Triunfo Canyon Creek Reach 2

Water body type: River & Stream

Assessed area: 3.32 miles

Integrated Report category: 5

Assessed water body in the Los Angeles Region.

Show all assessed waters

Show only impaired ("303(d)-listed") waters

Show water bodies by pollutant:

Pollutant category:

All

All

Pollutant:

Benthic-Macroinvertebrate

Pollutant assessments for Triunfo Canyon Creek Reach 2 Close

Pollutants	**Listing Decision** / *Comments*	**Detailed Report**	**Potential Sources**	**Schedule**
Benthic-Macroinvertebrate Bioassessments	Do Not List on 303(d) list (TMDL required list)	17211	n/a	
Lead	List on 303(d) list (TMDL required list)	7130	Nonpoint Source	Est. TMDL completion: 2019
Mercury	List on 303(d) list (TMDL required list)	7131	Nonpoint Source	Est. TMDL completion: 2019
Sedimentation/Siltation	List on 303(d) list (TMDL required list)	7132	Source Unknown	Est. TMDL completion: 2019

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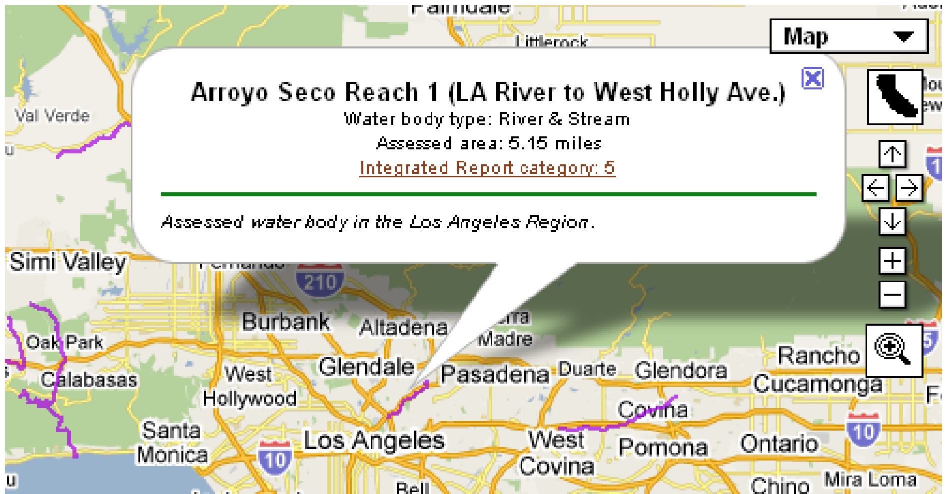

Show all assessed waters

Show only impaired ("303(d)-listed") waters

Show water bodies by pollutant:

Pollutant category:

All

All

Pollutant:

Benthic-Macroinvertebrate

Pollutant assessments for Arroyo Seco Reach 1 (LA River to West Holly Ave.) Close

Pollutants	Listing Decision / *Comments*	Detailed Report	Potential Sources	Schedule
Benthic-Macroinvertebrate Bioassessments	Do Not List on 303(d) list (TMDL required list)	17212	n/a	
Coliform Bacteria	List on 303(d) list (TMDL required list)	7179	Nonpoint Source	Est. TMDL completion: 2009
Excess Algal Growth	Delist from 303(d) list (TMDL required list)	4311	n/a	
Trash	List on 303(d) list (being addressed by USEPA approved TMDL)	7181	Nonpoint Source, Surface Runoff, Urban Runoff/Storm Sewers	USEPA TMDL approval: 2008

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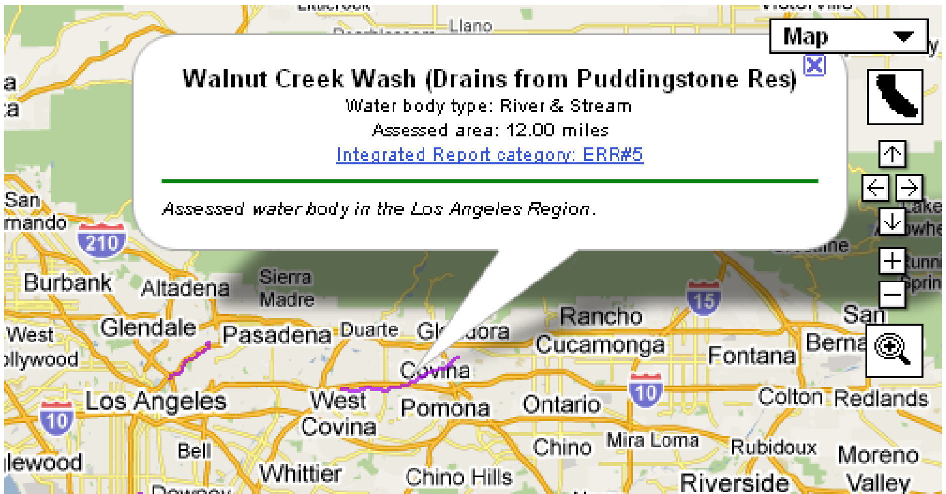
Water Boards



Show all assessed waters

Show only impaired ("303(d)-listed") waters

Show water bodies by pollutant:

Pollutant category:
All

All

Pollutant:
Benthic-Macroinvertebrate

Pollutant assessments for Walnut Creek Wash (Drains from Puddingstone Res) Close

Pollutants	**Listing Decision** *Comments*	**Detailed Report**	**Potential Sources**	**Schedule**
Benthic-Macroinvertebrate Bioassessments	Do Not List on 303(d) list (TMDL required list)	17216	n/a	
Copper, Dissolved	Do Not List on 303(d) list (TMDL required list)	9490	n/a	
Indicator Bacteria	List on 303(d) list (TMDL required list)	16193	Source Unknown	Est. TMDL completion: 2021
Lead	Do Not List on 303(d) list (TMDL required list)	9491	n/a	

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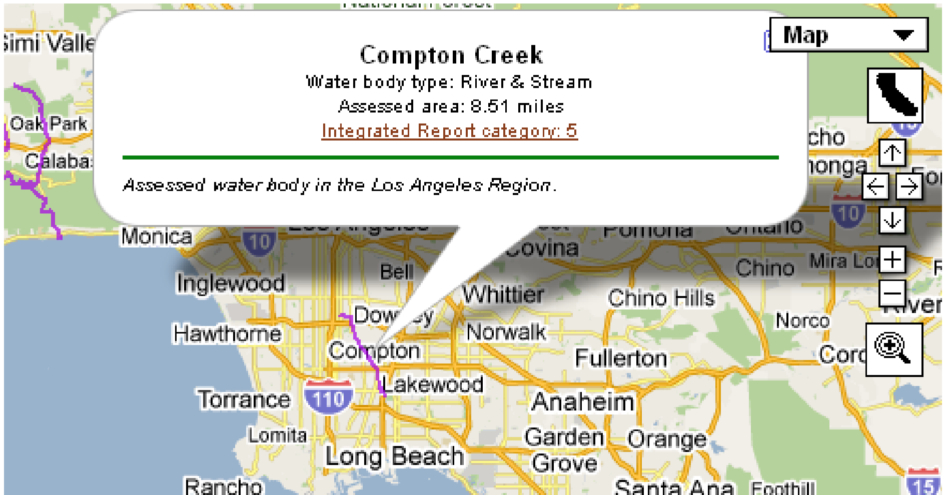
Water Boards



Show all assessed waters

Show only impaired ("303(d)-listed") waters

Show water bodies by pollutant:

Pollutant category:
All

All

Pollutant:
Benthic-Macroinvertebrate

Pollutant assessments for Compton Creek Close

Pollutants	Listing Decision / *Comments*	Detailed Report	Potential Sources	Schedule
Benthic-Macroinvertebrate Bioassessments	Do Not List on 303(d) list (TMDL required list)	17213	n/a	
Coliform Bacteria	List on 303(d) list (TMDL required list)	7119	Nonpoint Source, Point Source	Est. TMDL completion: 2009
Copper	List on 303(d) list (being addressed by USEPA approved TMDL)	6693	Nonpoint Source, Point Source	USEPA TMDL approval: 2005
Lead	List on 303(d) list (being addressed by USEPA approved TMDL)	6694	Nonpoint Source, Point Source	USEPA TMDL approval: 2005

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ATTACHMENT A - FIGURE 1

Location of DPW
mass emission site.

ATTACHMENT A - TABLE 1
SANTA CLARA RIVER REACH 6 - COPPER

Sample Date	Source	Location	Qualifier	Total Copper (ug/L)	Dissolved Copper (ug/L)	PQL/RL (ug/L)	Method	Is Sample Usable? (1=Yes)	Dissolved or Translated Copper Concentration	4-Day Average Concentration	Hardness	Dissolved Copper CMC (ug/L)	Dissolved Copper CCC (ug/L)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed CCC (1=Yes)
10/28/2003	LACDPW	S29		13.50	3.55	5.00	EPA200.8	1	3.55	*	400	49.6	29.3		
10/31/2003	LACDPW	S29		30.40	10.60	5.00	EPA200.8	1	10.60	7.08	200	25.8	16.2		
12/25/2003	LACDPW	S29		53.30	4.88	5.00	EPA200.8	1	4.88	4.88	170	22.2	14.1		
1/1/2004	LACDPW	S29		10.20	7.36	5.00	EPA200.8	1	7.36	7.36	140	18.5	11.9		
1/13/2004	LACDPW	S29		5.96	3.54	5.00	EPA200.8	1	3.54	3.54	450	55.4	32.4		
1/14/2004	LACSD	RB	<	8.00	NA	8.00	EPA200.8	1	7.68	7.68	520	63.5	36.6		
2/11/2004	LACSD	RB	<	8.00	NA	8.00	EPA200.8	1	7.68	7.68	226***	28.2	17.6		
3/10/2004	LACSD	RB	<	8.00	NA	8.00	EPA200.8	1	7.68	7.68	226***	28.2	17.6		
4/14/2004	LACSD	RB	E	4.00	NA	8.00	EPA200.8	1	3.84	3.84	175	22.8	14.4		
5/12/2004	LACSD	RB	<	8.00	NA	8.00	EPA200.8	1	7.68	7.68	226***	28.2	17.6		
6/9/2004	LACSD	RB	<	8.00	NA	8.00	EPA200.8	1	7.68	7.68	226***	28.2	17.6		
7/14/2004	LACSD	RB	<	8.00	NA	8.00	EPA200.8	1	7.68	7.68	181	23.5	14.9		
8/11/2004	LACSD	RB	<	8.00	NA	8.00	EPA200.8	1	7.68	7.68	226***	28.2	17.6		
9/15/2004	LACSD	RB	E	3.00	NA	8.00	EPA200.8	1	2.88	2.88	226***	28.2	17.6		
10/13/2004	LACSD	RB	E	3.00	NA	8.00	EPA200.8	1	2.88	2.88	193	25.0	15.7		
10/17/2004	LACDPW	S29		15.70	5.90	5.00	EPA200.8	1	5.90	5.90	428	52.9	31.0		
10/26/2004	LACDPW	S29		28.00	22.60	5.00	EPA200.8	1	22.60	22.60	90	12.2	8.2	1	1
11/10/2004	LACSD	RB	E	6.00	NA	8.00	EPA200.8	1	5.76	5.76	226***	28.2	17.6		
12/16/2004	LACSD	RB		5.50	NA	0.50	EPA200.8	1	5.28	5.28	226***	28.2	17.6		
1/7/2005	LACDPW	S29		19.50	17.20	5.00	EPA200.8	1	17.20	17.20	110	14.7	9.7	1	1
2/2/2005	LACSD	RB		2.70	NA	0.50	EPA200.8	1	2.59	2.59	226***	28.2	17.6		
2/9/2005	LACSD	RB		2.90	NA	0.50	EPA200.8	1	2.78	2.78	243	31.0	19.1		
3/2/2005	LACSD	RA		28.00	NA	0.50	EPA200.8	1	26.88	26.88	292**	35.7	21.7		1
3/2/2005	LACSD	RB		1.90	NA	0.50	EPA200.8	1	1.82	1.82	261	33.2	20.3		
3/9/2005	LACDPW	S29		18.50	3.83	5.00	EPA200.8	1	3.83	3.83	460	56.6	33.0		
4/13/2005	LACSD	RA		29.00	NA	0.50	EPA200.8	1	27.84	27.84	433	53.5	31.3		
4/13/2005	LACSD	RB		3.60	NA	0.50	EPA200.8	1	3.46	3.46	276	35.0	21.3		
5/18/2005	LACSD	RB		1.80	NA	0.50	EPA200.8	1	1.73	1.73	251	32.0	19.7		
6/15/2005	LACSD	RB		3.20	NA	0.50	EPA200.8	1	3.07	3.07	220	28.2	17.6		
7/20/2005	LACSD	RB		6.40	NA	0.50	EPA200.8	1	6.14	6.14	204	26.3	16.5		
8/17/2005	LACSD	RB		3.70	NA	0.50	EPA200.8	1	3.55	3.55	226***	28.2	17.6		
9/14/2005	LACSD	RB		7.00	NA	0.50	EPA200.8	1	6.72	6.72	220	28.2	17.6		
10/17/2005	LACDPW	S29		37.30	8.17	5.00	EPA200.8	1	8.17	8.17	128	17.0	11.1		
10/26/2005	LACSD	RB		7.90	NA	0.50	EPA200.8	1	7.58	7.58	257	32.7	20.1		
11/29/2005	LACDPW	S29		7.40	2.36	5.00	EPA200.8	1	2.36	2.36	408	50.6	29.8		
11/30/2005	LACSD	RB		4.20	NA	0.50	EPA200.8	1	4.03	4.03	226***	28.2	17.6		
12/21/2005	LACSD	RB		4.20	NA	0.50	EPA200.8	1	4.03	4.03	226***	28.2	17.6		
12/31/2005	LACDPW	S29		10.80	4.59	5.00	EPA200.8	1	4.59	4.59	90	12.2	8.2		
1/14/2006	LACDPW	S29		10.00	6.04	5.00	EPA200.8	1	6.04	6.04	245	31.3	19.3		
1/18/2006	LACSD	RA		0.80	NA	0.50	EPA200.8	1	0.77	0.77	249	31.7	19.5		
1/18/2006	LACSD	RB		4.60	NA	0.50	EPA200.8	1	4.42	4.42	222	28.5	17.7		

ATTACHMENT A - TABLE 1
SANTA CLARA RIVER REACH 6 - COPPER

Sample Date	Source	Location	Qualifier	Total Copper (ug/L)	Dissolved Copper (ug/L)	PQL/RL (ug/L)	Method	Is Sample Usable? (1=Yes)	Dissolved or Translated Copper Concentration	4-Day Average Concentration	Hardness	Dissolved Copper CMC (ug/L)	Dissolved Copper CCC (ug/L)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed CCC (1=Yes)
2/15/2006	LACSD	RA		1.63	NA	0.50	EPA200.8	1	1.56	1.56	292**	35.7	21.7		
2/15/2006	LACSD	RB		7.21	NA	0.50	EPA200.8	1	6.92	6.92	226***	28.2	17.6		
2/17/2006	LACDPW	S29		7.33	3.32	5.00	EPA200.8	1	3.32	3.32	340	42.6	25.5		
3/15/2006	LACSD	RA		1.42	NA	0.50	EPA200.8	1	1.36	1.36	292**	35.7	21.7		
3/15/2006	LACSD	RB		3.75	NA	0.50	EPA200.8	1	3.60	3.60	226***	28.2	17.6		
4/19/2006	LACSD	RA		15.90	NA	0.50	EPA200.8	1	15.26	15.26	282	35.7	21.7		
4/19/2006	LACSD	RB		3.64	NA	0.50	EPA200.8	1	3.49	3.49	248	31.6	19.5		
4/25/2006	LACDPW	S29		33.50	2.52	5.00	EPA200.8	1	2.52	2.52	360	44.9	26.8		
5/17/2006	LACSD	RA		1.04	NA	0.50	EPA200.8	1	1.00	1.00	292**	35.7	21.7		
5/17/2006	LACSD	RB		4.67	NA	0.50	EPA200.8	1	4.48	4.48	226***	28.2	17.6		
6/21/2006	LACSD	RB		2.71	NA	0.50	EPA200.8	1	2.60	2.60	226***	28.2	17.6		
7/19/2006	LACSD	RA		0.80	NA	0.50	EPA200.8	1	0.77	0.77	319	40.1	24.1		
7/19/2006	LACSD	RB		2.10	NA	0.50	EPA200.8	1	2.02	2.02	195	25.2	15.8		
8/23/2006	LACSD	RA		1.10	NA	0.50	EPA200.8	1	1.06	1.06	292**	35.7	21.7		
8/23/2006	LACSD	RB		3.64	NA	0.50	EPA200.8	1	3.49	3.49	226***	28.2	17.6		
9/13/2006	LACSD	RB		3.60	NA	0.50	EPA200.8	1	3.46	3.46	226***	28.2	17.6		
10/18/2006	LACSD	RB		3.73	NA	0.50	EPA200.8	1	3.58	3.58	373	46.5	27.6		
10/31/2006	LACDPW	S29		22.40	2.19	5.00	EPA200.8	1	2.19	2.19	430	53.1	31.1		
11/15/2006	LACSD	RB		4.30	NA	0.50	EPA200.8	1	4.13	4.13	226***	28.2	17.6		
12/9/2006	LACDPW	S29		50.30	5.08	5.00	EPA200.8	1	5.08	5.08	250	31.9	19.6		
12/16/2006	LACDPW	S29		28.30	4.99	5.00	EPA200.8	1	4.99	4.99	370	46.1	27.4		
12/20/2006	LACSD	RB		5.92	NA	0.50	EPA200.8	1	5.68	5.68	226***	28.2	17.6		
1/30/2007	LACDPW	S29		38.20	6.10	5.00	EPA200.8	1	6.10	6.10	310	39.0	23.5		
2/14/2007	LACSD	RB		8.99	NA	0.50	EPA200.8	1	8.63	8.63	232	29.7	18.4		
2/19/2007	LACDPW	S29		31.90	4.68	5.00	EPA200.8	1	4.68	*	210	27.0	16.9		
2/22/2007	LACDPW	S29		50.50	5.13	5.00	EPA200.8	1	5.13	4.91	160	20.9	13.4		
2/28/2007	LACSD	RB		8.03	NA	0.50	EPA200.8	1	7.71	7.71	226***	28.2	17.6		
3/14/2007	LACSD	RB		6.26	NA	0.50	EPA200.8	1	6.01	6.01	226***	28.2	17.6		
4/2/2007	LACDPW	S29		22.10	2.88	5.00	EPA200.8	1	2.88	2.88	440	54.3	31.8		
4/11/2007	LACSD	RB		6.43	NA	0.50	EPA200.8	1	6.17	6.17	235	30.1	18.6		

LACSD - Sanitation Districts of Los Angeles County
LACDPW - Los Angeles County Department of Public Works
* - Data is used in calculation of a 4-day average
** - Average RA hardness used when concurrent hardness was unavailable
*** - Average RB hardness used when concurrent hardness was unavailable

3 of 69 4-day averages exceed
Criterion Continuous Concentration (CCC)

2 of 71 samples exceed
Criterion Maximum Concentration (CMC)

ATTACHMENT A - TABLE 2
SANTA CLARA RIVER REACH 6 - CHLORPYRIFOS

Sample Date	Source	Location	Qualifier	Chlorpyrifos (ug/L)	Method	PQL/RL (ug/L)	QA/QC	Fish and Game 4-Day CCC	Is Sample Usable? (1=Yes)	Qualifier	4-Day Average Concentration (ug/L)	Does 4-Day Average Exceed CCC? (1=Yes)
10/31/2001	SWAMP	SCTBQT		0.059	ELISA	0.05	Pass	0.05	1		0.059	1
10/31/2001	SWAMP	SCTBQT	<	0.05	EPA 8141A	0.05	Fail	0.05			**	
11/15/2001	SWAMP	SCTBQT		0.077	ELISA	0.05	Pass	0.05	1		0.077	1
8/5/2002	SWAMP	SCTBQT		0.068	ELISA	0.05	Fail	0.05			**	
8/5/2002	SWAMP	SCTBQT		0.053	ELISA	0.05	Fail	0.05			**	
8/20/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
8/28/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
8/28/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
9/4/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
9/4/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
9/19/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
9/19/2002	SWAMP	SCTBQT		0.055	ELISA	0.05	Fail	0.05			**	
10/4/2002	SWAMP	SCTBQT		0.051	ELISA	0.05	Fail	0.05			**	
10/4/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
10/10/2002	LACDPW	S29	<	0.05	EPA 505	0.05	Pass	0.05	1	<	0.05	
10/19/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
10/19/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
11/7/2002	SWAMP	SCTBQT		0.061	ELISA	0.05	Fail	0.05			**	
11/8/2002	LACDPW	S29	<	0.05	EPA 501	0.05	Pass	0.05	1	<	0.05	
11/18/2002	SWAMP	SCTBQT		0.067	ELISA	0.05	Fail	0.05			**	
12/3/2002	SWAMP	SCTBQT		0.061	ELISA	0.05	Fail	0.05			**	
12/16/2002	LACDPW	S29	<	0.05	EPA 502	0.05	Pass	0.05	1	<	0.05	
12/18/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
12/18/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
1/2/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
1/2/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
1/13/2003	SWAMP	SCTBQT	<	0.05	EPA 8141A	0.05	Fail	0.05			**	
1/17/2003	SWAMP	SCTBQT		0.051	ELISA	0.05	Fail	0.05			**	
1/17/2003	SWAMP	SCTBQT		0.062	ELISA	0.05	Fail	0.05			**	
2/1/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
2/1/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
2/11/2003	LACDPW	S29	<	0.05	EPA 503	0.05	Pass	0.05	1	<	0.05	
2/16/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
2/16/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
3/3/2003	SWAMP	SCTBQT		0.096	ELISA	0.05	Fail	0.05			**	
3/3/2003	SWAMP	SCTBQT		0.07	ELISA	0.05	Fail	0.05			**	
3/15/2003	LACDPW	S29	<	0.05	EPA 504	0.05	Pass	0.05	1	<	0.05	
3/18/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
4/2/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
4/2/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
4/17/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
4/17/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
4/30/2003	LACDPW	S29	<	0.05	EPA 506	0.05	Pass	0.05	1	<	0.05	
5/2/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
5/2/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
5/17/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
5/17/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
10/28/2003	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
10/31/2003	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1		*	
12/25/2003	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
1/1/2004	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
1/13/2004	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
10/17/2004	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
10/26/2004	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
1/7/2005	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
3/9/2005	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
10/17/2005	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
11/29/2005	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
12/31/2005	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
1/14/2006	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
2/17/2006	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
4/25/2006	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
10/31/2006	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
12/9/2006	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
12/16/2006	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	

ATTACHMENT A - TABLE 2
SANTA CLARA RIVER REACH 6 - CHLORPYRIFOS

Sample Date	Source	Location	Qualifier	Chlorpyrifos (ug/L)	Method	PQL/RL (ug/L)	QA/QC	Fish and Game 4-Day CCC	Is Sample Usable? (1=Yes)	Qualifier	4-Day Average Concentration (ug/L)	Does 4-Day Average Exceed CCC? (1=Yes)
1/30/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
2/19/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1		*	
2/22/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
4/2/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
9/21/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
11/25/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1		*	
11/29/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
12/6/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
4/9/2008	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	

* = Data averaged for 4-Day average
** = Data failed QAPP provisions
LACDPW - Los Angeles County Department of Public Works
SWAMP - Surface Water Ambient Monitoring Program
Fish and Game - California Department of Fish and Game

2 of 32 4-day averages since EPA ban on residential sales exceed Criterion Continuous Concentration (CCC)

ATTACHMENT A - TABLE 3
SANTA CLARA RIVER REACH 6 - DIAZINON

Date	Source	Location	Qualifier	Diazinon (ug/L)	Method	PQL/RL (ug/L)	QA/QC	Is Sample Usable? (1=Yes)	CMC (ug/L)	Exceeds CMC (1 = Yes)	Qualifier	4-day Average (ug/L)	CCC (ug/L)	Exceeds CCC (1 = Yes)
10/31/2001	SWAMP	403STCBQT		2	ELISA	0.03	Pass	1	0.16			2	0.1	1
10/31/2001	SWAMP	403STCBQT		2.25	EPA 8141A	0.02	Fail		0.16			**	0.1	
11/15/2001	SWAMP	403STCBQT		1.69	ELISA	0.03	Pass	1	0.16			1.69	0.1	1
8/5/2002	SWAMP	403STCBQT		4.29	ELISA	0.03	Fail		0.16			**	0.1	
8/5/2002	SWAMP	403STCBQT		4.14	ELISA	0.03	Fail		0.16			**	0.1	
8/20/2002	SWAMP	403STCBQT		6.7	ELISA	0.03	Fail		0.16			**	0.1	
8/28/2002	SWAMP	403BQT104		0.858	ELISA	0.03	Fail		0.16			**	0.1	
8/28/2002	SWAMP	403BQT105		0.435	ELISA	0.03	Fail		0.16			**	0.1	
8/28/2002	SWAMP	403BQT106		4.07	ELISA	0.03	Fail		0.16			**	0.1	
8/28/2002	SWAMP	403BQT106		3.98	ELISA	0.03	Fail		0.16			**	0.1	
8/28/2002	SWAMP	403BQT109		0.862	ELISA	0.03	Fail		0.16			**	0.1	
8/28/2002	SWAMP	403STCBQT		5.74	ELISA	0.03	Fail		0.16			**	0.1	
8/28/2002	SWAMP	403STCBQT		5.75	ELISA	0.03	Fail		0.16			**	0.1	
9/4/2002	SWAMP	403STCBQT		6.05	ELISA	0.03	Fail		0.16			**	0.1	
9/4/2002	SWAMP	403STCBQT		5.57	ELISA	0.03	Fail		0.16			**	0.1	
9/19/2002	SWAMP	403STCBQT		1.29	ELISA	0.03	Fail		0.16			**	0.1	
9/19/2002	SWAMP	403STCBQT		1.23	ELISA	0.03	Fail		0.16			**	0.1	
10/4/2002	SWAMP	403STCBQT		1.52	ELISA	0.03	Fail		0.16			**	0.1	
10/10/2002	LADPW	S29	<	0.01	EPA505	0.01	Pass	1	0.16		<	0.01	0.1	
10/19/2002	SWAMP	403STCBQT		2.67	ELISA	0.03	Fail		0.16			**	0.1	
10/19/2002	SWAMP	403STCBQT		2.55	ELISA	0.03	Fail					**	0.1	
11/7/2002	SWAMP	403STCBQT		0.813	ELISA	0.03	Fail		0.16			**	0.1	
11/8/2002	LADPW	S29		0.43	EPA501	0.01	Pass	1	0.16	1		0.43	0.1	1
11/18/2002	SWAMP	403STCBQT		1.07	ELISA	0.03	Fail		0.16			**	0.1	
12/3/2002	SWAMP	403STCBQT		0.479	ELISA	0.03	Fail		0.16			**	0.1	
12/16/2002	LADPW	S29	<	0.01	EPA502	0.01	Pass	1	0.16		<	0.01	0.1	
12/18/2002	SWAMP	403STCBQT		1.67	ELISA	0.03	Fail		0.16			**	0.1	
12/18/2002	SWAMP	403STCBQT		1.57	ELISA	0.03	Fail		0.16			**	0.1	
1/2/2003	SWAMP	403STCBQT		0.499	ELISA	0.03	Fail		0.16			**	0.1	
1/2/2003	SWAMP	403STCBQT		0.382	ELISA	0.03	Fail		0.16			**	0.1	
1/13/2003	SWAMP	403STCBQT		0.4	EPA 8141A	0.02	Fail		0.16			**	0.1	
1/17/2003	SWAMP	403STCBQT		0.321	ELISA	0.03	Fail		0.16			**	0.1	
1/17/2003	SWAMP	403STCBQT		0.277	ELISA	0.03	Fail		0.16			**	0.1	
2/1/2003	SWAMP	403STCBQT		0.805	ELISA	0.03	Fail		0.16			**	0.1	
2/1/2003	SWAMP	403STCBQT		0.718	ELISA	0.03	Fail		0.16			**	0.1	
2/11/2003	LADPW	S29		0.265	EPA503	0.01	Pass	1	0.16	1		0.265	0.1	1
2/16/2003	SWAMP	403STCBQT		0.623	ELISA	0.03	Fail		0.16			**	0.1	
2/16/2003	SWAMP	403STCBQT		0.556	ELISA	0.03	Fail		0.16			**	0.1	
3/3/2003	SWAMP	403STCBQT		5.52	ELISA	0.03	Fail		0.16			**	0.1	
3/3/2003	SWAMP	403STCBQT		4.97	ELISA	0.03	Fail		0.16			**	0.1	
3/15/2003	LADPW	S29		0.05	EPA504	0.01	Pass	1	0.16			0.05	0.1	
3/18/2003	SWAMP	403STCBQT		0.054	ELISA	0.03	Fail		0.16			**	0.1	
4/2/2003	SWAMP	403STCBQT		0.979	ELISA	0.03	Fail		0.16			**	0.1	
4/2/2003	SWAMP	403STCBQT		0.947	ELISA	0.03	Fail		0.16			**	0.1	
4/17/2003	SWAMP	403STCBQT		0.315	ELISA	0.03	Fail		0.16			**	0.1	
4/17/2003	SWAMP	403STCBQT		0.35	ELISA	0.03	Fail		0.16			**	0.1	
4/30/2003	LADPW	S29		0.023	EPA506	0.01	Pass	1	0.16			0.023	0.1	
5/2/2003	SWAMP	403STCBQT		0.512	ELISA	0.03	Fail		0.16			**	0.1	
5/2/2003	SWAMP	403STCBQT		0.499	ELISA	0.03	Fail		0.16			**	0.1	
5/17/2003	SWAMP	403STCBQT		1.32	ELISA	0.03	Fail		0.16			**	0.1	
5/17/2003	SWAMP	403STCBQT		1.33	ELISA	0.03	Fail		0.16			**	0.1	
10/28/2003	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16			*	0.1	
10/31/2003	LADPW	S29		0.082	EPA507	0.01	Pass	1	0.16		<	0.05	0.1	
12/25/2003	LADPW	S29		0.021	EPA507	0.01	Pass	1	0.16			0.021	0.1	
1/1/2004	LADPW	S29		0.028	EPA507	0.01	Pass	1	0.16			0.028	0.1	
1/7/2004	LACSD	RB		0.39	SW8141	0.05	Pass	1	0.16	1		0.39	0.1	1
1/13/2004	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
4/14/2004	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
10/17/2004	LADPW	S29		0.41	EPA507	0.01	Pass	1	0.16	1		0.41	0.1	1
10/26/2004	LADPW	S29		0.03	EPA507	0.01	Pass	1	0.16			0.03	0.1	
11/1/2004	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
12/22/2004	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
EPA ceased sale of all indoor and outdoor non-agricultural products containing diazinon on December 31, 2004.														
1/7/2005	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
1/17/2005	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
2/7/2005	LACSD	RB		0.51	SW8141	0.05	Pass	1	0.16	1		0.51	0.1	1
2/9/2005	LACSD	RA	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
3/9/2005	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
4/13/2005	LACSD	RA	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
4/13/2005	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	

ATTACHMENT A - TABLE 3
SANTA CLARA RIVER REACH 6 - DIAZINON

Date	Source	Location	Qualifier	Diazinon (ug/L)	Method	PQL/RL (ug/L)	QA/QC	Is Sample Usable? (1=Yes)	CMC (ug/L)	Exceeds CMC (1 = Yes)	Qualifier	4-day Average (ug/L)	CCC (ug/L)	Exceeds CCC (1 = Yes)
7/6/2005	LACSD	RB	<	0.1	SW8141	0.1	Pass	1	0.16		<	0.1	0.1	
10/3/2005	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
10/17/2005	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
11/29/2005	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
12/31/2005	LADPW	S29		0.01	EPA507	0.01	Pass	1	0.16			0.01	0.1	
1/9/2006	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
1/14/2006	LADPW	S29		0.11	EPA507	0.01	Pass	1	0.16			0.11	0.1	1
2/17/2006	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
4/17/2006	LACSD	RA	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
4/17/2006	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
4/20/2006	LACSD	RA	<	0.05	SW8141	0.05	Pass	1	0.16			*	0.1	
4/25/2006	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
7/5/2006	LACSD	RA	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
7/5/2006	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
10/16/2006	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
10/31/2006	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
12/9/2006	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
12/16/2006	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
1/3/2007	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
1/30/2007	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
2/19/2007	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
2/22/2007	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16			*	0.1	
4/2/2007	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
4/2/2007	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	

* = Data averaged for 4-Day average
** = Data failed QAPP provisions
LADPW - Los Angeles Department of Public Works
SWAMP - Surface Water Ambient Monitoring Program
LACSD - Sanitation Districts of Los Angeles County

2 of 29 4-day averages from January 1, 2005 to April 2, 2007 exceed Criterion Continuous Concentration (CCC)

1 of 31 samples from January 1, 2005 to April 2, 2007 exceed Criterion Maximum Concentration (CMC)

ATTACHMENT A - TABLE 4
RIO HONDO REACH 2 - CYANIDE

Sample Date	Source	Location	Qualifier	Total Cyanide (ug/L)	PQL/RL (ug/L)	Cyanide CMC (ug/L)	Does Sample Exceed CMC (1=Yes)	Cyanide CCC (ug/L)	Is Sample Usable for CCC? (1=Yes)	Does Sample Exceed CCC (1=Yes)
10/16/2003	LACSD	RD1	<	10	10	22		5.2		
10/28/2003	LADPW	TS06		25	10	22	1	10.2	1	1
10/31/2003	LADPW	TS06		0	10	22		6.2		
11/11/2003	LACSD	RD1	<	5	5	22		5.2	1	
11/20/2003	LACSD	RD1	<	5	5	22		5.2	1	
12/11/2003	LACSD	RD1	<	5	5	22		5.2	1	
12/25/2003	LADPW	TS06		10	10	22		7.2	1	1
1/1/2004	LADPW	TS06		10	10	22		8.2	1	1
1/6/2004	LACSD	RD	<	5	5	22		5.2	1	
1/6/2004	LACSD	RD1	<	5	5	22		5.2	1	
1/13/2004	LADPW	TS06		5	10	22		11.2	1	
2/2/2004	LADPW	TS06		0	10	22		9.2		
2/11/2004	LACSD	RD	<	5	5	22		5.2	1	
2/11/2004	LACSD	RD1	<	5	5	22		5.2	1	
3/10/2004	LACSD	RD	E	2.2	5	22		5.2	1	
3/10/2004	LACSD	RD1	E	1.9	5	22		5.2	1	
4/14/2004	LACSD	RD	<	5	5	22		5.2	1	
4/14/2004	LACSD	RD1	<	5	5	22		5.2	1	
5/12/2004	LACSD	RD	<	5	5	22		5.2	1	
5/12/2004	LACSD	RD1	E	1.4	5	22		5.2	1	
6/9/2004	LACSD	RD	<	5	5	22		5.2	1	
6/9/2004	LACSD	RD1	<	5	5	22		5.2	1	
7/7/2004	LACSD	RD	E	3.7	5	22		5.2	1	
7/7/2004	LACSD	RD1	E	1.1	5	22		5.2	1	
8/11/2004	LACSD	RD	E	2.6	5	22		5.2	1	
8/11/2004	LACSD	RD1	E	1.1	5	22		5.2	1	
9/15/2004	LACSD	RD1	E	2.3	5	22		5.2	1	
10/6/2004	LACSD	RD	<	5	5	22		5.2	1	
10/6/2004	LACSD	RD1	<	5	5	22		5.2	1	
11/17/2004	LACSD	RD	E	4.5	5	22		5.2	1	
11/17/2004	LACSD	RD1	E	1.4	5	22		5.2	1	
12/15/2004	LACSD	RD	E	3.7	5	22		5.2	1	
12/15/2004	LACSD	RD1	E	1.7	5	22		5.2	1	
1/25/2005	LACSD	RD1	<	5	5	22		5.2	1	
2/28/2005	LACSD	RD1	<	5	5	22		5.2	1	
3/16/2005	LACSD	RD1	<	5	5	22		5.2	1	
4/13/2005	LACSD	RD	<	5	5	22		5.2	1	
4/13/2005	LACSD	RD1	E	1.1	5	22		5.2	1	
5/11/2005	LACSD	RD1	<	5	5	22		5.2	1	
6/22/2005	LACSD	RD	<	5	5	22		5.2	1	
6/22/2005	LACSD	RD1	<	5	5	22		5.2	1	
7/20/2005	LACSD	RD	<	5	5	22		5.2	1	
7/20/2005	LACSD	RD1	<	5	5	22		5.2	1	
8/24/2005	LACSD	RD	<	5	5	22		5.2	1	
8/24/2005	LACSD	RD1	<	5	5	22		5.2	1	
9/28/2005	LACSD	RD	E	2.9	5	22		5.2	1	
9/28/2005	LACSD	RD1	<	5	5	22		5.2	1	
10/5/2005	LACSD	RD		7	5	22		5.2	1	1
10/5/2005	LACSD	RD1	E	1.1	5	22		5.2	1	
11/9/2005	LACSD	RD	E	2.3	5	22		5.2	1	
11/9/2005	LACSD	RD1	E	1.1	5	22		5.2	1	
12/14/2005	LACSD	RD	E	1.5	5	22		5.2	1	
12/14/2005	LACSD	RD1	<	5	5	22		5.2	1	
1/18/2006	LACSD	RD	<	5	5	22		5.2	1	
1/18/2006	LACSD	RD1	E	1.4	5	22		5.2	1	
2/8/2006	LACSD	RD	E	1.6	5	22		5.2	1	
2/8/2006	LACSD	RD1	<	5	5	22		5.2	1	
3/27/2006	LACSD	RD	<	5	5	22		5.2	1	
3/27/2006	LACSD	RD1	<	5	5	22		5.2	1	

ATTACHMENT A - TABLE 4
RIO HONDO REACH 2 - CYANIDE

Sample Date	Source	Location	Qualifier	Total Cyanide (ug/L)	PQL/RL (ug/L)	Cyanide CMC (ug/L)	Does Sample Exceed CMC (1=Yes)	Cyanide CCC (ug/L)	Is Sample Usable for CCC? (1=Yes)	Does Sample Exceed CCC (1=Yes)
4/12/2006	LACSD	RD	<	5	5	22		5.2	1	
4/12/2006	LACSD	RD1	<	5	5	22		5.2	1	
5/10/2006	LACSD	RD	E	1.1	5	22		5.2	1	
5/10/2006	LACSD	RD1	<	5	5	22		5.2	1	
6/14/2006	LACSD	RD	<	5	5	22		5.2	1	
6/14/2006	LACSD	RD1	<	5	5	22		5.2	1	
7/19/2006	LACSD	RD	<	5	5	22		5.2	1	
7/19/2006	LACSD	RD1	<	5	5	22		5.2	1	
8/9/2006	LACSD	RD	<	5	5	22		5.2	1	
8/9/2006	LACSD	RD1	<	5	5	22		5.2	1	
9/20/2006	LACSD	RD	<	5	5	22		5.2	1	
9/20/2006	LACSD	RD1	<	5	5	22		5.2	1	
10/18/2006	LACSD	RD	E	1.1	5	22		5.2	1	
10/18/2006	LACSD	RD1	<	5	5	22		5.2	1	
11/15/2006	LACSD	RD	<	5	5	22		5.2	1	
11/15/2006	LACSD	RD1	<	5	5	22		5.2	1	
12/20/2006	LACSD	RD	<	5	5	22		5.2	1	
12/20/2006	LACSD	RD1	E	1.1	5	22		5.2	1	
1/17/2007	LACSD	RD	E	2.3	5	22		5.2	1	
1/17/2007	LACSD	RD1	<	5	5	22		5.2	1	
2/21/2007	LACSD	RD	<	5	5	22		5.2	1	
2/21/2007	LACSD	RD1	<	5	5	22		5.2	1	
3/27/2007	LACSD	RD	<	5	5	22		5.2	1	
3/27/2007	LACSD	RD1	<	5	5	22		5.2	1	
4/18/2007	LACSD	RD	<	5	5	22		5.2	1	
4/18/2007	LACSD	RD1	<	5	5	22		5.2	1	

LACSD - Sanitation Districts of Los Angeles County
LADPW - Los Angeles County Department of Public Works

4 of 82 4-day averages exceed
Criterion Continuous Concentration (CCC)

1 of 85 samples exceed
Criterion Maximum Concentration (CMC)

WATER RECLAMATION
SOLID WASTE MANAGEMENT

COUNTY SANITATION DISTRICTS OF LOS ANGELES COUNTY

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Mailing Address: P.O. Box 4998, Whittier, CA 90607-4998
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STEPHEN R. MAGUIN
Chief Engineer and General Manager

August 14, 2009
File No. 31-370.40.4A

Ms. Dorothy Rice, Executive Officer
State Water Resources Control Board
1001 I Street
Sacramento, CA 95814

Dear Ms. Rice:

Comments on the 2008 Los Angeles Region Clean Water Act
Section 303(d) List of Impaired Waters and Section 305(b) Report

The Sanitation Districts of Los Angeles County (Sanitation Districts) appreciate the opportunity to comment on the 2008 Los Angeles Region Clean Water Act Section 303(d) List of Impaired Waters (303(d) List) and Section 305(b) Report adopted by the California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board). The Sanitation Districts are a consortium of 24 independent special districts serving the wastewater and solid waste management needs of over five million people and 3,300 industries in Los Angeles County, California. The Sanitation Districts currently operate and maintain over 1,400 miles of trunk sewers and 11 wastewater treatment plants that collectively treat over 450 million gallons per day of wastewater. Of the 11 wastewater treatment plants, nine are located in the Los Angeles Region. Seven of the these treatment plants discharge to inland surface waters in the San Gabriel River, Santa Clara River, and Rio Hondo watersheds; one discharges to the Pacific Ocean; and one does not discharge to surface waters but instead solely supplies recycled water for irrigation.

The Sanitation Districts would like to take this opportunity to commend the State Water Resources Control Board (State Water Board) for the improvements that have been made to the process used to prepare 303(d) listings over the last two listing cycles. The State Water Board's Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (Listing Policy) has proven to be a valuable tool that, when correctly applied, results for the most part in a scientifically valid 303(d) List. In addition, the Sanitation Districts greatly appreciate the efforts of the State Water Board and the LA Regional Board to make the listing process more transparent, particularly through making the data used to assess listings available on the LA Regional Board's website and through production of clear fact sheets on each water body/pollutant combination.

Although the Sanitation Districts support the overall methodology used by the LA Regional Board to produce the 303(d) List, the Sanitation Districts do have concerns on some aspects of it, particularly where the methodology used was not consistent with direction provided by the State Water Board in their Listing Policy. If these concerns are not addressed, inappropriate impairment listings may be made which would in turn result in scarce resources being directed away from addressing actual water quality impairments. Given the limited resources available for the development and implementation of Total Maximum Daily Loads (TMDLs) to resolve impairments, the Sanitation Districts believe that it is important for the State Water Board to concentrate on those waters where problems are well established. General comments relating to these concerns are provided below and detailed specific comments are provided in Attachment 1 and appendices to this letter.

1. Impairment Listings for "Benthic-Macroinvertebrate Bioassessments"

The 303(d) List contains a number of proposed listings for "Benthic-Macroinvertebrate Bioassessments." The proposed listings are based on application of the Southern California Coastal Index of Biological Integrity (SoCal IBI). They include a listing for one water body to which a Sanitation Districts' treatment plan discharges (Santa Clara River Reach 6), as well as a number of other water bodies within the Los Angeles Region. While the Sanitation Districts' primary concern is with the listing determination for Santa Clara River Reach 6, the Sanitation Districts are also concerned about the listing of other water bodies within the Los Angeles Region due to the precedent that would be set by these listings.

The Sanitation Districts believe that the use of benthic macroinvertebrate bioassessments represents an over-all sound and scientifically defensible approach for evaluating biological condition. However, significant data information gaps associated with the So Cal IBI makes application of this index questionable for certain river systems in the Los Angeles Region, particularly low gradient/low elevation and highly modified streams. Recent communications with Peter Ode (Surface Water Ambient Monitoring Program (SWAMP) Bioassessment Coordinator), Ken Schiff (Deputy Director of the Southern California Coastal Water Research Project (SCCWRP)), and Jerry Diamond (Tetra Tech, Inc. (Tetra Tech)), as well as numerous published papers and technical reports, confirm that significant uncertainty remains regarding the use of the SoCal IBI to characterize low elevation/low gradient and highly modified streams in southern California. In particular, valid reference sites for low elevation/low gradient streams and significantly modified channels in southern California have not been identified. These shortcomings and information gaps have been well-documented and communicated to State Water Board and LA Regional Board staff, and specific state and regional efforts to address these concerns are on-going. The Sanitation Districts believe that it is premature at this time to make impairment decisions using the SoCal IBI in low gradient/low elevation and modified channels until the substantive issues regarding application of the index are fully resolved. The Sanitation Districts therefore request that the proposed listings for benthic macroinvertebrate bioassessments be removed for the following specific reasons:

- <u>Listings Based on SoCal IBI Are Inconsistent With State Policy Regarding Reference Sites</u>. The Listing Policy indicates that water bodies should only be listed for degradation of biological populations if they have significant degradation **relative to reference sites**. While the scientists that developed the SoCal IBI attempted to incorporate reference conditions into the index itself, the reference conditions used to develop the index were not representative of low elevation/low gradient and highly modified streams in the Los Angeles Region,[1] which represent the majority of reaches being proposed for inclusion on the 303(d) list. In the study used to develop the index, data was collected from 275 sites ranging from Monterey County in the north to the Mexican border in the south, but not a single site was located in the low elevation areas of Los Angeles County, nor were any highly modified channels included. Additionally, low elevation/low gradient streams representative of those in the Los Angeles Region were significantly under-represented in the study. The lead scientist for development of the SoCal IBI, Dr. Peter Ode, has even acknowledged the limitations of the SoCal IBI. In a recently published paper regarding a study examining the SoCal IBI relative to other benthic macroinvertebrate bioassessments, he concluded that the SoCal IBI did not adequately inherently address reference conditions in low elevation sites, stating that the SoCal IBI was "not completely effective at controlling for an

[1] Ode, P.R., A.C. Rehn, J.T. May. 2005. A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams. Environmental Management Vol. 35, No 4, pp. 494, Figure 1. Copy included in Appendix 1.

elevation gradient."[2] Dr. Ode was also the co-author of a March 2009 report on recommendations for development and maintenance of a network of reference sites to support biological assessment of California's wadeable streams.[3] This report describes recommendations made by a technical panel of experts on bioassessment, including experts from California Department of Fish and Game, SCCWRP, USEPA Region 9, and several universities. The technical panel laid out a number of steps that would be necessary to develop a network of adequate reference sites for implementation of criteria for bioassessments. They note that, "A crucial component to the development of assessment tools is understanding biological expectations at reference sites that consist of natural, undisturbed systems. These reference systems set the biological condition benchmarks for comparisons to the site(s) being evaluated." They also clearly note that adequate reference sites have not been identified in southern California, stating, "human-dominated landscapes can be so pervasive in locations such as urban southern California and the agriculturally dominated Central Valley that no undisturbed reference sites may currently exist in these regions. A statewide framework for consistent selection of reference sites must account for this complexity."

Additionally, a memorandum recently prepared by Jerry Diamond of Tetra Tech, one of the leading national technical experts on bioassessments, confirms that adequate reference sites are not available to assess benthic macroinvertebrate populations for low gradient and low elevation streams in the LA Region.[4] Dr. Diamond is the author of several technical reports prepared for the LA Regional Board on tiered aquatic life uses (TALU) based on bioassessments.[5,6] Dr. Diamond states that there is "high uncertainty regarding appropriate reference conditions for low gradient and low elevation streams in this region [Southern California]," and that "low elevation streams lacked clear reference conditions in this region [Southern California]." He further states that a technical advisory committee for a USEPA-funded project on TALU "identified a lack of appropriate reference sites for low elevation/low gradient streams as a critical data gap." The technical advisory committee consisted of regional experts from California Fish & Game, State Water Board, other Regional Boards, USEPA Region 9, and universities. Dr. Diamond also worked with SCCWRP and the LA Regional Board in facilitating two workshops on TALU for southern California. Dr. Diamond states, "In the most recent stakeholder workshop… there was agreement that low gradient (rather than low elevation) was perhaps the most critical factor distinguishing stream biology in the region and that the reference condition for low gradient streams (many but not all of which occur at low elevation) is a critical data gap…"[7]

- <u>A low SoCal IBI Score Does Not Necessarily Indicate Impairment.</u> The SoCal IBI is calculated by scoring bioassessment results from a receiving water location but a lower score does not necessarily indicate "impairment" because different types of streams would be expected to

[2] Ode, P.R., C.P. Hawkins, R.D. Mazor, Comparability of Biological Assessments Derived from Predictive Models and Multimetric Indices of Increasing Geographic Scope, J. N. Am. Benthol. Soc., 2008, 27(4):967-985.p. 982. Copy included in Appendix 2.

[3] Ode, P.R., K. Schiff. Recommendations for the Development and Maintenance of a Reference Condition Management Program to Support Biological Assessment of California's Wadeable Streams: Report to the Surface Water Ambient Monitoring Program. Southern California Coastal Water Research Project, Technical Report 581. March 2009. Copy included in Appendix 3.

[4] Diamond, Jerry. Reference Conditions and Bioassessments in Southern California Streams. July 31, 2009. Memorandum to Phil Markle of the Sanitation Districts. Copy included in Appendix 4.

[5] Tetra Tech, Revised Analyses of Biological Data to Evaluate Tiered Aquatic Life Uses (TALU) for Southern California Coastal Streams. Prepared for EPA Region 9 and California Regional Water Quality Control Board, Los Angeles Region. 2006. Tetra Tech, Inc., Owings Mills, MD. Copy included in Appendix 5.

[6] Schiff, K. and Diamond, J., Identifying Barriers to Tiered Aquatic Life Uses (TALU) in Southern California, Southern California Coastal Water Research Project, Technical Report 590. June 2009. Copy included in Appendix 6.

[7] For a report summarizing the outcome of the workshops, see Schiff, K. and Diamond, J., Identifying Barriers to Tiered Aquatic Life Uses (TALU) in Southern California, Southern California Coastal Water Research Project, Technical Report 590. June 2009. Copy included in Appendix 6.

support different types of invertebrate communities. In low-gradient streams, bed substrate is typically composed of fines and sand, rather than the cobbles, boulders, or bedrock typically found in high-gradient streams. In high-gradient streams, sediments and leaf litter are typically removed with increased flow velocities resulting in larger open spaces between rocks and cobble that provide different habitats for different types of invertebrates utilizing different feeding strategies (more predators and fewer detritus feeders). In the low-gradient streams, the sediment and leaf litter/detritus loads are naturally deposited in the channel filling up the available spaces between rocks. These habitats support a much different population of invertebrates (more detritus feeders and fewer predators), which is not necessarily an "impaired" population. Although the SoCal IBI was originally intended to inherently account for these differences in invertebrate communities, experience with application of the SoCal IBI has indicated that this is not the case, as detailed above. Therefore, adequate consideration of reference sites is an essential component in application of the SoCal IBI.

- The SoCal IBI Has Not Been Validated For Low-Gradient Streams. The scientific community acknowledges that existing assessment tools such as the SoCal IBI have not been validated for low-gradient streams. In a recent study that examined low gradient streams in California, including sites within Reach 6 of the Santa Clara River, Raphael D. Mazor of SCCWRP stated, "Several biomonitoring efforts in California specifically target low-gradient streams, as these habitats are subject to numerous impacts and alterations, ... even though the applicability of assessment tools created and validated in high-gradient streams have not been tested."[8] The study found that, "As a consequence of these differences [substrate material, bed morphology, and distribution of microhabitats], traditional bioassessment approaches in California that were developed in high-gradient streams with diverse microhabitats have limited applications in low-gradient reaches,"[8] and, "Caution should be used when applying sampling methods for assessment tools that were calibrated for specific habitat types (e.g., high gradient streams) to new habitats (e.g., low gradient streams)."[8] The study also concluded, "....observation of the sites in this study suggests that the lack of stable microhabitats (e.g., riffles and vegetated margins) may account for the reduced number of macroinvertebrates, as few species are adapted to the shifting sandy substrate found in most low gradient streams in California."[8]

- The SoCal IBI Not Appropriate For Modified Channels. The majority of sites for which impairment listing based on the SoCal IBI are being proposed consist of channels that are highly modified from natural conditions. These included streams with concrete sides, non-existent riparian zones, and artificially stabilized banks. The appropriate IBI reference index for such locations has not yet been defined.[9]

- Other State Agencies Recognize Limitations Associated with SoCal IBI. SWAMP, California Department of Fish and Game, and others recognize the limitations of the SoCal IBI regarding reference sites. They have identified application of TALU and the selection of more representative/appropriate regional reference locations as being necessary components of the state's bioassessment program.[3,6]

- Listings Based on SoCal IBI Are Inconsistent with State Policy Regarding Association with Other Impairments. The Listing Policy also indicates that water bodies should be listed for degradation of biological populations only if such impairment is "associated" with water or sediment pollutant concentrations. In the fact sheets supporting its 303(d) listing decisions, the LA Regional Board simply indicated that the low SoCal IBI scores in listed reaches co-occurred with 303(d) listed

[8] Mazor, Raphael D.; Schiff, Kenneth; Ritter, Kerry; Rehn, Andy; and Ode, Peter; Bioassessment Tools in Novel Habitats: An Evaluation of Indices and Sampling Methods in Low-Gradient Streams in California, Enviorn. Monit. Assess., DOI 10.1007/s10661-009-1033-3. Copy included in Appendix 7.

[9] Ken Schiff, Deputy Director of the Southern California Coastal Water Research Program. Personal communication. 7/14/2009.

water constituent impairments. Co-occurrence does not establish an association and no attempt was made by LA Regional Board staff to reasonably link the low SoCal IBI scores with a listed constituent. For example, in Santa Clara River Reach 6, the benthic macroinvertebrate impairment was justified by being "associated" with impairments for several pollutants including ammonia and diazinon. However, while concentrations of these pollutants have been substantially reduced since 2003 and are now consistently below water quality objectives, the SoCal IBI scores for this reach have essentially remained the same. Therefore, the data available for these pollutants indicates that no association exists. It is the Sanitation Districts' understanding that the intent of the State Water Board's Listing Policy is that listings for biological impairments only be made if there is a linkage established between a concentration of a pollutant and the biological impairment. Since no linkages were established by the LA Regional Board in the fact sheets supporting the 303(d) List, the listings for benthic macroinvertebrate impairments should be removed.

- The Proposed Listings Did Not Consider All Technical Information Available. The proposed listings based on SoCal IBI scores were not included in the LA Regional Board's original draft 303(d) List. They were instead first included in a revised version of the 303(d) List that was not made readily available until July 13, 2009, three days before the LA Regional Board hearing to adopt the proposed list. No opportunity was provided for submission of written technical comments or additional scientific information on the proposed listings. As this letter indicates, there has been extensive consideration by the scientific community regarding how to apply the SoCal IBI to determine water quality impairments. The Sanitation Districts were not given the opportunity to submit this information in writing to the LA Regional Board, and there is no indication that the LA Regional Board considered this information in its listing decisions. Although the LA Regional Board did provide an opportunity to provide oral testimony on the proposed listings, it is essentially impossible to convey large amounts of technical information in brief oral remarks. Therefore, the Sanitation Districts request that the State Water Board undertake a thorough review of the technical information transmitted in this letter, as it appears that the LA Regional Board did not fully consider this information in making its listing decisions.

In summary, the Sanitation Districts believe that it is premature at this time to make impairment decisions using the SoCal IBI. Substantive issues remain regarding application of the index, particularly with regard to identification of appropriate reference sites, but also with regard to whether use of the index is appropriate for low gradient/low elevation streams and highly modified channels. The Sanitation Districts therefore strongly recommend delaying decisions regarding benthic macroinvertebrate community impairments in this listing cycle. Instead, the State Water Board and LA Regional Board should work with stakeholders and scientists to resolve these outstanding issues, and consider impairments of benthic macroinvertebrate communities in the next listing cycle.

2. Nutrient Criteria Should Not be Promulgated as Part of the 303(d) Listing Process

Section 3.3.3 of the 2008 Update of the Los Angeles Region Integrated Report Clean Water Act Section 305(b) Report and the Section 303(d) List of Impaired Waters (303(d) List Staff Report) state that in the current 303(d) List update, nitrogen impairment decisions continue to be based on the current LA Basin Plan objectives for nitrogen compounds. However, in the 303(d) List Staff Report the LA Regional Board proposes to use a new methodology for assessing nutrient-related impairments in the future. This methodology would rely on an assessment of both nutrient concentrations and one or more biological response indicators such as pH or dissolved oxygen.

The 303(d) List Staff Report is an inappropriate vehicle to introduce proposed nutrient criteria and objectives. Promulgation of new nutrient criteria, and/or implementation policies related thereto constitute amendments to the Basin Plan and should therefore be handled exclusively through appropriate Basin Plan amendment procedures. Adoption of Basin Plan amendments requires fulfilling the requirements of the California Environmental Quality Act (CEQA) as well as conducting an analysis in accordance with California Water Code 13241/13000. The appropriate time to consider whether numeric nutrient criteria should be pursued is during the triennial review of the Basin Plan. During this and subsequent Basin Plan amendment review, the costs and benefits of adopting such criteria can be assessed and the priority for pursuing the criteria can be weighed against other basin planning priorities.

Notwithstanding our previous objection that proposed Basin Plan objectives and implementation policies should only be addressed through an appropriate Basin Plan amendment process, the Sanitation Districts have a number of concerns with the nutrient and biological response criteria approach proposed by the LA Regional Board. The Sanitation Districts do not believe that it is appropriate for the LA Regional Board to pursue development of its own numeric nutrient criteria at this time. The State Water Board, in conjunction with USEPA Region 9, has been actively working for a number of years on the development of numeric nutrient endpoint (NNE) tools for California to address nutrient objectives. Statewide tools to assess nutrient impairments in freshwater streams and lakes are currently being peer reviewed, with ongoing validation studies being conducted for estuaries. These tools utilize biological indicators to assess nutrient impairments (excess algal biomass and extremes in photosynthesis-caused dissolved oxygen and pH). The State Water Board and USEPA have put extensive resources toward development of scientifically sound NNE tools, and to avoid duplication of that effort, the LA Regional Board should wait until the State Water Board releases its NNE tools before considering whether it should develop its own independent nutrient objectives. The approach to nutrient criteria developed by the State Water Board and USEPA Region 9 is described in the report, "Technical Approach to Develop Nutrient Numeric Endpoints for California" (CA NNE), released in 2006. The CA NNE report calls for using multiple lines of biological responses to make an assessment of impairment. Based on this assessment, if an impairment exists, then nutrient concentrations can be examined to determine if they are causing or contributing to the impairment, and nutrient standards can then be developed as appropriate. In preparing this report, the State Water Board and other experts correctly recognized that ambient nutrient concentrations typically do not correlate with algal-related impairments, and thus nutrient concentrations should **not** be used to assess whether an impairment exists. In conflict with the statewide approach, the LA Regional Board approach includes nutrient concentrations (i.e., total nitrogen and phosphorous) as a line of evidence to use when assessing whether an impairment exists. Beneficial use impairment only occurs when, independent of nutrient loading, the biological response is of sufficient magnitude to adversely impact the use.

Examples of the proposed LA Regional Board approach to nutrient criteria are presented in Tables 3-2 and 3-3 of its 303(d) List Staff Report. In this table, the LA Regional Board lists criteria from a number of different sources, including the 2000 USEPA National Nutrient Criteria Technical Guidance (National Guidance) and the subsequent 2001 USEPA Ecoregion III Nutrient Criteria Recommendations for Rivers and Streams (Ecoregion III Guidance). The purpose of the National Guidance was not to recommend specific nutrient criteria, but rather to describe an approach to be used by the states to develop such criteria. The numbers cited by the LA Regional Board in Tables 3-2 and 3-3 of the 303(d) List Staff Report from the National Guidance were taken from a table listing a number of examples of numeric thresholds drawn from various studies. No justification was provided by the LA Regional Board as to why these particular values were chosen, or why these particular values would be applicable to waterbodies in the Los Angeles Region. Furthermore, the approach described in the National Guidance and in the Ecoregion III Guidance, which covers the Xeric West ecoregion that includes most of the Los Angeles Basin, has been widely criticized for its technical shortcomings. Under this approach, criteria for nutrients are set at the 25th percentile of nutrient concentrations for all waterbodies within an ecoregion, which arbitrarily delineates 75% of the waterbodies in a region as impaired. Additionally, no attempt was made in the guidance documents to show a relationship between the nutrient criteria and eutrophic conditions that would affect beneficial uses. In response to these and other flaws, the guidance was never adopted in California, and the State Water Board and USEPA Region 9 continued to pursue efforts to develop guidance specific to California, as described above.

Another criteria source listed by the LA Regional Board was a New Zealand guidance document. The Sanitation Districts believe that criteria for another continent should not be used without a high degree of scrutiny to ensure that it is appropriate for the Los Angeles Region. A site-specific study for Malibu Creek was also referenced; however, criteria for one specific water body should not be applied region-wide unless a technical review indicates that it is appropriate region-wide. The last source mentioned is "Nutrient Numeric Endpoints – SWRCB Nutrient Screening Tools for 303(d) Listing." The Sanitation Districts have been unable to obtain a copy of these screening tools. However, the potential criteria for pH, dissolved oxygen, total nitrogen, and total phosphorus presented in the LA Regional Board's tables as being from these screening tools are not consistent with the CA NNE report. Additionally, the CA NNE report criteria for chlorophyll a, which are identical to the criteria listed for chlorophyll a for the screening tools, were not meant to be interpreted as thresholds for impairment. These criteria were instead established as thresholds to establish a **lack** of impairment. This means that when chlorophyll a concentrations are below the criteria a water body is definitely not impaired. When chlorophyll a concentrations are above the criteria then a potential impairment may exist, but further study would be needed to establish whether an impairment actually does exist.

Should the LA Regional Board elect to develop regional nutrient criteria, this should be accomplished through the Basin Plan amendment process. Development of nutrient criteria should not be conducted as part of the 303(d) listing process. Therefore, the Sanitation Districts request that Section 3.3.3 of the 303(d) List Staff Report be stricken from the report, and that such information not be included in the staff report prepared by the State Water Board on the 303(d) List.

3. Analysis of Data for Metals Listings

The Sanitation Districts have concerns regarding the LA Regional Board's determination of metals impairments. The LA Regional Board's impairment determinations were not consistent with written guidance from the State Water Board as provided in its September 2006 Staff Report, Revision of the Clean Water Act Section 303(d) List of Water Quality Limited Segments, Responses to Comments. Under the State Water Board guidance, new impairment listings for metals should be determined only by comparing dissolved metals data with California Toxics Rule (CTR) standards, as the CTR mandates the criteria to be the dissolved fraction. Total metals data should not be considered when assessing whether a new impairment listing should be made. When evaluating whether an existing metals listing should be removed, total metals data should be considered, but only in comparison with dissolved metals criteria. Translators to convert total metals concentrations to dissolved metals concentrations should not be used when assessing either new or existing listings. In making listing determinations, the LA Regional Board considered both dissolved and total metals data, for both reevaluation of existing listings and consideration of new listings. Translators were applied to convert total metals concentrations to dissolved metals concentrations. To be consistent with State Water Board guidance, the LA Regional Board listing decisions for listings that relied on the use of translators to convert total metals concentrations to dissolved metals concentrations should be reevaluated without application of translators.

In additional to using totals metals data to make decisions regarding new metals listings, the LA Regional Board considered total metals data sets and dissolved metals data sets as independent sets of evidence. This is inconsistent with Section 6.1.5.6 of the Listing Policy, which states that data should first be subject to any necessary mathematical transformation prior to conducting any statistical analysis for placement on the 303(d) list. While State Water Board guidance as described above specifies an approach to analyzing metals data that does not rely on mathematical transformations (i.e., application of translators), if in spite of this guidance both total metals data and dissolved metals data are used to reevaluate existing listings then the total and dissolved metal data sets should be combined into one data set prior to statistical analysis. Combining dissolved and total metals datasets into one data set is the most valid and unbiased approach for listing assessments, and is consistent with the Listing Policy. Separate analysis of total and dissolved metals data sets does not allow for appropriate consideration of averaging periods, as required under Section 6.1.5.6 of the Listing Policy. Furthermore, separate analysis of total and dissolved metals datasets is not fully protective. It could result in a non-impairment decision when an impairment decision is more appropriate. For example, if two datasets each have one exceedance out of two samples, neither dataset alone would generate a listing decision. However, if the two datasets were combined, then the combined dataset would show two exceedances out of four samples and would support a listing decision.

4. Consideration of Analytical Method Data Quality

The LA Regional Board inappropriately used copper data analyzed with EPA Method 200.8 to assess copper impairment of the San Gabriel River Estuary. This is in conflict with Section 6.1.4 of the Listing Policy, which states that data used must be of "sufficient high quality" to make determinations of water quality impairments. In the case of saline/estuarine samples, EPA Method 200.8 is susceptible to positive interferences from the salt present in the water. The interference is caused by sodium in the sample combining with argon used in the instrumentation to form a complex that has the same molecular weight as copper, resulting in an overestimation of the actual copper concentration. Although this interference can be partially minimized with varying success by using collision cell techniques and sample dilution, the potential for a significant over-estimation of the actual copper concentrations remains. The Sanitation Districts consulted with Dr. Peter Kozelka of EPA Region 9, who recommended the use of EPA Method 1640 for all estuarine receiving water copper measurements.[10] In 1997, to address the shortcomings of EPA Method 200.8, the EPA developed and subsequently approved EPA Method 1640 for the quantification of trace metals.[11] EPA Method 1640 directly addresses the sodium/argon interference by incorporating a chelation preparation step that removes the metal from the matrix.

To verify whether interference was occurring in San Gabriel River Estuary copper analyses when EPA Method 200.8 is used, data collected during studies conducted by the Sanitation Districts, as well as data collected by the two power plants discharging to the estuary were examined. The data demonstrate an over-estimation for copper in the estuarine samples using EPA Method 200.8 that is statistically significant, with 99% certainty, when compared to measurements using EPA Method 1640.[12] LA Regional Board staff agreed that interferences occur when using EPA Method 200.8 for estuarine copper samples, stating, "Regional Board staff consulted with State Board staff and carefully reviewed analytical method comparison data (Method 1640 vs. Method 200.8) from the aforementioned studies and agree with your finding that using EPA Method 200.8 with collision cell technology for copper analysis of estuarine water samples may significantly overestimate the actual copper concentration."[13] Despite agreement that results from estuarine copper samples analyzed using EPA Method 200.8 are not accurate, the LA Regional Board included EPA Method 200.8 estuarine copper data in its copper impairment determination for the San Gabriel River Estuary. In order to provide an accurate determination of impairment for copper in the San Gabriel River Estuary, the Sanitation Districts therefore request that copper concentration data obtained using EPA Method 200.8 be excluded from the impairment determination.

5. Consideration of Recent Data and Recent Changes to Water Quality Standards

In several instances the Sanitation Districts' analyses of listing decisions reached different conclusions than analyses conducted by the LA Regional Board because the Sanitation Districts identified additional data

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[10] Peter Kozelka, EPA Region 9. Personal communications, June 2008.

[11] USEPA. 1997. Method 1640 – Determination of trace elements in water by preconcentration and inductively coupled plasma-mass spectroscopy. USEAP Office of Water, Washington D.C.

[12] Email from Phil Markle, Sanitation Districts, to C.P. Lai, LA Regional Board, "SGR Estuary Copper Study Update," dated June 16, 2008. Copy included in Appendix 8.

[13] Letter from Tracy J. Egoscue, LA Regional Board Executive Officer, to Stephen R. Maguin, Sanitation Districts Chief Engineer and General Manager, "Response to Request for Amendments to Copper Monitoring Requirements for Estuarine Receiving Waters Under the Long Beach Water Reclamation Plant Monitoring and Reporting Program – Joint Outfall System, Long Beach Water Reclamation Plant (NPDES No. CA0054119, Order No. R4-2007-0047, CI No. 5662)," dated August 15, 2008. Copy included in Appendix 9.

or included newly approved site specific objectives that, when considered together with the data considered by the LA Regional Board, demonstrate attainment. The Sanitation Districts continue to believe that all available water quality data should be used to make impairment decisions, even data that was collected after the initial data solicitation for the 2008 303(d) List. Re-examination of proposed decisions with respect to listing is warranted to ensure that sound listing decisions are made. Additionally, if data are found to be "existing" and "readily available," federal regulations require consideration of the data, in accordance with 40 Code of Federal Regulations Part 130.10(d)(6). In all instances, these data meet the definition of "existing and readily available data" and therefore should be considered.

In its Response to Comments on the Draft 2008 303(d) List, Comment Due Date: June 17, 2009 (Response to Comments), the LA Regional Board indicated that data submitted after the initial data solicitation would not be considered for the 2008 303(d) List, but would instead be evaluated during the next listing cycle. While the Sanitation Districts recognize that it is impractical to continuously evaluate new data that is collected during preparation of impairment decisions, the Sanitation Districts believe that the Water Boards should, as a minimum, evaluate data that is submitted in a readily available format during the public comment period on the 303(d) List. This is particularly important in the case of new listing decisions, as additional data may indicate that a listing is not justified. Once a listing is made, there is a higher burden of proof necessary to make a delisting than there was to make the original listing. Furthermore, the Sanitation Districts believe that excluding from consideration all data that is submitted after the initial data solicitation is inconsistent with the federal requirement to evaluate all existing and readily available water quality-related data. The Sanitation Districts therefore request that the additional data submitted by the Sanitation Districts to the LA Regional Board during the public comment period be considered during the State Water Board review of the 303(d) List.

6. Specific Comments on Listing Decisions

In addition to these general comments, the Sanitation Districts also have specific comments on the listing decisions for a number of water body/pollutant combinations. Detailed specific comments are provided in the appendices to this letter, and Attachment 1 includes a tabular summary of the specific comments. Based on review of the data and fact sheets released for public comment, the Sanitation Districts have identified a number of water body/pollutant combinations proposed for inclusion on the 2008 303(d) List that are attaining water quality standards and therefore qualify for delisting (or alternatively, when they are not already on the 303(d) List do not qualify for listing). The Sanitation Districts believe it is very important for the State Water Board to follow-up on this information and make changes to the proposed 2008 303(d) List where appropriate, since the implications of erroneous listings are substantial.

7. Support Proposed Delistings for Certain Water body/Pollutant Combinations

The Sanitation Districts have reviewed the LA Regional Board's 303(d) delisting analyses for the water body/pollutant combinations listed below. The Sanitation Districts believe the analyses are correct and support the LA Regional Board's decisions to remove these water body/pollutant combinations from the 303(d) list:

- Ballona Creek - Silver
- Coyote Creek - Zinc
- Los Angeles River Estuary - Lead (sediment) and zinc (sediment)
- Rio Hondo Reach 2 - Ammonia
- San Jose Creek - Selenium
- Santa Clara River Reach 5 - Ammonia and Nitrate and Nitrite
- Santa Clara River Reach 6 - Ammonia
- Wilmington Drain - Ammonia
- Walnut Creek Wash - Toxicity

In conclusion, the Sanitation Districts would like to thank the State Water Board for its efforts in reviewing the proposed 2008 303(d) List. We urge the State Water Board to consider the information and analyses we are submitting to complete the development of a 303(d) list that properly focuses scarce resources on truly impaired water bodies. If you have any questions regarding our comments or the information and data we are providing to you, please contact Ken Hoffman at (562) 908-4288, extension 2445, or khoffman@lacsd.org.

Very truly yours,
Stephen R. Maguin

Raymond Tremblay
Assistant Departmental Engineer
Technical Services

RT:KMH:lmb
Attachments

cc: Shakoora Azimi-Gaylon - State Water Board
Dr. Peter Kozelka - EPA Region 9

ATTACHMENT 1

Table 1: Summary of Comments on Specific 303(d) Listings

Fact Sheet	Water Body	Constituent	LA Regional Board Proposed Decision	Sanitation Districts Recommendation	Reason
A	San Gabriel River Estuary	Copper	Do Not Delist	Delist	Water quality objective being achieved
B	Coyote Creek	Ammonia	Do Not Delist	Delist	Water quality objective being achieved
C	Santa Clara River Reach 6	Copper	List	Do not list	Water quality objective being achieved
D	San Jose Creek Reach 1	Ammonia	Do Not Delist	Delist	Water quality objective being achieved
E	Santa Clara River Reach 6	Chlorpyrifos	Do Not Delist	Delist	Water quality objective being achieved
F	San Gabriel River Estuary	Nickel	List	Do not list	Insufficient basis to list
G	Santa Clara River Reach 6	Diazinon	Do Not Delist	Delist	Water quality objective being achieved
H	Coyote Creek	Diazinon	List	Do not list	Water quality objective being achieved
I	Coyote Creek	Copper	Do Not Delist	Delist	Water quality objective being achieved
J	Coyote Creek	Lead	Do Not Delist	Delist	Water quality objective being achieved
K	Santa Clara River Reach 6	Benthic Macroinvertebrate Bioassessments	List	Do not list	Fails to meet State Listing Policy Requirements
L	Arroyo Seco Reach 1, Compton Creek, Lindero Creek Reach 1, Medea Creek Reach 2, and Walnut Creek Wash	Benthic Macroinvertebrate Bioassessments	List	Do not list	Fails to meet State Listing Policy Requirements
M	Las Virgenes Creek, Malibu Creek, and Triunfo Canyon Creek Reach 2	Benthic Macroinvertebrate Bioassessments	List	Do not list	Fails to meet State Listing Policy Requirements

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FACT SHEET A

Water Body: **San Gabriel River Estuary**
Pollutant: **Copper**

Listing: **Listed on the 303(d) List (Being Addressed by EPA Approved TMDL)**

Comment & Recommendation: **Delist – Water Quality Objective Being Achieved**

The California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) is currently proposing that this listing be moved to the list of constituents "being addressed by an EPA-approved TMDL." In 2006 the Environmental Protection Agency (EPA) added copper impairment to the 303(d) List for the San Gabriel River Estuary (SGRE) based on total copper monitoring data, and a TMDL for copper was completed by EPA in March 2007. The LA Regional Board fact sheet states from a sample size of 40 dissolved copper results five samples were found to exceed the California Toxic Rule (CTR) standard.

State Water Resource Control Board Guidance

In the September 2006 State Water Resources Control Board (State Water Board) evaluation of the 303(d) List, the State Water Board addressed the issue of using total metals data to assess impairments, stating:

> "The CTR mandates the criteria to be the dissolved fraction. Although a translator exists to convert dissolved criteria to total fraction effluent limit, no provision in the CTR allows calculating total metals fraction receiving water quality criterion. Staff has reevaluated listings where total metals data were applicable and would result in a change to the analysis. Use of total metals data were applied only to delisting evaluations and only in comparison with dissolved metals criteria. No translators were used to convert total metal fractions to dissolved metal fractions."[1]

Existing Listing Reevaluation

As stated by the State Water Board, only the dissolved fraction of metals should be used for comparison with the CTR criteria. Therefore, in accordance with State Water Board direction, the copper listing should be reevaluated using only dissolved copper data. After the 2006 listing cycle, the Sanitation Districts of Los Angeles County (Sanitation Districts) and Los Angeles Department of Water and Power (LADWP) began conducting dissolved copper analyses on SGRE samples. Table A1 of Appendix A contains the results of this dissolved copper monitoring. From the 120 total usable samples, ninety four-day chronic criteria averages were calculated, none of which exceeded the Criterion Continuous Concentration (CCC) for dissolved copper of 3.1 μg/L for marine waters. Even combining this readily available data with the LA Regional Board's previous analysis, results in only a total of five copper exceedances of the Criterion Continuous Concentration (CCC) out of sample size of 134. For a sample size from 130 to 142, Table 4.1 of the State's listing policy recommends delisting a previously listed pollutant/water body combination if the number exceedances are equal or less than eleven. Since 134 four-day average dissolved copper results through February 2009 show only five exceedances of the CCC, copper should be delisted from the SGRE.

[1] Staff Report Volume IV Revision of the Clean Water Act Section 303(d) List of Water Quality Limited Segments Response to Comments page 63 (Comments: 66.9, 73.17, 81.1, 83.5, 107.17, 107.6, 212.5, 228.5, 242.3), September 2006.

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EPA Method 200.8 compared with EPA Method 1640

The LA Regional Board inappropriately used copper data analyzed with EPA Method 200.8 to assess copper impairment in the San Gabriel River Estuary. This is in conflict with Section 6.1.4 of the Listing Policy, which states that data used must be of "sufficient high quality" to make determinations of water quality impairments. In the case of saline/estuarine samples, EPA Method 200.8 is susceptible to positive interferences from the salt present in the water. The interference is caused by sodium in the sample combining with argon used in the instrumentation to form a complex that has the same molecular weight as copper, resulting in an overestimation of the actual copper concentration. Although this interference can be partially minimized with varying success by using collision cell techniques and sample dilution, the potential for a significant over-estimation of the actual copper concentrations remains. The Sanitation Districts consulted with Dr. Peter Kozelka of EPA Region 9, who recommended the use of EPA Method 1640 for all estuarine receiving water copper measurements.[2] In 1997, to address the shortcomings of EPA Method 200.8, the EPA developed and subsequently approved EPA Method 1640 for the quantification of trace metals.[3] EPA Method 1640 directly addresses the sodium/argon interference by incorporating a chelation preparation step that removes the metal from the matrix.

To verify whether interference was occurring in San Gabriel River Estuary copper analyses when EPA Method 200.8 is used, data collected during studies conducted by the Sanitation Districts as well as data collected by the two power plants discharging to the estuary were examined. The data demonstrate an over-estimation for copper in the estuarine samples using EPA Method 200.8 that is statistically significant, with 99% certainty, when compared to measurements using EPA Method 1640.[4] LA Regional Board staff agreed that interferences occur when using EPA Method 200.8 for estuarine copper samples, stating, "Regional Board staff consulted with State Board staff and carefully reviewed analytical method comparison data (Method 1640 vs. Method 200.8) from the aforementioned studies and agree with your finding that using EPA Method 200.8 with collision cell technology for copper analysis of estuarine water samples may significantly overestimate the actual copper concentration."[5] In order to provide an accurate determination of impairment for copper in the San Gabriel River Estuary, the Sanitation Districts therefore request that copper concentration data obtained using EPA Method 200.8 be excluded from the impairment determination. Of the 86 four-day averages analyzed using EPA Method 1640, no samples exceed the CCC of 3.1 μg/L for marine waters.

[2] Peter Kozelka, EPA Region 9. Personal communications, June 2008.

[3] USEPA. 1997. Method 1640 – Determination of trace elements in water by preconcentration and inductively coupled plasma-mass spectroscopy. USEAP Office of Water, Washington D.C.

[4] Email from Phil Markle, Sanitation Districts, to C.P. Lai, LA Regional Board, "SGR Estuary Copper Study Update," dated June 15, 2008. Copy included in Appendix 8.

[5] Letter from Tracy J. Egoscue, LA Regional Board Executive Officer, to Stephen R. Maguin, Sanitation Districts Chief Engineer and General Manager, "Response to Request for Amendments to Copper Monitoring Requirements for Estuarine Receiving Waters Under the Long Beach Water Reclamation Plant Monitoring and Reporting Program – Joint Outfall System, Long Beach Water Reclamation Plant (NPDES No. CA0054119, Order No. R4-2007-0047, CI No. 5662)," dated August 15, 2008. Copy included in Appendix 9.

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FACT SHEET B

Water Body: **Coyote Creek**
Pollutant: **Ammonia**

Listing: **Listed on the 303(d) List (Being Addressed by Actions Other than a TMDL)**

Comment & Recommendation: **Delist – Water Quality Objectives Being Achieved**

Site-specific objectives (SSOs) for ammonia were developed for Coyote Creek and became effective and adopted into the Basin Plan on April 23, 2009. However, these objectives were approved by the California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) in 2007 and subsequently approved by the State Water Resources Control Board in January 2008. Considering that the LA Regional Board has been aware of these impending changes to the Basin Plan since 2007, the chronic ammonia water quality standards reflected in the SSOs should have been used to evaluate ammonia listings for this 303(d) listing cycle.

Existing Listing Reevaluation

An examination of the Coyote Creek ammonia, pH, and temperature data provided to the LA Regional Board as part of their 303(d) listing review (March 2004 through February 2007) reveals that the four-day chronic SSO-adjusted Criterion Continuous Concentration (CCC) threshold for ammonia was only exceeded in Coyote Creek on 17 occasions out of a total 374 measurements, as presented in Appendix B Table B1. For a sample size of 363 to 374 the State's 303(d) listing policy, using the binomial distribution formula associated with Table 4.1, recommends delisting a previously listed pollutant/water body combination if the number of exceedances are equal to or fewer than 31. Since 374 four-day average ammonia results show 17 exceedances of the CCC, ammonia should be delisted from Coyote Creek.

FACT SHEET C

Water Body:	**Santa Clara River Reach 6**
Pollutant:	**Copper**
Listing:	**List on the 303(d) List (TMDL required list)**
Comment & Recommendation:	**Do not list – Water Quality Objectives Being Achieved**

The California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) is currently proposing that a new listing for copper be made to the 303(d) list in Santa Clara River Reach 6. The fact sheet for copper in Santa Clara River Reach 6 states: "two of 20 samples exceeded the California Toxics Rule (CTR) Criterion Continuous Concentration (CCC) for copper in the dissolved fraction" and "one of 39 samples exceeded the CTR CCC for copper in the total fraction." The fact sheet also states the standard was compared against data collected at Los Angeles County MS4 Mass Emission Santa Clara River Monitoring Station (S29 - San Francisquito Creek) for data collected from October 31, 2003 to April 2, 2007.

State Water Resource Control Board Guidance

In the September 2006 State Water Resources Control Board (State Water Board) evaluation of the 303(d) List, the use of dissolved and total fraction metals data was discussed. The State Water Board directed that dissolved fraction metals data should be used for assessing listings when available, and total fraction data may be used only for listing reevaluation when dissolved fraction data is unavailable:

> "The CTR mandates the criteria to be the dissolved fraction. Although a translator exists to convert dissolved criteria to total fraction effluent limit, no provision in the CTR allows calculating total metals fraction receiving water quality criterion. Staff has reevaluated listings where total metals data were applicable and would result in a change to the analysis. Use of total metals data were applied only to delisting evaluations and only in comparison with dissolved metals criteria. No translators were used to convert total metal fractions to dissolved metal fractions."[6]

Proposed Listing Reevaluation

In accordance with the State Water Board's direction, when listings are assessed dissolved metals data should be used when available and total metals data may be used in addition to dissolved metals data only for reevaluation of listings.

To evaluate the listing, all readily available copper measurements collected and reported to the California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) by the Sanitation Districts and LACDPW in Reach 6 of Santa Clara should be considered. A complete summary of the copper and hardness data along with the CTR hardness-dependent objective calculations can be found in Appendix C - Table C1. Although dissolved copper was not measured in the Sanitation Districts data set, it is conservative to estimate that 100% of the measured total copper was in the dissolved form as described by the September 2006 State Water Board comments mentioned above. With these conservative assumptions, and combining the Sanitation Districts data with the MS4 data, there were two

[6] Staff Report Volume IV Revision of the Clean Water Act Section 303(d) List of Water Quality Limited Segments Response to Comments page 63 (Comments: 66.9, 73.17, 81.1, 83.5, 107.17, 107.6, 212.5, 228.5, 242.3), September 2006.

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copper exceedances of the Criterion Maximum Concentration (CMC) observed out of sample size of 71 and three exceedances of the Criterion Continuous Concentration (CCC) were observed out of sample size of 69. For a sample size of 60 to 71, Table 4.1 of the State 303(d) listing policy recommends delisting a pollutant/water body combination if the number of exceedances are equal or less than five. Therefore, copper in Reach 6 of Santa Clara River Coyote Creek should be delisted.

Notwithstanding the Sanitation Districts' request that listing decisions should be based on comparisons with CTR standards for dissolved metals, if the State Water Board instead makes comparisons of total metals data with translated CTR standards for total metals, total and dissolved data sets for copper in Santa Clara River Reach 6 should still be combined into one data set and considered one line of evidence for listing assessment. If the total and dissolved copper data sets are combined and reviewed as one line of evidence, the data does not support a listing.

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FACT SHEET D

Water Body: **San Jose Creek Reach 1**
Pollutant: **Ammonia**

Listing: **Listed on the 303(d) List (Being Addressed by Actions Other than a TMDL)**

Comment & Recommendation: **Delist – Water Quality Objectives Being Achieved**

Site-specific objectives (SSOs) for ammonia were developed for San Jose Creek Reach 1 and became effective and adopted into the Basin Plan on April 23, 2009. However, these objectives were approved by the California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) in 2007 and subsequently approved by the State Water Resources Control Board in January 2008. Considering that the LA Regional Board has been aware of these impending changes to the Basin Plan since 2007, the chronic ammonia water quality standards reflected in the SSOs should have been used to evaluate ammonia listings for this 303(d) listing cycle.

Existing Listing Reevaluation

An examination of the San Jose Creek Reach 1 ammonia, pH, and temperature data provided to the LA Regional Board as part of their 303(d) listing review (March 2004 through February 2007) reveals that the four-day chronic SSO-adjusted Criterion Continuous Concentration (CCC) threshold for ammonia was exceeded in San Jose Creek Reach 1 on 14 occasions out of a total 282 measurements, as presented in Appendix D - Table D1. Furthermore, there were no exceedances of the Criterion Maximum Concentration (CMC) threshold out of 296 single sample measurements. For a sample size of 282 to 292, using the binomial distribution formula associated with Table 4.1, the State's 303(d) listing policy recommends delisting a previously listed pollutant/water body combination if the number of exceedances are equal to or fewer than 24. Since 282 four-day average ammonia results show only 14 exceedances of the CCC, ammonia should be delisted from San Jose Creek Reach 1.

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FACT SHEET E

Water Body:	**Santa Clara River Reach 6**
Pollutant:	**Chlorpyrifos**
Listing:	**Listed on the 303(d) List (TMDL Required List)**
Comment & Recommendation:	**Delist – Water Quality Objectives Being Achieved or List – "Being Addressed by Actions Other Than TMDL"**

The California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) included chlorpyrifos for Reach 6 of the Santa Clara River during the 2006 listing cycle. Their evaluation of available data indicated an impairment of the California Department of Fish Game four-day Criterion Continuous Concentration (CCC) threshold of 0.05 µg/L using data collected as part of the Surface Water Ambient Monitoring Program (SWAMP) study conducted in Bouquet Canyon Creek (SCTBQT) from 2001 through 2003. A contemporary analysis of available data from October 2001 to April 2008 yields two valid sample results collected by the SWAMP and 33 valid sample results collected by the Los Angeles County Department of Public Works (LADPW) at the Los Angeles County MS4 Mass Emission Santa Clara River Monitoring Station (S29 - San Francisquito Creek).

SWAMP Data Quality

A review of the SWAMP data shows 41 samples were collected for chlorpyrifos from October 2001 to May 2003. SWAMP invalidated the results of 39 of these samples for failure of Quality Assurance/Quality Control (QA/QC) protocols. The state should not be using invalid sample results to determine whether a water quality body impairment exists. Therefore, in accordance with Section 6.1.4. of the State's listing policy, these 39 samples should not be used to evaluate a potential chlorpyrifos impairment in Santa Clara River Reach 6.

State Water Resource Control Board Guidance and EPA Sale Ban

Section 6.1.5.3 of the Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (Listing Policy) states:

> "If the implementation of a management practice(s) has resulted in a change in the water body segment, only recently collected data [since the implementation of the management measure(s)] should be considered."

By December 31, 2001, United States Environmental Protection Agency (EPA) bans on sales of all indoor and outdoor residential products containing chlorpyrifos took effect. Because Santa Clara River Reach 6 is in a highly urbanized area with little agricultural activity, these bans are expected to have eliminated essentially all sources of chlorpyrifos to Santa Clara River Reach 6. Data for chlorpyrifos in Santa Clara River Reach 6 confirm that the bans changed the quality of water in the river. Prior to the bans, two of three valid samples in this reach exceeded the CCC for chlorpyrifos. Since the bans took effect, there have been no exceedances of the CCC for chlorpyrifos based on valid data. Therefore, the bans should be considered a management practice that resulted in a change in the water body segment. Accordingly, only data collected since January 1, 2002 should only be used for listing reevaluation.

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Existing Listing Reevaluation

The chlorpyrifos dataset, along with the associated CCC objective, can be found in Appendix E - Table E1. When data generated after the residential use ban, January 1, 2002 to April 2008, are considered, no four-day average chlorpyrifos results exceeded the CCC, with a sample size of 30. For a sample size of 28 to 36, Table 4.1 of the State's Listing Policy recommends delisting a previously listed pollutant/water body combination if the number of exceedances are equal or less than two. Therefore, Santa Clara River Reach 6 should be delisted for chlorpyrifos.

Recategorization of Listing

Santa Clara Reach 6 does not show an impairment for chlorpyrifos if invalid samples are excluded from the analysis or if samples collected prior to the EPA bans on chlorpyrifos are excluded from the analysis. However if the State Water Resources Control Board (State Water Board) does not delist Santa Clara Reach 6 for chlorpyrifos, the listing should be moved to the "Water Quality Limited Segments Being Addressed by Actions Other Than a TMDL" list. The EPA chlorpyrifos bans are a regulatory action (other than a TMDL) that is expected to result, and has indeed resulted, in attainment of water quality standards. Although the invalid SWAMP data suggests that concentrations of chlorpyrifos were occasionally elevated for over a year after the bans took effect, these data do not indicate that the bans were not successful. The bans were placed on sales of chlorpyrifos, not use, and stocks of previously purchased chlorpyrifos would be expected to be used up in the time period immediately following the bans taking effect. The fact that there have been no detections of chlorpyrifos and no water quality objective exceedances since November 2001 (or March 2003, if the invalid SWAMP data is considered) indicate that the bans have successfully addressed the chlorpyrifos impairment.

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FACT SHEET F

Water Body: **San Gabriel River Estuary**
Pollutant: **Nickel**

Listing: **List on the 303(d) List (TMDL required list)**

Comment & Recommendation: **Do Not List – Insufficient Basis to List**

The California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) is currently proposing to add nickel to the 2008 303(d) List for the San Gabriel River Estuary. The fact sheet for nickel in San Gabriel River Estuary states "13 of 47 samples exceed the California Toxics Rule Criterion Continuous Concentration (CCC)" and the "California Toxics Rule (CTR) lists a Criterion Continuous Concentration of 8.2 µg/L and a Criterion Maximum Concentration (CMC) of 74 µg/L for nickel to protect aquatic life in saltwater for the total fraction."

California Toxic Rule and State Water Resources Control Board Guidance

Footnote m of the CTR, which is applicable to nickel, states that the CCC and CMC are expressed as the dissolved fraction of the metal, not the total concentration. The CTR states:

> "These freshwater and saltwater criteria for metals are expressed in terms of the dissolved fraction of the metal in the water column." [7]

The use of dissolved metal criteria and data to assess 303(d) listing was clearly stated by the State Water Resources Control Board (State Water Board) in response to comments for the 2006 303(d) listing cycle. The State Water Board stated:

> "The CTR [California Toxic Rule] mandates the criteria to be the dissolved fraction. Although a translator exists to convert dissolved criteria to total fraction effluent limit, no provision in the CTR allows calculating total metals fraction receiving water quality criterion. Staff has reevaluated listings where total metals data were applicable and would result in a change to the analysis. Use of total metals data were applied only to delisting evaluations and only in comparison with dissolved metals criteria. No translators were used to convert total metal fractions to dissolved metal fractions."[8]

Proposed Listing Reevaluation

The analysis conducted to justify the nickel listing was incorrect. The analysis using the CTR was conducted by comparing the CCC and CMC against the total fraction of nickel. The correct approach is to assess whether there is an impairment by comparing dissolved nickel data to the CMC and CCC. The fact sheet states that data collected by the Sanitation Districts of Los Angeles County and Los Angeles Department of Water and Power were used for the listing. Both of these data sets contain only total nickel results for the San Gabriel River Estuary, so this data should not have been used to assess whether there is impairment. Since no data is available for the purposes of evaluating an impairment, nickel should not be added to the 2008 303(d) List for the San Gabriel River Estuary.

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[7] Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California; Rule, 40 CFR Part 131, page 31716, footnote m, May 18, 2000.
[8] Staff Report Volume IV Revision of the Clean Water Act Section 303(d) List of Water Quality Limited Segments Response to Comments page 63 (Comments: 66.9, 73.17, 81.1, 83.5, 107.17, 107.6, 212.5, 228.5, 242.3), September 2006.

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FACT SHEET G

Water Body:	**Santa Clara River Reach 6**
Pollutant:	**Diazinon**
Listing:	**Listed on the 303(d) List (TMDL Required List)**
Comment & Recommendation:	**Delist – Water Quality Objectives Being Achieved or List - "Being Addressed by Actions Other Than TMDL"**

The California Regional Water Quality Control Board, Los Angeles (LA Regional Board) included diazinon for Reach 6 of the Santa Clara River during the 2006 listing cycle because their evaluation of available data indicated that the California Department of Fish and Game (CADFG) four-day Criterion Continuous Concentration (CCC) threshold of 0.10 µg/L diazinon[9] was exceeded in samples collected from Bouquet Canyon Creek. All of the utilized monitoring data was collected as part of a Surface Water Ambient Monitoring Program (SWAMP). A contemporary analysis of available data finds two valid samples available from the SWAMP program, 33 samples collected by the Los Angeles County Department of Public Works, and 25 samples collected by the Sanitation Districts of Los Angeles County (Sanitation Districts). This dataset is attached as Appendix G – Table G1.

SWAMP Data Quality

A review of the SWAMP data shows 45 samples were collected for diazinon from October 2001 to May 2003. SWAMP invalidated the results of 43 of these samples for failure of Quality Assurance/Quality Control (QA/QC) protocols. The state should not be using invalid sample results to determine whether a water quality impairment exists. Therefore, in accordance with Section 6.1.4. of the State's listing policy, these 43 samples should be excluded from consideration.

State Water Resource Control Board Guidance

Section 6.1.5.3 of the Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List states:

> "If the implementation of a management practice(s) has resulted in a change in the water body segment, only recently collected data [since the implementation of the management measure(s)] should be considered."

By December 31, 2004, Environmental Protection Agency (EPA) bans on sales of all indoor and outdoor non-agricultural products containing diazinon took effect. Because Santa Clara River Reach 6 is in a highly urbanized area with little agricultural activity, these bans are expected to have essentially eliminated all sources of diazinon to Santa Clara River Reach 6. Data for diazinon in Santa Clara River Reach 6 confirm that the bans changed the quality of the water in the river. Prior to the bans, six of 19 valid samples in this reach exceeded the CCC for diazinon. Since the bans took effect, there have been only two exceedances of the CCC in a sample size of 38. Therefore, the bans should be considered a management practice that resulted in a change in the water body segment. Accordingly, only data collected since January 1, 2005 should only be used for listing reevaluation.

[9] At the time of original listing, the CADFG CCC for diazinon was 0.08 and was has since been modified to 0.10 µg/L diazinon.

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Existing Listing Reevaluation

If data generated after the residential sales ban took effect, January 1, 2005 to April 2007 are considered, only two four-day average diazinon results exceeded the CCC with a sample size of 29. For a sample size of 28 to 36, Table 4.1 of the State's listing policy recommends delisting a previously listed pollutant/water body combination if the number of exceedances are equal or less than two. Therefore, diazinon in Reach 6 of the Santa Clara River should be removed from the 303(d) list.

Recategorization of Listing

Water quality objectives are being achieved and no impairment is present. Notwithstanding our request to have this water body delisted for diazinon, at minimum this listing should be moved to the "Water Quality Limited Segments Being Addressed by Actions Other Than a TMDL" category. The EPA indoor and outdoor non-agriculture ban on sales of diazinon products are a regulatory action (other than a TMDL) that is expected to result, and has indeed resulted, in attainment of water quality standards. Although concentrations of diazinon were occasionally elevated for a little over a year after the bans took effect, these data do not indicate that the bans were not successful. The bans were placed on sales of diazinon, not use, and stocks of previously purchased diazinon would be expected to be used up in the time period immediately following the bans taking effect. The fact there have been no detections of diazinon and no water quality exceedances since January 2006 indicate that the bans have successfully addressed the diazinon impairment.

ATTACHMENT 1

FACT SHEET H

Water Body:	**Coyote Creek**
Pollutant:	**Diazinon**
Listing:	**Listed on the 303(d) List (TMDL Required List)**
Comment & Recommendation:	**Delist – Water Quality Objectives Being Achieved**

The California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) included diazinon for Coyote Creek during the 2006 listing cycle because their evaluation of available data indicated that the California Department of Fish and Game (CADFG) four-day Criterion Continuous Concentration (CCC) threshold of 0.10 μg/L diazinon[10] was exceeded in samples collected by the Los Angeles County Department of Public Works (LACDPW) and the Sanitation Districts of Los Angeles County (Sanitation Districts). A contemporary analysis of available data indicates that 31 diazinon samples are now available from the LACDPW and 42 diazinon samples are now available from the Sanitation Districts to reassess the listing. This dataset is attached as Appendix H – Table H1.

State Water Resource Control Board Guidance and EPA Sale Ban

Section 6.1.5.3 of the Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List states:

> "If the implementation of a management practice(s) has resulted in a change in the water body segment, only recently collected data [since the implementation of the management measure(s)] should be considered."

By December 31, 2004, Environmental Protection Agency (EPA) bans on sales of all indoor and outdoor non-agricultural products containing diazinon took effect. Because Coyote Creek is in a highly urbanized area with little agricultural activity, these bans are expected to have essentially eliminated all sources of diazinon to Coyote Creek. Data for diazinon in Coyote Creek confirm that the bans changed the quality of the water in the river. Prior to the bans, four of 17 sampling events showed exceedances of the CCC. Since the bans took effect, only three of 51 sampling events showed such exceedances. Therefore, the bans should be considered a management practice that resulted in a change in the water body segment. Accordingly, only data collected since January 1, 2005 should be used for listing reevaluation.

Existing Listing Reevaluation

If data generated after the residential sales ban took effect, January 1, 2005 to April 2008 is considered, only three four-day average diazinon results exceeded the CCC with a sample size of 51. For a sample size from 48 to 59, Table 4.1 of the State's listing policy recommends delisting a previously listed pollutant/water body combination if the number exceedances are equal or less than four. In addition, the most recent data available indicates that there have been no exceedances in 17 samples since July 2007. Therefore, diazinon in Coyote Creek should be removed from the 303(d) list.

Recategorization of Listing

Water quality objectives are being achieved and no impairment is present. Notwithstanding our request to have this water body delisted for diazinon, at minimum this listing should be moved to the "Water

[10] At the time of original listing, the CADFG CCC for diazinon was 0.08 and was has since been modified to 0.10 μg/L diazinon.

ATTACHMENT 1

Quality Limited Segments Being Addressed by Actions Other Than a TMDL" category. The EPA residential use phase-out of diazinon is a regulatory action (other than a TMDL) that is expected to result, and has indeed resulted, in attainment of water quality standards. Although concentrations of diazinon were occasionally elevated for a little over two years after the bans took effect, these data do not indicate that the bans were not successful. The bans were placed on sales of diazinon, not use, and stocks of previously purchased diazinon would be expected to be used up in the time period immediately following the bans taking effect. The fact there have been no detections of diazinon and no water quality exceedances since April 2007 indicate that the bans have successfully addressed the diazinon impairment.

FACT SHEET I

Water Body: **Coyote Creek**
Pollutant: **Copper**

Listing: **List on the 303(d) List (Being Addressed by an EPA-Approved TMDL)**

Comment & Recommendation: **Delist – Water Quality Objectives Being Achieved**

Coyote Creek is currently listed for copper under the category of being addressed by an EPA-approved TMDL. The original listing determination was made prior to 2006, using total copper data in the reach collected by the Los Angeles County Department of Public Works (LACDPW) and the Sanitation Districts of Los Angeles County (Sanitation Districts). EPA completed a TMDL for copper in March 2007. The current fact sheet states: "19 of 76 samples exceeded the lead CTR Criterion Continuous Concentration for the dissolved fraction, four of 178 samples exceeded the lead CTR Criterion Continuous Concentration for the total fraction." The fact sheet also states data from November 1997 to April 2007 was used for dissolved faction assessment and data from August 2004 to February 2007 collected by the Sanitation Districts was used for total fraction assessment. The Sanitation Districts believe there to be errors in the prepared fact sheet but do not have the dataset used by the LA Regional Board to analyze these errors.

State Water Resource Control Board

In the September 2006 State Water Resources Control Board (State Water Board) evaluation of the 303(d) List, the use of dissolved and total fraction metals data was discussed. The State Water Board directed that dissolved fraction metals data should be used for assessing listings when available, and total fraction data may be used only for listing reevaluation when dissolved fraction data is unavailable:

> "The CTR [California Toxic Rule] mandates the criteria to be the dissolved fraction. Although a translator exists to convert dissolved criteria to total fraction effluent limit, no provision in the CTR allows calculating total metals fraction receiving water quality criterion. Staff has reevaluated listings where total metals data were applicable and would result in a change to the analysis. Use of total metals data were applied only to delisting evaluations and only in comparison with dissolved metals criteria. No translators were used to convert total metal fractions to dissolved metal fractions."[11]

Existing Listing Reevaluation

In accordance with the State Water Board's direction, when listings are assessed dissolved metals data should be used when available and total metals data may be used in addition to dissolved metals data only for reevaluation of listings.

To reevaluate the existing listing, all readily available copper measurements collected and reported to the California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) by the Sanitation Districts and LACDPW in Coyote should be considered. The Sanitation Districts were unable to assemble data prior to 1998. A complete summary of the available copper and hardness data along with the CTR hardness-dependent objective calculations can be found in Appendix I - Table I1. Although

[11] Staff Report Volume IV Revision of the Clean Water Act Section 303(d) List of Water Quality Limited Segments Response to Comments page 63 (Comments: 66.9, 73.17, 81.1, 83.5, 107.17, 107.6, 212.5, 228.5, 242.3), September 2006.

dissolved copper was not measured in the Sanitation Districts data set, it is conservative to estimate that 100% of the measured total copper was in the dissolved form as described by the September 2006 State Water Board comments mentioned above. With these conservative assumptions, and combining the Sanitation Districts data with the MS4 data, there were three copper exceedances of the Criterion Maximum Concentration (CMC) observed out of sample size of 225 and ten exceedance of the Criterion Continuous Concentration (CCC) were observed out of sample size of 210. For a sample size of 200 to 211, using the binomial distribution formula associated with Table 4.1, the State's 303(d) listing policy recommends delisting a previously listed pollutant/water body combination if the number of exceedances are equal to or fewer than sixteen. Therefore, copper in Coyote Creek should be delisted.

Notwithstanding the Sanitation Districts' request that listing decisions should be based on comparisons with CTR standards for dissolved metals, if the State Water Board instead makes comparisons of total metals data with translated CTR standards for total metals, total and dissolved data sets for copper in Coyote Creek should still be combined into one data set and considered one line of evidence for listing assessment. If the total and dissolved copper data sets are combined and reviewed as one line of evidence, the data indicates that copper in Coyote Creek should be delisted.

FACT SHEET J

Water Body:	**Coyote Creek**
Pollutant:	**Lead**
Listing:	**List on the 303(d) List (Being addressed by an EPA-approved TMDL)**
Comment & Recommendation:	**Delist – Water Quality Objectives Being Achieved**

The California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) is currently proposing that a new listing for lead be made to the 303(d) list in Coyote Creek. The fact sheet for lead in Coyote Creek states: "Seven of 51 samples exceeded the lead CTR Criterion Continuous Concentration for the dissolved fraction, zero out of 75 samples exceeded the lead CTR Criterion Continuous Concentration for the total fraction." The fact sheet also states that the standard was compared against data collected at Los Angeles County MS4 Coyote Creek Monitoring Station (S13) for data collected from 1995 through April 2007.

State Water Resource Control Board Guidance

In the September 2006 State Water Resources Control Board (State Water Board) evaluation of the 303(d) List, the use of dissolved and total fraction metals data was discussed. The State Water Board directed that dissolved fraction metals data should be used for assessing listings when available, and total fraction data may be used only for listing reevaluation when dissolved fraction data is unavailable:

> "The CTR mandates the criteria to be the dissolved fraction. Although a translator exists to convert dissolved criteria to total fraction effluent limit, no provision in the CTR allows calculating total metals fraction receiving water quality criterion. Staff has reevaluated listings where total metals data were applicable and would result in a change to the analysis. Use of total metals data were applied only to delisting evaluations and only in comparison with dissolved metals criteria. No translators were used to convert total metal fractions to dissolved metal fractions."[12]

Proposed Listing Reevaluation

In accordance with the State Water Board's direction, when listings are assessed dissolved metals data should be used when available and total metals data may be used in addition to dissolved metals data only for reevaluation of listings.

To reevaluate the existing listing, all readily available lead measurements collected and reported to the California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) by the Sanitation Districts and LACDPW in Coyote Creek should be considered. A complete summary of the lead and hardness data along with the CTR hardness-dependent objective calculations can be found in Appendix J - Table J1. Although dissolved lead was not measured in the Sanitation Districts data set, it is conservative to estimate that 100% of the measured total lead was in the dissolved form as described by the September 2006 State Water Board comments mentioned above. With these conservative assumptions, and combining the Sanitation Districts data with the MS4 data, there were zero lead exceedances of the Criterion Maximum Concentration (CMC) observed out of sample size of 267 and

[12] Staff Report Volume IV Revision of the Clean Water Act Section 303(d) List of Water Quality Limited Segments Response to Comments page 63 (Comments: 66.9, 73.17, 81.1, 83.5, 107.17, 107.6, 212.5, 228.5, 242.3), September 2006.

nine exceedances of the Criterion Continuous Concentration (CCC) were observed out of sample size of 195. For a sample size of 188 to 199, using the binomial distribution formula associated with Table 4.1, the State's 303(d) listing policy recommends delisting a previously listed pollutant/water body combination if the number of exceedances are equal to or fewer than seventeen. Therefore, lead in Coyote Creek should be delisted.

Notwithstanding the Sanitation Districts' request that listing decisions should be based on comparisons with CTR standards for dissolved metals, if the State Water Board instead makes comparisons of total metals data with translated CTR standards for total metals, total and dissolved data sets for lead in Coyote Creek should still be combined into one data set and considered one line of evidence for listing assessment. If the total and dissolved lead sets are combined and reviewed as one line of evidence, the data indicates that lead in Coyote Creek should be delisted

FACT SHEET K

Water Body: **Santa Clara River Reach 6**
Pollutant: **Benthic Macroinvertebrate Bioassessments**

Listing: **List on 303(d) list (TMDL required list)**

Comment & Recommendation: **Do not list –Fails to meet State Listing Policy Requirements**

The California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) is proposing that a new listing for "benthic macroinvertebrate bioassessments" be made to the 303(d) list in Santa Clara River Reach 6, based on "poor" benthic macroinvertebrate scores as measured using the southern California Index of Biotic Integrity (SoCal IBI).

State Water Resource Control Board Guidance

Section 3.9 of the State Water Resources Control Board Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (Listing Policy) states:

> "A water segment shall be placed on the section 303(d) list if the water segment exhibits significant degradation in biological populations and/or communities **as compared to reference site(s)** and is associated with water or sediment concentrations of pollutants including but not limited to chemical concentrations, temperature, dissolved oxygen, and trash." [Emphasis added.]

While the LA Regional Board assumed that the SoCal IBI inherently accounted for reference conditions, the reference conditions used to develop the SoCal IBI were not representative of low elevation/low gradient and highly modified streams in the Los Angeles Region.[13] Santa Clara River Reach 6 is an extremely low gradient (less than 1%), low elevation coastal water body, and thus the SoCal IBI does not adequately account for reference conditions. In the study used to develop the index, data was collected from 275 sites, ranging from Monterey County in the north to the Mexican border in the south, but not a single site was located in the low elevation areas of Los Angeles County, nor were any highly modified channels included. Additionally, low elevation/ gradient streams representative of those in the Los Angeles Region were significantly under-represented in the study.

The lead scientist for development of the SoCal IBI, Dr. Peter Ode, has acknowledged the limitations on application of the SoCal IBI. In a recently published paper regarding a study examining the SoCal IBI relative to other benthic macroinvertebrate bioassessments, he concluded that the SoCal IBI was did not adequately inherently address reference conditions in low elevation sites, stating that the SoCal IBI was "not completely effective at controlling for an elevation gradient."[14] Dr. Ode was also the co-author of a March 2009 report on recommendations for development and maintenance of a network of reference sites to support biological assessment of California's wadeable streams.[15] This report describes

[13] Ode, P.R., A.C. Rehn, J.T. May. 2005. A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams. Environmental Management Vol. 35, No 4, pp. 494, Figure 1. Copy included in Appendix 1.
[14] Ode, P.R., C.P. Hawkins, R.D. Mazor, Comparability of Biological Assessments Derived from Predictive Models and Multimetric Indices of Increasing Geographic Scope, J. N. Am. Benthol. Soc., 2008, 27(4):967-985.p. 982. Copy included in Appendix 2.
[15] Ode, P.R., K. Schiff. Recommendations for the Development and Maintenance of a Reference Condition Management Program to Support Biological Assessment of California's Wadeable Streams: Report to the Surface Water Ambient Monitoring Program. Southern California Coastal Water Research Project, Technical Report 581. March 2009. Copy included in Appendix 3.

recommendations made by a technical panel of experts on bioassessment, including experts from California Department of Fish and Game, Southern California Coastal Water Research Project (SCCWRP), US EPA Region 9, and various universities. The technical panel laid out a number of steps that would be necessary to develop a network of adequate reference sites for implementation of criteria for bioassessments. They note that, "A crucial component to the development of assessment tools is understanding biological expectations at reference sites that consist of natural, undisturbed systems. These reference systems set the biological condition benchmarks for comparisons to the site(s) being evaluated." They also clearly note that adequate reference sites have not been identified in southern California, stating, "human-dominated landscapes can be so pervasive in locations such as urban southern California and the agriculturally dominated Central Valley that no undisturbed reference sites may currently exist in these regions. A statewide framework for consistent selection of reference sites must account for this complexity."

Furthermore, a memorandum recently prepared by Jerry Diamond of Tetra Tech, one of the leading national technical experts on bioassessments, confirms that adequate reference sites are not available to assess benthic macroinvertebrate populations for low gradient and low elevation streams in the LA Region.[16] Dr. Diamond is the author of several technical reports prepared for the LA Regional Board on tiered aquatic life uses (TALU) based on bioassessments.[17,18] Dr. Diamond states that there is "high uncertainty regarding appropriate reference conditions for low gradient and low elevation streams in this region [Southern California]," and that "low elevation streams lacked a clear reference conditions in this region [Southern California]." He further states that a technical advisory committee for a US EPA-funded project on TALU "identified a lack of appropriate reference sites for low elevation/low gradient streams as a critical data gap." The technical advisory committee consisted of regional experts from California Fish & Game, State Water Board, other Regional Boards, US EPA Region 9, and universities. Dr. Diamond also worked with SCCWRP and the LA Regional Board in facilitating two workshops on TALU for Southern California. Dr. Diamond states, "In the most recent stakeholder workshop... there was agreement that low gradient (rather than low elevation) was perhaps the most critical factor distinguishing stream biology in the region and that the reference condition for low gradient streams (many but not all of which occur at low elevation) is a critical data gap..."[19]

Other scientific experts concur with Dr. Diamond's conclusions. In a recent study that examined low gradient streams in California, including sites within Reach 6 of the Santa Clara River, Raphael D. Mazor of SCCWRP stated, "Several biomonitoring efforts in California specifically target low-gradient streams, as these habitats are subject to numerous impacts and alterations, ... even though the applicability of assessment tools created and validated in high-gradient streams have not been tested."[20] The study found that, "As a consequence of these differences [substrate material, bed morphology, and distribution of microhabitats], traditional bioassessment approaches in California that were developed in high-gradient

[16] Diamond, Jerry. Reference Conditions and Bioassessments in Southern California Streams. July 31, 2009. Memorandum to Phil Markle of the Sanitation Districts. Copy included in Appendix 4.

[17] Schiff, K. and Diamond, J., Identifying Barriers to Tiered Aquatic Life Uses (TALU) in Southern California, Southern California Coastal Water Research Project, Technical Report 590. June 2009. Copy included in Appendix 6.

[18] Tetra Tech, Revised Analyses of Biological Data to Evaluate Tiered Aquatic Life Uses (TALU) for Southern California Coastal Streams. Prepared for EPA Region 9 and California Regional Water Quality Control Board, Los Angeles Region. 2006. Tetra Tech, Inc., Owings Mills, MD. Copy included in Appendix 5.

[19] For a report summarizing the outcome of the workshops, see Schiff, K. and Diamond, J., Identifying Barriers to Tiered Aquatic Life Uses (TALU) in Southern California, Southern California Coastal Water Research Project, Technical Report 590. June 2009. Copy included in Appendix 6.

[20] Mazor, Raphael D.; Schiff, Kenneth; Ritter, Kerry; Rehn, Andy; and Ode, Peter; Bioassessment Tools in Novel Habitats: An Evaluation of Indices and Sampling Methods in Low-Gradient Streams in California, Enviorn. Monit. Assess., DOI 10.1007/s10661-009-1033-3. Copy included in Appendix 7.

streams with diverse microhabitats have limited applications in low-gradient reaches,"[20] and, "Caution should be used when applying sampling methods for assessment tools that were calibrated for specific habitat types (e.g., high gradient streams) to new habitats (e.g., low gradient streams)."[20] The study also concluded, "....observation of the sites in this study suggests that the lack of stable microhabitats (e.g., riffles and vegetated margins) may account for the reduced number of macroinvertebrates, as few species are adapted to the shifting sandy substrate found in most low gradient streams in California."[20] Moreover, the State Water Board, Surface Water Ambient Monitoring Program, California Department of Fish and Game, and others recognize the limitations of the SoCal IBI regarding reference sites. They have identified application of TALU and the selection of more representative/appropriate regional reference locations as being necessary components to the state's bioassessment program.[15, 17]

The SoCal IBI does not inherently account for reference conditions and adequate consideration of reference sites is an essential component in application of the index. The SoCal IBI is calculated by scoring bioassessment results from a receiving water location, but a lower score does not necessarily indicate "impairment." Different types of streams would be expected to support different types of invertebrate communities. In low-gradient streams, bed substrate is typically composed of fines and sand, rather than the cobbles, boulders, or bedrock typically found in high-gradient streams. In high-gradient streams, sediments and leaf litter are typically removed with the increased flow velocities resulting in larger open spaces between rocks and cobble that provide different habitats for different types of invertebrates utilizing different feeding strategies (more predators and fewer detritus feeders). In the low-gradient streams, the sediment and leaf litter/detritus loads are naturally deposited in the channel, filling up the available spaces between rocks. These habitats support a much different population of invertebrates (more detritus feeders and fewer predators), not necessarily an "impaired" population.

Besides not adequately considering reference conditions, the proposed listings are also not in conformance with state policy regarding association with other pollutants. The Listing Policy states:

> "A water segment shall be placed on the section 303(d) list if the water segment exhibits significant degradation in biological populations and/or communities as compared to reference site(s) and **is associated with** water or sediment concentrations of pollutants including but not limited to chemical concentrations, temperature, dissolved oxygen, and trash." [Emphasis added.]

In the fact sheets supporting its impairment decisions for each of these listings, the LA Regional Board simply identified that the low SoCal IBI scores in listed reaches co-occurred with 303(d) listed impairments. Co-occurrence does not establish an association and no attempt was made by the LA Regional Board to reasonably link the low SoCal IBI scores with a listed constituent. In Santa Clara River Reach 6 the benthic macroinvertebrate community impairment was justified by being "associated" with impairments for several pollutants, including ammonia and diazinon. However, while concentrations of these pollutants have been substantially reduced since 2003 and are now consistently below water quality objectives, the SoCal IBI scores for this reach have essentially remained the same. It is the Sanitation Districts' understanding that the intent of the Listing Policy is that listings for biological impairments only be made if there is a linkage established between a concentration of a pollutant and the biological impairment. Since no linkages were established by the LA Regional Board in the fact sheets supporting the proposed listings, the proposed listings for benthic macroinvertebrates should be removed.

Proposed Listing Revaluation

The SoCal IBI fails to adequately incorporate low gradient reference conditions for comparison of macroinvertebrate scores in Santa Clara River Reach 6. Additionally, no reasonable association of low IBI scores with water or sediment pollutant concentration was adequately established. Therefore, the

ATTACHMENT 1

listing does not meet the specific provisions contained in the Listing Policy for degradation of biological populations and communities, and Santa Clara River Reach 6 should not be listed as impaired for "benthic macroinvertebrate bioassessments".

ATTACHMENT 1

FACT SHEET L

Water Body: **Arroyo Seco Reach 1, Compton Creek, Lindero Creek Reach 1, Medea Creek Reach 2, and Walnut Creek Wash**

Pollutant: **Benthic Macroinvertebrate Bioassessments**

Listing: **List on 303(d) list (TMDL required list)**

Comment & Recommendation: **Do not list –Fails to meet State Listing Policy Requirements**

The California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) is proposing new 303(d) listings for "benthic macroinvertebrate bioassessments" be made for Arroyo Seco, Compton Creek, Lindero Creek, Madea Creek, and Walnut Creek. Based on "poor" or "very poor" benthic macroinvertebrate scores as measured using the southern California Index of Biological Integrity (SoCal IBI).

State Water Resource Control Board Guidance

Section 3.9 of the State Water Resources Control Board Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (Listing Policy) indicates that water bodies should only be listed for degradation of biological populations and communities if significant degradation relative to reference site(s) is observed. The Listing Policy states:

> "A water segment shall be placed on the section 303(d) list if the water segment exhibits significant degradation in biological populations and/or communities **as compared to reference site(s)** and is associated with water or sediment concentrations of pollutants including but not limited to chemical concentrations, temperature, dissolved oxygen, and trash." [Emphasis added.]

While the LA Regional Board assumed that the SoCal IBI inherently accounted for reference conditions, the reference conditions used to develop the SoCal IBI were not representative of low elevation/low gradient streams and highly modified streams in the Los Angeles Region.[21] Arroyo Seco Reach 1, Compton Creek, Lindero Creek Reach 1, Medea Creek Reach 2, and Walnut Creek Wash are extremely low gradient (less than 1%) and low elevation streams in Los Angeles County with significant habitat modifications that include partial channelization, elimination of riparian cover, and bank stabilization. Thus the SoCal IBI does not adequately account for reference conditions relative to these water bodies. In the study used to develop the index, data was collected from 275 sites, ranging from Monterey County in the north to the Mexican border in the south, but not a single site was located in the low elevation areas of Los Angeles County, nor were any highly modified channels included. Additionally, low elevation/ gradient streams representative of those in the Los Angeles Region were significantly under-represented in the study.

The lead scientist for development of the SoCal IBI, Dr. Peter Ode, has acknowledged the limitations on application of the SoCal IBI. In a recently published paper regarding a study examining the SoCal IBI relative to other benthic macroinvertebrate bioassessments, he concluded that the SoCal IBI was did not adequately inherently address reference conditions in low elevation sites, stating that the SoCal IBI was

[21] Ode, P.R., A.C. Rehn, J.T. May. 2005. A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams. Environmental Management Vol. 35, No 4, pp. 494, Figure 1. Copy included in Appendix 1.

"not completely effective at controlling for an elevation gradient."[22] Dr. Ode was also the co-author of a March 2009 report on recommendations for development and maintenance of a network of reference sites to support biological assessment of California's wadeable streams.[23] This report describes recommendations made by a technical panel of experts on bioassessment, including experts from California Department of Fish and Game, Southern California Coastal Water Research Project (SCCWRP), US EPA Region 9, and various universities. The technical panel laid out a number of steps that would be necessary to develop a network of adequate reference sites for implementation of criteria for bioassessments. They note that, "A crucial component to the development of assessment tools is understanding biological expectations at reference sites that consist of natural, undisturbed systems. These reference systems set the biological condition benchmarks for comparisons to the site(s) being evaluated." They also clearly note that adequate reference sites have not been identified in southern California, stating, "human-dominated landscapes can be so pervasive in locations such as urban southern California and the agriculturally dominated Central Valley that no undisturbed reference sites may currently exist in these regions. A statewide framework for consistent selection of reference sites must account for this complexity."

Furthermore, a memorandum recently prepared by Jerry Diamond of Tetra Tech, one of the leading national technical experts on bioassessments, confirms that adequate reference sites are not available to assess benthic macroinvertebrate populations for low gradient and low elevation streams in the LA Region.[24] Dr. Diamond is the author of several technical reports prepared for the LA Regional Board on tiered aquatic life uses (TALU) based on bioassessments.[25,26] Dr. Diamond states that there is "high uncertainty regarding appropriate reference conditions for low gradient and low elevation streams in this region [Southern California]," and that "low elevation streams lacked a clear reference conditions in this region [Southern California]." He further states that a technical advisory committee for an US EPA-funded project on TALU "identified a lack of appropriate reference sites for low elevation/low gradient streams as a critical data gap." The technical advisory committee consisted of regional experts from California Fish & Game, State Water Board, other Regional Boards, US EPA Region 9, and universities. Dr. Diamond also worked with SCCWRP and the LA Regional Board in facilitating two workshops on TALU for Southern California. Dr. Diamond states, "In the most recent stakeholder workshop… there was agreement that low gradient (rather than low elevation) was perhaps the most critical factor distinguishing stream biology in the region and that the reference condition for low gradient streams (many but not all of which occur at low elevation) is a critical data gap..."[27]

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[22] Ode, P.R., C.P. Hawkins, R.D. Mazor, Comparability of Biological Assessments Derived from Predictive Models and Multimetric Indices of Increasing Geographic Scope, J. N. Am. Benthol. Soc., 2008, 27(4):967-985.p. 982. Copy included in Appendix 2.

[23] Ode, P.R., K. Schiff. Recommendations for the Development and Maintenance of a Reference Condition Management Program to Support Biological Assessment of California's Wadeable Streams: Report to the Surface Water Ambient Monitoring Program. Southern California Coastal Water Research Project, Technical Report 581. March 2009. Copy included in Appendix 3.

[24] Diamond, Jerry. Reference Conditions and Bioassessments in Southern California Streams. July 31, 2009. Memorandum to Phil Markle of the Sanitation Districts. Copy included in Appendix 4.

[25] Schiff, K. and Diamond, J., Identifying Barriers to Tiered Aquatic Life Uses (TALU) in Southern California, Southern California Coastal Water Research Project, Technical Report 590. June 2009. Copy included in Appendix 6.

[26] Tetra Tech, Revised Analyses of Biological Data to Evaluate Tiered Aquatic Life Uses (TALU) for Southern California Coastal Streams. Prepared for EPA Region 9 and California Regional Water Quality Control Board, Los Angeles Region. 2006. Tetra Tech, Inc., Owings Mills, MD. Copy included in Appendix 5.

[27] For a report summarizing the outcome of the workshops, see Schiff, K. and Diamond, J., Identifying Barriers to Tiered Aquatic Life Uses (TALU) in Southern California, Southern California Coastal Water Research Project, Technical Report 590. June 2009. Copy included in Appendix 6.

Other scientific experts concur with Dr. Diamond's conclusions. In a recent study that examined low gradient streams in California, including sites within Reach 6 of the Santa Clara River, Raphael D. Mazor of SCCWRP stated, "Several biomonitoring efforts in California specifically target low-gradient streams, as these habitats are subject to numerous impacts and alterations, ... even though the applicability of assessment tools created and validated in high-gradient streams have not been tested."[28] The study found that, "As a consequence of these differences [substrate material, bed morphology, and distribution of microhabitats], traditional bioassessment approaches in California that were developed in high-gradient streams with diverse microhabitats have limited applications in low-gradient reaches,"[28] and, "Caution should be used when applying sampling methods for assessment tools that were calibrated for specific habitat types (e.g., high gradient streams) to new habitats (e.g., low gradient streams)."[28] The study also concluded, "....observation of the sites in this study suggests that the lack of stable microhabitats (e.g., riffles and vegetated margins) may account for the reduced number of macroinvertebrates, as few species are adapted to the shifting sandy substrate found in most low gradient streams in California."[28] Moreover, the State Water Board, Surface Water Ambient Monitoring Program, California Department of Fish and Game, and others recognize the limitations of the SoCal IBI regarding reference sites. They have identified application of TALU and the selection of more representative/appropriate regional reference locations as being necessary components to the state's bioassessment program.[23, 25]

The SoCal IBI does not inherently account for reference conditions and adequate consideration of reference sites is an essential component in application of the index. The SoCal IBI is calculated by scoring bioassessment results from a receiving water location, but a lower score does not necessarily indicate "impairment." Different types of streams would be expected to support different types of invertebrate communities. In low-gradient streams, bed substrate is typically composed of fines and sand, rather than the cobbles, boulders, or bedrock typically found in high-gradient streams. In high-gradient streams, sediments and leaf litter are typically removed with the increased flow velocities resulting in larger open spaces between rocks and cobble that provide different habitats for different types of invertebrates utilizing different feeding strategies (more predators and fewer detritus feeders). In the low-gradient streams, the sediment and leaf litter/detritus loads are naturally deposited in the channel, filling up the available spaces between rocks. These habitats support a much different population of invertebrates (more detritus feeders and fewer predators), not necessarily an "impaired" population.

In addition to not adequately addressing reference conditions for low elevation/low gradient streams, the SoCal IBI does not adequately address reference conditions for modified channels such as the Arroyo Seco Reach 1, Compton Creek, Lindero Creek Reach 1, Madea Creek Reach 2, and Walnut Creek Wash. These water bodies have significant habitat modifications that include partial channelization, elimination of riparian cover, and bank stabilization. The appropriate SoCal IBI reference index for such locations has not yet been defined.[29]

Besides not adequately considering reference conditions, the proposed listings are also not in conformance with state policy regarding association with other pollutants. The Listing Policy states:

> "A water segment shall be placed on the section 303(d) list if the water segment exhibits significant degradation in biological populations and/or communities as compared to reference site(s) and **is associated with** water or sediment concentrations of pollutants including but not limited to chemical concentrations, temperature, dissolved oxygen, and trash." [Emphasis added.]

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[28] Mazor, Raphael D.; Schiff, Kenneth; Ritter, Kerry; Rehn, Andy; and Ode, Peter; Bioassessment Tools in Novel Habitats: An Evaluation of Indices and Sampling Methods in Low-Gradient Streams in California, Enviorn. Monit. Assess., DOI 10.1007/s10661-009-1033-3. Copy included in Appendix 7.

[29] Ken Schiff, Deputy Director of the Southern California Coastal Water Research Program. Personal communication. 7/14/2009.

ATTACHMENT 1

In the fact sheets supporting its impairment decisions for each of these listings, the LA Regional Board simply identified that the low SoCal IBI scores in listed reaches co-occurred with 303(d) listed impairments. Co-occurrence does not establish an association and no attempt was made by the LA Regional Board to reasonably link the low SoCal IBI scores with a listed constituent. It is the Sanitation Districts' understanding that the intent of the Listing Policy is that listings for biological impairments only be made if there is a linkage established between a concentration of a pollutant and the biological impairment. Since no linkages were established by the LA Regional Board in the fact sheets supporting the proposed listings, the proposed listings for benthic macroinvertebrates should be removed.

Proposed Listing Revaluation

The SoCal IBI fails to adequately incorporate low gradient or modified channel reference conditions for comparison of macroinvertebrate scores in the listed reaches. Arroyo Seco, Compton Creek, Lindero Creek, Madea Creek, and Walnut Creek are extremely low gradient (less than 1%) streams with significant habitat modifications. Additionally, no reasonable association of low SoCal IBI scores with water or sediment pollutant concentration was established. Therefore, these listings do not meet the specific provisions contained in the Listing Policy for degradation of biological populations and communities. Arroyo Seco, Compton Creek, Lindero Creek, Madea Creek, and Walnut Creek should not be listed as impaired for "benthic macroinvertebrate bioassessments".

ATTACHMENT 1

FACT SHEET M

Water Body:	**Las Virgenes Creek, Malibu Creek, and Triunfo Canyon Creek Reach 2**
Pollutant:	**Benthic Macroinvertebrate Bioassessments**
Listing:	**List on 303(d) list (TMDL required list)**
Comment & Recommendation:	**Do not list –Fails to meet State Listing Policy Requirements**

The California Regional Water Quality Control Board, Los Angeles Region (LA Regional Board) is proposing new 303(d) listings for "benthic macroinvertenbrate bioassessments" be made for Las Virgenes Creek, Malibu Creek, and Triunfo Canyon Creek Reach 2, based on "poor" or "very poor" benthic macroinvertebrate scores as measured using the southern California Index of Biological Integrity (SoCal IBI).

State Water Resource Control Board Guidance

Section 3.9 of the State Water Resources Control Board Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (Listing Policy) states:

> "A water segment shall be placed on the section 303(d) list if the water segment exhibits significant degradation in biological populations and/or communities as compared to reference site(s) and **is associated with** water or sediment concentrations of pollutants including but not limited to chemical concentrations, temperature, dissolved oxygen, and trash." [Emphasis added.]

In the fact sheets supporting its impairment decisions for each of these listings, the LA Regional Board simply identified that the low SoCal IBI scores in listed reaches co-occurred with 303(d) listed impairments. Co-occurrence does not establish an association and no attempt was made by the LA Regional Board to reasonably link the low SoCal IBI scores with a listed constituent. It is the Sanitation Districts' understanding that the intent of the Listing Policy is that listings for biological impairments only be made if there is a linkage established between a concentration of a pollutant and the biological impairment. Since no linkages were established by the LA Regional Board in the fact sheets supporting the proposed listings, the proposed listings for benthic macroinvertebrates should be removed.

<u>Proposed Listing Revaluation</u>

Because the LA Regional Board failed to demonstrate a reasonable association between low SoCal IBI scores and water or sediment pollutant concentrations, the proposed listings do not meet the specific provisions contained in the Listing Policy for degradation of biological populations and communities. Therefore, Las Virgenes Creek, Malibu Creek, and Triunfo Canyon Creek Reach 2 should not be listed as impaired for "benthic macroinvertebrate bioassessments".

ATTACHMENT B

ATTACHMENT B
APPENDIX A - TABLE A1
SAN GABRIEL RIVER ESTUARY - COPPER

Sample Date	Source	Location	Qualifier	Dissolved Copper (ug/L)	Method	PQL/RL (ug/L)	Dissolved Copper Marine CCC (ug/L)	Dissolved Copper Marine CMC (ug/L)	Is Sample Usable? (1=Yes)	4-Day Average Concentration	Does Sample Exceed CCC (1=Yes)	Does Sample Exceed CMC (1=Yes)
9/12/2007	LADWP	HCS-01-001A		1.21	EPA 1640m	0.01	3.10	4.80	1	1.21		
9/12/2007	LADWP	HCS-01-002A		1.05	EPA 1640m	0.01	3.10	4.80	1	1.05		
9/12/2007	LADWP	HCS-01-002B		1.04	EPA 1640m	0.01	3.10	4.80	1	1.04		
9/12/2007	LADWP	HCS-01-003B		1.13	EPA 1640m	0.01	3.10	4.80	1	1.13		
9/12/2007	LADWP	HCS-01-RW_SGCP		1.85	EPA 1640m	0.01	3.10	4.80	1	1.85		
9/12/2007	LADWP	HCS-01-RW12		0.98	EPA 1640m	0.01	3.10	4.80	1	0.98		
9/17/2007	LADWP	HCS-02-001A		0.71	EPA 1640m	0.01	3.10	4.80	1	0.71		
9/17/2007	LADWP	HCS-02-001B		1.06	EPA 1640m	0.01	3.10	4.80	1	1.06		
9/17/2007	LADWP	HCS-02-002A		0.7	EPA 1640m	0.01	3.10	4.80	1	0.7		
9/17/2007	LADWP	HCS-02-002B		0.6	EPA 1640m	0.01	3.10	4.80	1	0.6		
9/17/2007	LADWP	HCS-02-003B		1.01	EPA 1640m	0.01	3.10	4.80	1	1.01		
9/17/2007	LADWP	HCS-02-RW_SGCP		1.97	EPA 1640m	0.01	3.10	4.80	1	1.97		
9/17/2007	LADWP	HCS-02-RW12		1.43	EPA 1640m	0.01	3.10	4.80	1	1.43		
12/4/2007	LACSD	RA2		1.16	EPA 200.8	0.5	3.10	4.80	1	1.16		
12/4/2007	LACSD	RA2		1.06	EPA 200.8	0.5	3.10	4.80	1	*		
12/4/2007	LACSD	RA2		1.18	EPA 200.8	0.5	3.10	4.80	1	1.13		
2/12/2008	LACSD	R6	E	1.34	EPA 200.8	5	3.10	4.80		**		
2/12/2008	LACSD	R7	E	1.11	EPA 200.8	5	3.10	4.80		**		
2/12/2008	LACSD	R8	E	1.33	EPA 200.8	5	3.10	4.80		**		
2/12/2008	LACSD	RA2	E	1.4	EPA 200.8	5	3.10	4.80		**		
2/29/2008	LACSD	R6		0.81	EPA 1640m	0.02	3.10	4.80	1	0.81		
2/29/2008	LACSD	R6	E	1.72	EPA 200.8	5	3.10	4.80		**		
2/29/2008	LACSD	R7		1.1	EPA 1640m	0.02	3.10	4.80	1	1.1		
2/29/2008	LACSD	R7	E	2.02	EPA 200.8	5	3.10	4.80		**		
2/29/2008	LACSD	R8		0.78	EPA 1640m	0.02	3.10	4.80	1	0.78		
2/29/2008	LACSD	R8	E	1.69	EPA 200.8	5	3.10	4.80		**		
2/29/2008	LACSD	RA2	E	1.49	EPA 200.8	5	3.10	4.80		**		
2/29/2008	LACSD	RA-2		0.66	EPA 1640m	0.02	3.10	4.80	1	0.66		
3/10/2008	LACSD	R6	E	0.73	EPA 200.8	5	3.10	4.80		**		
3/10/2008	LACSD	R7	E	0.56	EPA 200.8	5	3.10	4.80		**		
3/10/2008	LACSD	R8	E	0.55	EPA 200.8	5	3.10	4.80		**		
3/10/2008	LACSD	RA2	E	1.55	EPA 200.8	5	3.10	4.80		**		
3/11/2008	LACSD	R6		1.09	EPA 1640m	0.02	3.10	4.80	1	1.09		
3/11/2008	LACSD	R6	E	0.56	EPA 200.8	5	3.10	4.80		**		
3/11/2008	LACSD	R7		0.69	EPA 1640m	0.02	3.10	4.80	1	0.69		
3/11/2008	LACSD	R7	E	0.67	EPA 200.8	5	3.10	4.80		**		
3/11/2008	LACSD	R8		1.07	EPA 1640m	0.02	3.10	4.80	1	1.07		
3/11/2008	LACSD	R8	E	0.99	EPA 200.8	5	3.10	4.80		**		
3/11/2008	LACSD	RA2	E	1.41	EPA 200.8	5	3.10	4.80		**		
3/11/2008	LACSD	RA-2		1.85	EPA 1640m	0.02	3.10	4.80	1	1.85		
4/1/2008	LACSD	R6	E	1.95	EPA 200.8	5	3.10	4.80		**		
4/1/2008	LACSD	R7	E	1.37	EPA 200.8	5	3.10	4.80		**		
4/1/2008	LACSD	R8	E	1.38	EPA 200.8	5	3.10	4.80		**		
4/1/2008	LACSD	RA2	E	1.76	EPA 200.8	5	3.10	4.80		**		
4/9/2008	LACSD	R6		2.08	EPA 1640m	0.02	3.10	4.80	1	2.08		
4/9/2008	LACSD	R6	E	1.86	EPA 200.8	5	3.10	4.80		**		
4/9/2008	LACSD	R7		1.33	EPA 1640m	0.02	3.10	4.80	1	*		
4/9/2008	LACSD	R7		3.14	EPA 200.8	2.5	3.10	4.80	1	2.24		
4/9/2008	LACSD	R8		1.17	EPA 1640m	0.02	3.10	4.80	1	1.17		
4/9/2008	LACSD	R8	E	1.53	EPA 200.8	5	3.10	4.80		**		
4/9/2008	LACSD	RA2	E	1.41	EPA 200.8	5	3.10	4.80		**		
4/9/2008	LACSD	RA-2		1.46	EPA 1640m	0.02	3.10	4.80	1	1.46		
5/5/2008	LACSD	R6	E	1.23	EPA 200.8	5	3.10	4.80		**		
5/5/2008	LACSD	R7	E	0.69	EPA 200.8	5	3.10	4.80		**		
5/5/2008	LACSD	R8	E	1.08	EPA 200.8	5	3.10	4.80		**		
5/5/2008	LACSD	RA2	E	1.23	EPA 200.8	5	3.10	4.80		**		
5/7/2008	LACSD	R6		0.95	EPA 1640m	0.02	3.10	4.80	1	0.95		
5/7/2008	LACSD	R6	E	0.96	EPA 200.8	5	3.10	4.80		**		
5/7/2008	LACSD	R7		0.62	EPA 1640m	0.02	3.10	4.80	1	0.62		
5/7/2008	LACSD	R7	E	0.69	EPA 200.8	5	3.10	4.80		**		
5/7/2008	LACSD	R8		1.18	EPA 1640m	0.02	3.10	4.80	1	1.18		
5/7/2008	LACSD	R8	E	1.29	EPA 200.8	5	3.10	4.80		**		
5/7/2008	LACSD	RA2	E	0.88	EPA 200.8	5	3.10	4.80		**		
5/7/2008	LACSD	RA-2		0.86	EPA 1640m	0.02	3.10	4.80	1	0.86		
6/3/2008	LACSD	R6	E	1.08	EPA 200.8	5	3.10	4.80		**		

ATTACHMENT B
APPENDIX A - TABLE A1
SAN GABRIEL RIVER ESTUARY - COPPER

Sample Date	Source	Location	Qualifier	Dissolved Copper (ug/L)	Method	PQL/RL (ug/L)	Dissolved Copper Marine CCC (ug/L)	Dissolved Copper Marine CMC (ug/L)	Is Sample Usable? (1=Yes)	4-Day Average Concentration	Does Sample Exceed CCC (1=Yes)	Does Sample Exceed CMC (1=Yes)
6/3/2008	LACSD	R7	E	1.09	EPA 200.8	5	3.10	4.80		**		
6/3/2008	LACSD	R8	E	0.96	EPA 200.8	5	3.10	4.80		**		
6/3/2008	LACSD	RA2	E	0.98	EPA 200.8	5	3.10	4.80		**		
6/13/2008	LACSD	R6		1.77	EPA 1640m	0.02	3.10	4.80	1	1.77		
6/13/2008	LACSD	R6	E	1.89	EPA 200.8	5	3.10	4.80		**		
6/13/2008	LACSD	R7		1.62	EPA 1640m	0.02	3.10	4.80	1	1.62		
6/13/2008	LACSD	R7	E	1.32	EPA 200.8	5	3.10	4.80		**		
6/13/2008	LACSD	R8		1.03	EPA 1640m	0.02	3.10	4.80	1	1.03		
6/13/2008	LACSD	R8	E	1.45	EPA 200.8	5	3.10	4.80		**		
6/13/2008	LACSD	RA2	E	1.96	EPA 200.8	5	3.10	4.80		**		
6/13/2008	LACSD	RA-2		1.57	EPA 1640m	0.02	3.10	4.80	1	1.57		
7/8/2008	LACSD	R6		2.16	EPA 1640m	0.02	3.10	4.80	1	*		
7/8/2008	LACSD	R7		0.79	EPA 1640m	0.02	3.10	4.80	1	*		
7/8/2008	LACSD	R8		1.19	EPA 1640m	0.02	3.10	4.80	1	*		
7/8/2008	LACSD	RA-2		2.08	EPA 1640m	0.02	3.10	4.80	1	*		
7/9/2008	LACSD	R6		1.38	EPA 1640m	0.02	3.10	4.80	1	1.77		
7/9/2008	LACSD	R7		0.8	EPA 1640m	0.02	3.10	4.80	1	0.80		
7/9/2008	LACSD	R8		0.7	EPA 1640m	0.02	3.10	4.80	1	0.95		
7/9/2008	LACSD	RA-2		0.74	EPA 1640m	0.02	3.10	4.80	1	1.41		
7/16/2008	LACSD	R6		1.55	EPA 1640m	0.02	3.10	4.80	1	*		
7/16/2008	LACSD	R7		1.59	EPA 1640m	0.02	3.10	4.80	1	*		
7/16/2008	LACSD	R8		0.78	EPA 1640m	0.02	3.10	4.80	1	*		
7/16/2008	LACSD	RA-2		1.4	EPA 1640m	0.02	3.10	4.80	1	*		
7/17/2008	LACSD	R6		1.38	EPA 1640m	0.02	3.10	4.80	1	1.47		
7/17/2008	LACSD	R7		0.62	EPA 1640m	0.02	3.10	4.80	1	1.11		
7/17/2008	LACSD	R8		0.33	EPA 1640m	0.02	3.10	4.80	1	0.56		
7/17/2008	LACSD	RA-2		1.55	EPA 1640m	0.02	3.10	4.80	1	1.48		
7/22/2008	LACSD	R7		0.75	EPA 1640m	0.02	3.10	4.80	1	*		
7/22/2008	LACSD	R8		0.71	EPA 1640m	0.02	3.10	4.80	1	*		
7/22/2008	LACSD	RA-2		0.8	EPA 1640m	0.02	3.10	4.80	1	*		
7/25/2008	LACSD	R6		1.77	EPA 1640m	0.02	3.10	4.80	1	1.77		
7/25/2008	LACSD	R7		1.09	EPA 1640m	0.02	3.10	4.80	1	0.92		
7/25/2008	LACSD	R8		0.88	EPA 1640m	0.02	3.10	4.80	1	0.80		
7/25/2008	LACSD	RA-2		0.97	EPA 1640m	0.02	3.10	4.80	1	0.89		
7/30/2008	LACSD	R6		1.17	EPA 1640m	0.02	3.10	4.80	1	*		
7/30/2008	LACSD	R7		0.92	EPA 1640m	0.02	3.10	4.80	1	*		
7/30/2008	LACSD	R8		0.85	EPA 1640m	0.02	3.10	4.80	1	*		
7/30/2008	LACSD	RA-2		1.44	EPA 1640m	0.02	3.10	4.80	1	*		
7/31/2008	LACSD	R6		1.29	EPA 1640m	0.02	3.10	4.80	1	1.23		
7/31/2008	LACSD	R7		1.01	EPA 1640m	0.02	3.10	4.80	1	0.97		
7/31/2008	LACSD	R8		0.85	EPA 1640m	0.02	3.10	4.80	1	0.85		
7/31/2008	LACSD	RA-2		1.16	EPA 1640m	0.02	3.10	4.80	1	1.30		
8/6/2008	LACSD	R6		0.45	EPA 1640m	0.02	3.10	4.80	1	*		
8/6/2008	LACSD	R7	<	0.02	EPA 1640m	0.02	3.10	4.80	1	*		
8/6/2008	LACSD	R8	<	0.02	EPA 1640m	0.02	3.10	4.80	1	*		
8/6/2008	LACSD	RA-2		0.34	EPA 1640m	0.02	3.10	4.80	1	*		
8/7/2008	LACSD	R6		1.42	EPA 1640m	0.02	3.10	4.80	1	0.94		
8/7/2008	LACSD	R7		0.75	EPA 1640m	0.02	3.10	4.80	1	0.39		
8/7/2008	LACSD	R8		0.79	EPA 1640m	0.02	3.10	4.80	1	0.41		
8/7/2008	LACSD	RA-2		1.1	EPA 1640m	0.02	3.10	4.80	1	0.72		
8/13/2008	LACSD	R6		0.9	EPA 1640m	0.02	3.10	4.80	1	*		
8/13/2008	LACSD	R7		1.6	EPA 1640m	0.02	3.10	4.80	1	*		
8/13/2008	LACSD	R8		1.5	EPA 1640m	0.02	3.10	4.80	1	*		
8/13/2008	LACSD	RA-2		1.5	EPA 1640m	0.02	3.10	4.80	1	*		
8/14/2008	LACSD	R6		1.8	EPA 1640m	0.02	3.10	4.80	1	1.35		
8/14/2008	LACSD	R7		1.07	EPA 1640m	0.02	3.10	4.80	1	1.34		
8/14/2008	LACSD	R8		1.03	EPA 1640m	0.02	3.10	4.80	1	1.27		
8/14/2008	LACSD	RA-2		1.61	EPA 1640m	0.02	3.10	4.80	1	1.56		
8/19/2008	LACSD	R6		1.12	EPA 1640m	0.02	3.10	4.80	1	*		
8/19/2008	LACSD	R7		0.99	EPA 1640m	0.02	3.10	4.80	1	*		
8/19/2008	LACSD	R8		0.94	EPA 1640m	0.02	3.10	4.80	1	*		
8/19/2008	LACSD	RA-2		0.9	EPA 1640m	0.02	3.10	4.80	1	*		
8/20/2008	LACSD	R6		1.29	EPA 1640m	0.02	3.10	4.80	1	1.21		
8/20/2008	LACSD	R7		1.21	EPA 1640m	0.02	3.10	4.80	1	1.10		
8/20/2008	LACSD	R8		1.05	EPA 1640m	0.02	3.10	4.80	1	1.00		

ATTACHMENT B
APPENDIX A - TABLE A1
SAN GABRIEL RIVER ESTUARY - COPPER

Sample Date	Source	Location	Qualifier	Dissolved Copper (ug/L)	Method	PQL/RL (ug/L)	Dissolved Copper Marine CCC (ug/L)	Dissolved Copper Marine CMC (ug/L)	Is Sample Usable? (1=Yes)	4-Day Average Concentration	Does Sample Exceed CCC (1=Yes)	Does Sample Exceed CMC (1=Yes)
8/20/2008	LACSD	RA-2		0.99	EPA 1640m	0.02	3.10	4.80	1	0.95		
8/27/2008	LACSD	R6		0.41	EPA 1640m	0.02	3.10	4.80	1	0.41		
8/27/2008	LACSD	R7		0.65	EPA 1640m	0.02	3.10	4.80	1	0.65		
8/27/2008	LACSD	R8	<	0.02	EPA 1640m	0.02	3.10	4.80	1	0.02		
8/27/2008	LACSD	RA-2	<	0.02	EPA 1640m	0.02	3.10	4.80	1	0.02		
9/11/2008	LACSD	R6		1.16	EPA 1640m	0.2	3.10	4.80	1	1.16		
9/11/2008	LACSD	R7		0.89	EPA 1640m	0.2	3.10	4.80	1	0.89		
9/11/2008	LACSD	R8		0.92	EPA 1640m	0.2	3.10	4.80	1	0.92		
9/11/2008	LACSD	RA2		1.39	EPA 1640m	0.2	3.10	4.80	1	1.39		
10/9/2008	LACSD	R6		1.27	EPA 1640m	0.2	3.10	4.80	1	1.27		
10/9/2008	LACSD	R7		0.81	EPA 1640m	0.2	3.10	4.80	1	0.81		
10/9/2008	LACSD	R8		0.79	EPA 1640m	0.2	3.10	4.80	1	0.79		
10/9/2008	LACSD	RA2		1.35	EPA 1640m	0.2	3.10	4.80	1	1.35		
11/12/2008	LACSD	R6		1.24	EPA 1640m	0.2	3.10	4.80	1	1.24		
11/12/2008	LACSD	R7		1.14	EPA 1640m	0.2	3.10	4.80	1	1.14		
11/12/2008	LACSD	R8		1.06	EPA 1640m	0.2	3.10	4.80	1	1.06		
11/12/2008	LACSD	RA2		0.54	EPA 1640m	0.2	3.10	4.80	1	0.54		
12/30/2008	LACSD	R6		2.3	EPA 1640m	0.2	3.10	4.80	1	2.3		
12/30/2008	LACSD	R7		0.8	EPA 1640m	0.2	3.10	4.80	1	0.8		
12/30/2008	LACSD	R8		1	EPA 1640m	0.2	3.10	4.80	1	1		
12/30/2008	LACSD	RA2		2.1	EPA 1640m	0.2	3.10	4.80	1	2.1		
1/20/2009	LACSD	R6		1.6	EPA 1640m	0.2	3.10	4.80	1	1.6		
1/20/2009	LACSD	R7		1.4	EPA 1640m	0.2	3.10	4.80	1	1.4		
1/20/2009	LACSD	R8		1.1	EPA 1640m	0.2	3.10	4.80	1	1.1		
1/20/2009	LACSD	RA2		1.4	EPA 1640m	0.2	3.10	4.80	1	1.4		
2/26/2009	LACSD	R6		1.81	EPA 1640m	0.2	3.10	4.80	1	1.81		
2/26/2009	LACSD	R7		1.22	EPA 1640m	0.2	3.10	4.80	1	1.22		
2/26/2009	LACSD	R8		0.73	EPA 1640m	0.2	3.10	4.80	1	0.73		
2/26/2009	LACSD	RA2		1.75	EPA 1640m	0.2	3.10	4.80	1	1.75		

LACSD - Los Angeles County Sanitation Districts
LADWP - Los Angeles Department of Water and Power

* - Data is used in calculation of a 4 day average
** Data not usable

0 of 90 4-day averages exceed
Criterion Continuous Concentration (CCC)

0 of 120 4-day averages exceed
Criterion Maximum Concentration (CMC)

ATTACHMENT B

APPENDIX B - TABLE B1

COYOTE CREEK - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (F)	CMC (mg/L)	Does Sample Exceed CMC (1=Yes)	SSO Adjusted 4-Day Average CCC	Does Sample Exceed 4-Day CCC (1=Yes)
3/29/2004	LACSD	R9E		0.50	0.50	0.10	8.16	72.5	6.19		2.33	
4/6/2004	LACSD	R9E		0.50	0.50	0.10	8.37	66.9	4.12		2.02	
4/13/2004	LACSD	R9E		1.30	1.30	0.10	8.69	72.2	2.24		0.98	1
4/20/2004	LACSD	R9E		0.90	0.90	0.10	8.50	71.2	3.20		1.39	
4/28/2004	LACSD	R9E		0.30	0.30	0.10	9.20	73.1	0.99		0.44	
5/5/2004	LACSD	R9E		0.70	0.70	0.10	8.58	75.8	2.75		1.03	
5/11/2004	LACSD	R9E		1.20	1.20	0.10	8.50	77.2	3.20		1.12	1
5/18/2004	LACSD	R9E		0.80	0.80	0.10	8.71	76.2	2.16		0.82	
5/25/2004	LACSD	R9E	<	0.10	0.10	0.10	8.67	70.3	2.33		1.08	
6/1/2004	LACSD	R9E		0.30	0.30	0.10	8.61	75.9	2.60		0.98	
6/8/2004	LACSD	R9E	<	0.10	0.10	0.10	8.43	70.0	3.66		1.64	
6/15/2004	LACSD	R9E	<	0.10	0.10	0.10	8.28	69.4	4.90		2.15	
6/22/2004	LACSD	R9E	<	0.10	0.10	0.10	7.92	67.5	9.76		3.97	
6/29/2004	LACSD	R9E	<	0.10	*	0.10	7.77	80.1	12.80		*	
6/29/2004	LACSD	R9E		0.50	0.30	0.10	9.16	74.1	1.05		1.76	
7/6/2004	LACSD	R9E	<	0.10	0.10	0.10	8.32	74.1	4.53		1.70	
7/13/2004	LACSD	R9E		0.70	0.70	0.10	8.49	77.5	3.26		1.13	
7/20/2004	LACSD	R9E		0.30	0.30	0.10	8.43	77.2	3.66		1.26	
7/27/2004	LACSD	R9E	<	0.10	0.10	0.10	8.79	70.2	1.88		0.89	
8/3/2004	LACSD	R9E		0.60	0.60	0.10	8.44	81.5	3.59		1.07	
8/10/2004	LACSD	R9E		2.00	2.00	0.10	8.12	79.0	6.69		1.97	1
8/17/2004	LACSD	R9E		1.10	1.10	0.10	8.39	79.0	3.96		1.27	
8/24/2004	LACSD	R9E		1.20	1.20	0.10	8.32	80.5	4.53		1.35	
8/31/2004	LACSD	R9E		1.30	1.30	0.10	8.29	79.7	4.81		1.46	
9/7/2004	LACSD	R9E		0.50	0.50	0.10	8.34	78.1	4.36		1.42	
9/14/2004	LACSD	R9E		1.20	1.20	0.10	8.27	78.1	5.00		1.60	
9/20/2004	LACSD	R9E		1.30	1.30	0.10	8.45	80.8	3.53		1.07	1
9/28/2004	LACSD	R9E		1.00	1.00	0.10	7.96	75.2	9.06		2.85	
10/4/2004	LACSD	R9E		0.90	0.90	0.10	7.85	74.8	11.10		3.36	
10/13/2004	LACSD	R9E		0.70	0.70	0.10	8.69	81.1	2.24		0.71	
10/26/2004	LACSD	R9E		0.70	0.70	0.10	8.16	68.4	6.19		2.70	
11/1/2004	LACSD	R9E		0.90	0.90	0.10	8.54	71.3	2.97		1.30	
11/8/2004	LACSD	R9E		0.90	0.90	0.10	8.49	74.1	3.26		1.28	
11/15/2004	LACSD	R9E		0.70	0.70	0.10	8.47	74.2	3.39		1.32	
11/22/2004	LACSD	R9E		0.70	0.70	0.10	8.41	66.4	3.81		1.93	
11/30/2004	LACSD	R9E		0.90	0.90	0.10	8.27	64.3	5.00		2.62	
12/7/2004	LACSD	R9E		2.80	2.80	0.10	8.13	66.2	6.56		3.06	
12/13/2004	LACSD	R9E		0.40	0.40	0.10	8.52	68.8	3.08		1.47	
12/21/2004	LACSD	R9E		0.70	0.70	0.10	8.34	71.1	4.36		1.83	
12/27/2004	LACSD	R9E		0.50	0.50	0.10	8.71	65.7	2.16		1.19	
1/25/2005	LACSD	R9E		0.50	0.50	0.10	8.16	68.8	6.19		2.66	
1/31/2005	LACSD	R9E		0.50	0.50	0.10	8.07	69.5	7.36		2.98	
2/8/2005	LACSD	R9E		0.20	0.20	0.10	8.45	68.2	3.53		1.69	
2/14/2005	LACSD	R9E		0.30	0.30	0.10	8.11	68.2	6.82		2.94	
3/1/2005	LACSD	R9E		0.70	0.70	0.10	8.30	73.3	4.71		1.81	
3/8/2005	LACSD	R9E		0.40	0.40	0.10	8.31	69.1	4.62		2.07	
3/15/2005	LACSD	R9E	<	0.10	0.10	0.10	8.10	67.9	6.95		3.02	
3/22/2005	LACSD	R9E		0.30	0.30	0.10	7.97	70.7	8.90		3.31	
3/30/2005	LACSD	R9E		0.40	0.40	0.10	8.04	69.4	7.79		3.13	
4/5/2005	LACSD	R9E		0.30	0.30	0.10	8.39	69.7	3.96		1.77	
4/12/2005	LACSD	R9E	<	0.10	0.10	0.10	8.50	72.1	3.20		1.35	
4/19/2005	LACSD	R9E	<	0.10	0.10	0.10	8.35	68.9	4.28		1.95	
4/26/2005	LACSD	R9E		0.40	0.40	0.10	8.26	73.4	5.10		1.92	
5/3/2005	LACSD	R9E		0.40	0.40	0.10	8.45	76.9	3.53		1.24	
5/9/2005	LACSD	R9E		0.60	0.60	0.10	8.30	69.8	4.71		2.05	
5/17/2005	LACSD	R9E		4.20	4.20	0.10	8.29	72.0	4.81		1.92	1
5/24/2005	LACSD	R9E		0.10	0.10	0.10	8.41	72.2	3.81		1.56	
5/31/2005	LACSD	R9E		0.40	0.40	0.10	8.15	69.7	6.31		2.62	
6/7/2005	LACSD	R9E	<	0.10	0.10	0.10	8.46	71.3	3.46		1.48	

ATTACHMENT B
APPENDIX B - TABLE B1
COYOTE CREEK - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (F)	CMC (mg/L)	Does Sample Exceed CMC (1=Yes)	SSO Adjusted 4-Day Average CCC	Does Sample Exceed 4-Day CCC (1=Yes)
6/14/2005	LACSD	R9E	<	0.10	0.10	0.10	8.20	72.3	5.73		2.20	
6/21/2005	LACSD	R9E	<	0.10	0.10	0.10	8.51	78.1	3.14		1.07	
6/28/2005	LACSD	R9E	<	0.10	0.10	0.10	8.08	70.0	7.22		2.89	
7/5/2005	LACSD	R9E		0.40	0.40	0.10	8.37	77.7	4.12		1.37	
7/12/2005	LACSD	R9E		0.30	0.30	0.10	8.32	76.3	4.53		1.57	
7/19/2005	LACSD	R9E		0.50	0.50	0.10	8.08	77.9	7.22		2.17	
7/26/2005	LACSD	R9E	<	0.10	0.10	0.10	8.69	85.8	2.24		0.60	
8/2/2005	LACSD	R9E		0.30	0.30	0.10	8.15	72.9	6.31		2.33	
8/9/2005	LACSD	R9E		0.40	0.40	0.10	8.59	82.8	2.70		0.79	
8/16/2005	LACSD	R9E	<	0.10	0.10	0.10	8.22	71.6	5.51		2.19	
8/23/2005	LACSD	R9E	<	0.10	0.10	0.10	8.65	76.0	2.42		0.91	
8/30/2005	LACSD	R9E		0.60	0.60	0.10	8.41	75.9	3.81		1.37	
9/6/2005	LACSD	R9E		7.20	7.20	0.10	8.22	79.2	5.51	1	1.67	1
9/15/2005	LACSD	R9E	<	0.10	0.10	0.10	8.58	72.5	2.75		1.16	
9/23/2005	LACSD	R9E		0.20	0.20	0.10	8.16	73.0	6.19		2.29	
9/28/2005	LACSD	R9E		0.10	0.10	0.10	8.52	71.1	3.08		1.35	
10/4/2005	LACSD	R9E		0.50	0.50	0.10	8.16	75.4	6.19		2.10	
10/11/2005	LACSD	R9E		3.30	3.30	0.10	8.32	77.4	4.53		1.51	1
10/25/2005	LACSD	R9E		0.20	0.20	0.10	8.34	67.5	4.36		2.08	
11/1/2005	LACSD	R9E		0.20	0.20	0.10	8.56	68.0	2.86		1.41	
11/15/2005	LACSD	R9E		0.50	0.50	0.10	8.24	73.9	5.30		1.95	
11/21/2005	LACSD	R9E		0.60	0.60	0.10	8.49	73.0	3.26		1.33	
11/29/2005	LACSD	R9E		0.40	0.40	0.10	8.19	67.3	5.84		2.68	
12/6/2005	LACSD	R9E		1.10	1.10	0.10	8.44	69.3	3.59		1.65	
12/13/2005	LACSD	R9E		0.50	0.50	0.10	8.28	67.6	4.90		2.29	
12/19/2005	LACSD	R9E		2.90	2.90	0.10	8.39	71.1	3.96		1.68	1
12/28/2005	LACSD	R9E		0.60	0.60	0.10	8.32	67.6	4.53		2.14	
1/5/2006	LACSD	R9E		0.80	0.80	0.10	8.06	70.2	7.50		2.95	
1/10/2006	LACSD	R9E		0.50	0.50	0.10	8.22	67.3	5.51		2.55	
1/17/2006	LACSD	R9E	<	0.10	0.10	0.10	8.27	50.9	5.00		4.23	
1/24/2006	LACSD	R9E		0.30	0.30	0.10	8.26	61.3	5.10		2.97	
1/31/2006	LACSD	R9E		0.30	0.30	0.10	9.01	69.6	1.30		0.65	
2/7/2006	LACSD	R9E		0.50	0.50	0.10	8.38	68.2	4.04		1.90	
2/14/2006	LACSD	R9E		0.20	0.20	0.10	8.70	66.7	2.20		1.17	
2/23/2006	LACSD	R9E		0.60	*	0.10	8.15	66.0	6.31		*	
2/27/2006	LACSD	R9E		0.70	0.65	0.10	8.23	69.1	5.40		2.67	
3/9/2006	LACSD	R9E		0.40	0.40	0.10	8.27	69.4	5.00		2.18	
3/14/2006	LACSD	R9E		0.60	0.60	0.10	8.18	64.4	5.95		3.02	
3/23/2006	LACSD	R9E		0.60	*	0.10	8.22	66.4	5.51		*	
3/27/2006	LACSD	R9E		0.50	0.55	0.10	8.73	70.3	2.09		1.81	
4/3/2006	LACSD	R9E		0.65	0.65	0.10	8.47	65.1	3.39		1.82	
4/10/2006	LACSD	R9E		0.48	0.48	0.10	8.39	70.9	3.96		1.69	
4/17/2006	LACSD	R9E		0.36	0.36	0.10	8.49	64.8	3.26		1.78	
4/25/2006	LACSD	R9E		0.80	0.80	0.10	8.90	73.5	1.56		0.67	1
5/1/2006	LACSD	R9E		0.78	0.78	0.10	8.05	72.9	7.65		2.72	
5/9/2006	LACSD	R9E		0.50	0.50	0.10	8.33	71.8	4.45		1.81	
5/16/2006	LACSD	R9E		0.30	0.30	0.10	8.37	71.8	4.12		1.70	
5/25/2006	LACSD	R9E		0.63	0.63	0.10	8.37	82.0	4.12		1.18	
5/30/2006	LACSD	R9E		0.61	0.61	0.10	8.35	75.6	4.28		1.53	
6/6/2006	LACSD	R9E		0.89	0.89	0.10	8.27	75.2	5.00		1.77	
6/13/2006	LACSD	R9E		0.26	0.26	0.10	8.66	77.5	2.37		0.85	
6/20/2006	LACSD	R9E		0.21	0.21	0.10	8.57	77.5	2.80		0.99	
6/27/2006	LACSD	R9E		0.59	0.59	0.10	8.57	76.3	2.80		1.03	
7/5/2006	LACSD	R9E		0.24	0.24	0.10	9.02	88.0	1.28		0.33	
7/11/2006	LACSD	R9E		0.25	0.25	0.10	8.55	81.1	2.91		0.90	
7/20/2006	LACSD	R9E		0.26	0.26	0.10	8.83	86.4	1.75		0.47	
7/25/2006	LACSD	R9E		0.17	0.17	0.10	8.58	85.8	2.75		0.72	
8/1/2006	LACSD	R9E	<	0.10	0.10	0.10	8.56	74.6	2.86		1.11	
8/8/2006	LACSD	R9E		0.24	0.24	0.10	8.91	82.0	1.53		0.48	

ATTACHMENT B

APPENDIX B - TABLE B1

COYOTE CREEK - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (F)	CMC (mg/L)	Does Sample Exceed CMC (1=Yes)	SSO Adjusted 4-Day Average CCC	Does Sample Exceed 4-Day CCC (1=Yes)
8/15/2006	LACSD	R9E	<	0.10	0.10	0.10	8.25	70.0	5.20		2.21	
8/22/2006	LACSD	R9E	<	0.10	0.10	0.10	8.64	76.3	2.46		0.92	
8/29/2006	LACSD	R9E		0.24	0.24	0.10	8.64	76.3	2.46		0.92	
9/5/2006	LACSD	R9E		0.18	0.18	0.10	8.53	75.5	3.03		1.13	
9/12/2006	LACSD	R9E		0.23	0.23	0.10	8.58	74.6	2.75		1.08	
9/19/2006	LACSD	R9E		0.10	0.10	0.10	8.60	65.9	2.65		1.42	
3/29/2004	LACSD	RA		0.40	0.40	0.10	7.84	72.5	11.30		3.69	
4/6/2004	LACSD	RA		1.00	1.00	0.10	8.48	67.5	3.33		1.64	
4/13/2004	LACSD	RA		1.40	1.40	0.10	8.66	73.1	2.37		0.99	1
4/20/2004	LACSD	RA		1.50	1.50	0.10	8.36	72.9	4.20		1.66	
4/28/2004	LACSD	RA		1.30	1.30	0.10	8.35	73.8	4.28		1.63	
5/5/2004	LACSD	RA		1.30	1.30	0.10	8.49	79.4	3.26		1.06	1
5/11/2004	LACSD	RA		0.30	0.30	0.10	8.43	76.8	3.66		1.28	
5/18/2004	LACSD	RA		1.70	1.70	0.10	8.45	77.5	3.53		1.21	1
5/25/2004	LACSD	RA		0.20	0.20	0.10	8.67	71.9	2.33		1.02	
6/1/2004	LACSD	RA		0.20	0.20	0.10	8.47	75.0	3.39		1.28	
6/8/2004	LACSD	RA	<	0.10	0.10	0.10	8.33	70.3	4.45		1.91	
6/15/2004	LACSD	RA		0.40	0.40	0.10	8.14	71.6	6.43		2.48	
6/22/2004	LACSD	RA		0.40	0.40	0.10	7.67	69.3	15.19		5.06	
6/29/2004	LACSD	RA		1.00	1.00	0.10	8.94	80.2	1.46		0.49	1
7/6/2004	LACSD	RA		1.40	1.40	0.10	8.23	75.0	5.40		1.91	
7/13/2004	LACSD	RA		0.80	0.80	0.10	8.42	76.7	3.74		1.31	
7/20/2004	LACSD	RA		0.70	0.70	0.10	8.24	79.9	5.30		1.57	
7/27/2004	LACSD	RA		0.50	0.50	0.10	8.55	80.2	2.91		0.93	
8/3/2004	LACSD	RA		0.80	0.80	0.10	8.23	81.9	5.40		1.49	
8/10/2004	LACSD	RA		1.10	1.10	0.10	8.37	77.2	4.12		1.40	
8/17/2004	LACSD	RA		1.50	1.50	0.10	8.26	80.3	5.10		1.50	
8/24/2004	LACSD	RA		1.50	1.50	0.10	8.01	82.6	8.25		2.04	
8/31/2004	LACSD	RA		1.80	1.80	0.10	8.15	81.0	6.31		1.75	1
9/7/2004	LACSD	RA		0.90	0.90	0.10	8.21	80.2	5.62		1.63	
9/14/2004	LACSD	RA		0.40	0.40	0.10	8.44	74.5	3.59		1.37	
9/20/2004	LACSD	RA		1.50	1.50	0.10	8.22	81.2	5.51		1.55	
9/28/2004	LACSD	RA		1.10	1.10	0.10	7.92	76.9	9.76		2.84	
10/4/2004	LACSD	RA		1.00	1.00	0.10	8.04	76.3	7.79		2.44	
10/13/2004	LACSD	RA		0.90	0.90	0.10	8.03	78.4	7.94		2.30	
10/26/2004	LACSD	RA		1.00	1.00	0.10	8.01	72.0	8.25		2.98	
11/1/2004	LACSD	RA		1.10	1.10	0.10	7.99	73.8	8.57		2.88	
11/8/2004	LACSD	RA		1.00	1.00	0.10	8.20	74.5	5.73		2.04	
11/15/2004	LACSD	RA		0.50	0.50	0.10	8.46	70.9	3.46		1.51	
11/22/2004	LACSD	RA		1.00	1.00	0.10	8.18	71.5	5.95		2.34	
11/30/2004	LACSD	RA		1.00	1.00	0.10	8.25	64.8	5.20		2.66	
12/7/2004	LACSD	RA		2.50	2.50	0.10	8.07	68.6	7.36		3.08	
12/13/2004	LACSD	RA		0.70	0.70	0.10	8.29	71.8	4.81		1.94	
12/21/2004	LACSD	RA		1.00	1.00	0.10	8.15	71.4	6.31		2.46	
12/27/2004	LACSD	RA		0.80	0.80	0.10	8.48	66.4	3.33		1.71	
1/18/2005	LACSD	RA		0.30	0.30	0.10	8.27	68.4	5.00		2.26	
1/25/2005	LACSD	RA		0.60	0.60	0.10	7.97	69.3	8.90		3.48	
1/31/2005	LACSD	RA		0.60	0.60	0.10	8.05	71.3	7.65		2.88	
2/8/2005	LACSD	RA		0.30	0.30	0.10	8.13	67.9	6.56		2.88	
2/14/2005	LACSD	RA		0.40	0.40	0.10	8.15	70.5	6.31		2.54	
3/1/2005	LACSD	RA		0.40	0.40	0.10	8.24	68.2	5.30		2.39	
3/8/2005	LACSD	RA		0.50	0.50	0.10	8.12	69.5	6.69		2.76	
3/15/2005	LACSD	RA		0.40	0.40	0.10	8.06	69.3	7.50		3.05	
3/22/2005	LACSD	RA		0.20	0.20	0.10	7.95	70.9	9.23		3.38	
3/30/2005	LACSD	RA		0.40	0.40	0.10	8.13	68.9	6.56		2.78	
4/5/2005	LACSD	RA		0.20	0.20	0.10	8.14	62.8	6.43		3.41	
4/12/2005	LACSD	RA	<	0.10	0.10	0.10	8.32	68.9	4.53		2.05	
4/19/2005	LACSD	RA		0.20	0.20	0.10	8.33	68.9	4.45		2.01	
4/26/2005	LACSD	RA		0.20	0.20	0.10	8.43	70.4	3.66		1.61	

APPENDIX B - TABLE B1

COYOTE CREEK - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (F)	CMC (mg/L)	Does Sample Exceed CMC (1=Yes)	SSO Adjusted 4-Day Average CCC	Does Sample Exceed 4-Day CCC (1=Yes)
5/3/2005	LACSD	RA	<	0.10	0.10	0.10	8.64	72.5	2.46		1.05	
5/9/2005	LACSD	RA		0.50	0.50	0.10	8.10	71.4	6.95		2.66	
5/17/2005	LACSD	RA		4.50	4.50	0.10	8.16	72.9	6.19		2.30	1
5/24/2005	LACSD	RA	<	0.10	0.10	0.10	8.46	70.6	3.46		1.52	
5/31/2005	LACSD	RA		0.30	0.30	0.10	8.35	67.1	4.28		2.08	
6/7/2005	LACSD	RA	<	0.10	0.10	0.10	8.58	71.8	2.75		1.19	
6/14/2005	LACSD	RA		0.20	0.20	0.10	8.19	72.5	5.84		2.22	
6/21/2005	LACSD	RA		0.30	0.30	0.10	8.41	79.4	3.81		1.21	
6/28/2005	LACSD	RA		0.20	0.20	0.10	7.99	73.6	8.57		2.90	
7/5/2005	LACSD	RA	<	0.10	0.10	0.10	8.67	74.8	2.33		0.92	
7/12/2005	LACSD	RA		0.60	0.60	0.10	8.17	77.0	6.07		1.95	
7/19/2005	LACSD	RA		0.70	0.70	0.10	8.00	78.8	8.41		2.37	
7/26/2005	LACSD	RA		0.20	0.20	0.10	8.60	85.5	2.65		0.70	
8/2/2005	LACSD	RA		0.40	0.40	0.10	8.22	73.8	5.51		2.02	
8/9/2005	LACSD	RA		0.40	0.40	0.10	8.41	84.6	3.81		1.00	
8/23/2005	LACSD	RA		0.40	0.40	0.10	8.47	77.0	3.39		1.19	
8/30/2005	LACSD	RA		0.40	0.40	0.10	8.58	75.7	2.75		1.04	
9/6/2005	LACSD	RA		7.30	7.30	0.10	8.16	80.1	6.19	1	1.78	1
9/15/2005	LACSD	RA	<	0.10	0.10	0.10	8.58	74.1	2.75		1.10	
9/23/2005	LACSD	RA		0.40	0.40	0.10	8.16	76.3	6.19		2.03	
9/28/2005	LACSD	RA		0.30	0.30	0.10	8.43	75.0	3.66		1.37	
10/4/2005	LACSD	RA		0.50	0.50	0.10	8.10	74.3	6.95		2.40	
10/11/2005	LACSD	RA		2.20	2.20	0.10	8.36	75.6	4.20		1.51	1
10/25/2005	LACSD	RA		0.40	0.40	0.10	8.09	70.2	7.08		2.82	
11/1/2005	LACSD	RA		0.20	0.20	0.10	8.60	70.9	2.65		1.19	
11/15/2005	LACSD	RA		0.60	0.60	0.10	8.30	74.1	4.71		1.76	
11/21/2005	LACSD	RA		0.70	0.70	0.10	8.44	72.3	3.59		1.48	
11/29/2005	LACSD	RA		0.50	0.50	0.10	8.04	70.2	7.79		3.04	
12/6/2005	LACSD	RA		0.50	0.50	0.10	8.28	64.4	4.90		2.57	
12/13/2005	LACSD	RA		0.40	0.40	0.10	8.27	68.2	5.00		2.28	
12/19/2005	LACSD	RA		0.40	0.40	0.10	8.13	67.6	6.56		2.91	
12/28/2005	LACSD	RA		0.80	0.80	0.10	8.17	69.1	6.07		2.59	
1/5/2006	LACSD	RA		1.10	1.10	0.10	7.91	72.1	9.95		3.42	
1/10/2006	LACSD	RA		0.60	0.60	0.10	8.04	70.7	7.79		2.99	
1/17/2006	LACSD	RA		0.40	0.40	0.10	8.17	62.8	6.07		3.25	
1/24/2006	LACSD	RA		0.70	0.70	0.10	8.17	66.0	6.07		2.90	
1/31/2006	LACSD	RA		0.50	0.50	0.10	8.03	69.6	7.94		3.15	
2/7/2006	LACSD	RA		0.80	0.80	0.10	8.25	69.6	5.20		2.24	
2/14/2006	LACSD	RA		0.40	0.40	0.10	8.24	66.0	5.30		2.59	
2/23/2006	LACSD	RA		0.50	*	0.10	8.22	64.9	5.51		*	
2/27/2006	LACSD	RA		0.70	0.60	0.10	7.91	69.1	9.95		3.29	
3/9/2006	LACSD	RA		0.60	0.60	0.10	8.05	71.4	7.65		2.87	
3/14/2006	LACSD	RA		0.50	0.50	0.10	8.22	66.0	5.51		2.67	
3/23/2006	LACSD	RA		0.60	*	0.10	8.22	66.7	5.51		*	
3/27/2006	LACSD	RA		0.90	0.75	0.10	8.45	71.4	3.53		2.06	
4/3/2006	LACSD	RA		1.10	1.10	0.10	8.10	67.8	6.95		3.03	
4/10/2006	LACSD	RA		0.57	0.57	0.10	8.18	71.8	5.95		2.32	
4/17/2006	LACSD	RA		0.71	0.71	0.10	8.17	70.2	6.07		2.49	
4/25/2006	LACSD	RA		0.94	0.94	0.10	8.67	73.5	2.33		0.96	
5/1/2006	LACSD	RA		0.46	0.46	0.10	8.23	70.5	5.40		2.24	
5/9/2006	LACSD	RA		0.60	0.60	0.10	8.31	73.8	4.62		1.75	
5/16/2006	LACSD	RA		0.40	0.40	0.10	8.27	73.8	5.00		1.86	
5/25/2006	LACSD	RA		1.00	1.00	0.10	8.15	77.7	6.31		1.97	
5/30/2006	LACSD	RA		0.97	0.97	0.10	8.07	76.8	7.36		2.30	
6/6/2006	LACSD	RA		1.10	1.10	0.10	8.09	76.5	7.08		2.25	
6/13/2006	LACSD	RA		0.87	0.87	0.10	8.37	77.9	4.12		1.36	
6/20/2006	LACSD	RA		0.90	0.90	0.10	8.20	79.5	5.73		1.70	
6/26/2006	LACSD	RA		0.56	*	0.10	8.10	77.5	6.95		*	
6/27/2006	LACSD	RA		0.80	0.68	0.10	8.35	86.9	4.28		1.58	

APPENDIX B - TABLE B1

COYOTE CREEK - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (F)	CMC (mg/L)	Does Sample Exceed CMC (1=Yes)	SSO Adjusted 4-Day Average CCC	Does Sample Exceed 4-Day CCC (1=Yes)
7/5/2006	LACSD	RA		0.43	0.43	0.10	8.90	81.1	1.56		0.51	
7/11/2006	LACSD	RA		0.26	0.26	0.10	8.66	87.6	2.37		0.59	
7/20/2006	LACSD	RA		0.39	0.39	0.10	8.78	85.3	1.91		0.53	
7/25/2006	LACSD	RA		0.22	0.22	0.10	8.63	75.1	2.51		0.97	
8/1/2006	LACSD	RA		0.20	0.20	0.10	8.81	80.6	1.81		0.59	
8/8/2006	LACSD	RA		0.32	0.32	0.10	8.66	69.6	2.37		1.13	
8/15/2006	LACSD	RA	<	0.10	0.10	0.10	8.50	77.0	3.20		1.13	
8/22/2006	LACSD	RA	<	0.10	0.10	0.10	8.67	77.5	2.33		0.83	
8/29/2006	LACSD	RA		0.42	0.42	0.10	8.62	76.3	2.55		0.95	
9/5/2006	LACSD	RA		0.13	0.13	0.10	8.58	76.1	2.75		1.02	
9/12/2006	LACSD	RA		0.52	0.52	0.10	8.25	72.6	5.20		2.01	
9/19/2006	LACSD	RA		0.36	0.36	0.10	8.45	75.0	3.53		1.32	
10/24/2006	LACSD	RA	<	0.10	0.10	0.10	8.08	74.1	7.22		2.49	
11/21/2006	LACSD	RA		1.90	1.90	0.10	8.00	72.1	8.41		3.01	
12/14/2006	LACSD	RA		0.91	0.91	0.10	8.13	74.1	6.56		2.31	
1/9/2007	LACSD	RA		0.86	0.86	0.10	7.82	67.1	11.71		4.60	
2/22/2007	LACSD	RA		0.71	0.71	0.10	7.74	69.5	13.48		4.65	
3/29/2004	LACSD	RA1	<	0.10	0.10	0.10	8.64	65.8	2.46		1.33	
4/6/2004	LACSD	RA1	<	0.10	0.10	0.10	8.71	63.5	2.16		1.29	
4/13/2004	LACSD	RA1	<	0.10	0.10	0.10	9.07	70.7	1.19		0.57	
4/20/2004	LACSD	RA1		0.70	0.70	0.10	8.85	68.4	1.69		0.86	
4/28/2004	LACSD	RA1	<	0.10	0.10	0.10	8.86	70.0	1.66		0.80	
5/5/2004	LACSD	RA1	<	0.10	0.10	0.10	8.86	79.9	1.66		0.56	
5/11/2004	LACSD	RA1	<	0.10	0.10	0.10	8.82	76.8	1.78		0.67	
5/18/2004	LACSD	RA1	<	0.10	0.10	0.10	8.92	76.5	1.51		0.58	
5/25/2004	LACSD	RA1	<	0.10	0.10	0.10	8.79	69.7	1.88		0.91	
6/1/2004	LACSD	RA1	<	0.10	0.10	0.10	8.44	74.3	3.59		1.38	
6/8/2004	LACSD	RA1	<	0.10	0.10	0.10	8.62	70.3	2.55		1.17	
6/15/2004	LACSD	RA1	<	0.10	0.10	0.10	8.55	69.8	2.91		1.35	
6/22/2004	LACSD	RA1	<	0.10	0.10	0.10	8.13	66.9	6.56		2.99	
6/29/2004	LACSD	RA1	<	0.10	0.10	0.10	9.02	80.6	1.28		0.43	
7/6/2004	LACSD	RA1	<	0.10	0.10	0.10	8.37	72.7	4.12		1.64	
7/13/2004	LACSD	RA1		0.10	0.10	0.10	8.64	75.4	2.46		0.95	
7/20/2004	LACSD	RA1	<	0.10	0.10	0.10	8.46	74.8	3.46		1.31	
7/27/2004	LACSD	RA1	<	0.10	0.10	0.10	8.90	79.7	1.56		0.53	
8/3/2004	LACSD	RA1	<	0.10	0.10	0.10	8.86	80.6	1.66		0.55	
8/10/2004	LACSD	RA1	<	0.10	0.10	0.10	8.58	71.6	2.75		1.20	
8/17/2004	LACSD	RA1	<	0.10	0.10	0.10	8.80	74.3	1.84		0.76	
8/24/2004	LACSD	RA1	<	0.10	0.10	0.10	8.92	78.1	1.51		0.55	
8/31/2004	LACSD	RA1	<	0.10	0.10	0.10	8.73	76.8	2.09		0.77	
9/7/2004	LACSD	RA1	<	0.10	0.10	0.10	8.63	74.8	2.51		0.98	
9/14/2004	LACSD	RA1	<	0.10	0.10	0.10	8.63	74.3	2.51		1.00	
9/20/2004	LACSD	RA1		0.20	0.20	0.10	9.04	77.8	1.24		0.46	
9/28/2004	LACSD	RA1	<	0.10	0.10	0.10	8.24	67.1	5.30		2.49	
10/4/2004	LACSD	RA1	<	0.10	0.10	0.10	8.43	65.7	3.66		1.91	
10/13/2004	LACSD	RA1	<	0.10	0.10	0.10	8.50	72.0	3.20		1.35	
10/26/2004	LACSD	RA1	<	0.10	0.10	0.10	8.33	61.7	4.45		2.61	
11/1/2004	LACSD	RA1	<	0.10	0.10	0.10	8.61	64.9	2.60		1.45	
11/8/2004	LACSD	RA1	<	0.10	0.10	0.10	9.07	66.7	1.19		0.66	
11/15/2004	LACSD	RA1	<	0.10	0.10	0.10	8.67	65.7	2.33		1.27	
11/22/2004	LACSD	RA1	<	0.10	0.10	0.10	8.63	59.0	2.51		1.73	
11/30/2004	LACSD	RA1		0.90	0.90	0.10	8.61	49.3	2.60		2.53	
12/7/2004	LACSD	RA1	<	0.10	0.10	0.10	8.76	54.2	1.98		1.66	
12/13/2004	LACSD	RA1	<	0.10	0.10	0.10	8.72	63.5	2.13		1.27	
12/21/2004	LACSD	RA1	<	0.10	0.10	0.10	8.84	63.0	1.72		1.06	
12/27/2004	LACSD	RA1	<	0.10	0.10	0.10	8.88	55.2	1.61		1.32	
1/18/2005	LACSD	RA1	<	0.10	0.10	0.10	8.56	62.8	2.86		1.70	
1/25/2005	LACSD	RA1	<	0.10	0.10	0.10	8.35	61.4	4.28		2.55	
1/31/2005	LACSD	RA1	<	0.10	0.10	0.10	8.48	61.7	3.33		2.02	

ATTACHMENT B
APPENDIX B - TABLE B1
COYOTE CREEK - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (F)	CMC (mg/L)	Does Sample Exceed CMC (1=Yes)	SSO Adjusted 4-Day Average CCC	Does Sample Exceed 4-Day CCC (1=Yes)
2/8/2005	LACSD	RA1	<	0.10	0.10	0.10	8.47	57.2	3.39		2.42	
2/14/2005	LACSD	RA1	<	0.10	0.10	0.10	8.59	62.6	2.70		1.63	
3/1/2005	LACSD	RA1	<	0.10	0.10	0.10	8.44	65.2	3.59		1.91	
3/8/2005	LACSD	RA1	<	0.10	0.10	0.10	8.34	64.1	4.36		2.35	
3/15/2005	LACSD	RA1	<	0.10	0.10	0.10	8.35	63.5	4.28		2.36	
3/22/2005	LACSD	RA1	<	0.10	0.10	0.10	8.37	70.3	4.12		1.79	
3/30/2005	LACSD	RA1	<	0.10	0.10	0.10	8.23	63.0	5.40		2.93	
4/5/2005	LACSD	RA1	<	0.10	0.10	0.10	8.37	57.1	4.12		2.87	
4/12/2005	LACSD	RA1	<	0.10	0.10	0.10	8.49	65.8	3.26		1.72	
4/19/2005	LACSD	RA1	<	0.10	0.10	0.10	8.28	67.3	4.90		2.32	
4/26/2005	LACSD	RA1	<	0.10	0.10	0.10	8.60	71.6	2.65		1.16	
5/3/2005	LACSD	RA1	<	0.10	0.10	0.10	8.56	72.4	2.86		1.21	
5/9/2005	LACSD	RA1	<	0.10	0.10	0.10	8.53	64.6	3.03		1.68	
5/17/2005	LACSD	RA1	<	0.10	0.10	0.10	8.52	65.9	3.08		1.63	
5/24/2005	LACSD	RA1	<	0.10	0.10	0.10	8.68	70.6	2.29		1.05	
5/31/2005	LACSD	RA1	<	0.10	0.10	0.10	8.40	67.5	3.88		1.88	
6/7/2005	LACSD	RA1	<	0.10	0.10	0.10	8.58	71.5	2.75		1.20	
6/14/2005	LACSD	RA1	<	0.10	0.10	0.10	8.25	69.8	5.20		2.22	
6/21/2005	LACSD	RA1	<	0.10	0.10	0.10	8.60	79.9	2.65		0.86	
6/28/2005	LACSD	RA1	<	0.10	0.10	0.10	8.37	68.2	4.12		1.93	
7/5/2005	LACSD	RA1	<	0.10	0.10	0.10	8.65	78.1	2.42		0.84	
7/12/2005	LACSD	RA1	<	0.10	0.10	0.10	8.35	78.1	4.28		1.40	
7/19/2005	LACSD	RA1	<	0.10	0.10	0.10	8.31	75.9	4.62		1.62	
7/26/2005	LACSD	RA1	<	0.10	0.10	0.10	8.70	86.8	2.20		0.57	
8/2/2005	LACSD	RA1		0.20	0.20	0.10	8.24	71.3	5.30		2.14	
8/9/2005	LACSD	RA1	<	0.10	0.10	0.10	8.63	84.0	2.51		0.71	
8/16/2005	LACSD	RA1	<	0.10	0.10	0.10	8.34	69.3	4.36		1.95	
8/23/2005	LACSD	RA1	<	0.10	0.10	0.10	8.56	74.2	2.86		1.13	
8/30/2005	LACSD	RA1		0.20	0.20	0.10	8.50	75.0	3.20		1.22	
9/6/2005	LACSD	RA1	<	0.10	0.10	0.10	8.60	73.4	2.65		1.09	
9/15/2005	LACSD	RA1	<	0.10	0.10	0.10	8.69	68.9	2.24		1.10	
9/23/2005	LACSD	RA1	<	0.10	0.10	0.10	8.38	67.5	4.04		1.95	
9/28/2005	LACSD	RA1	<	0.10	0.10	0.10	8.61	68.2	2.60		1.29	
10/4/2005	LACSD	RA1	<	0.10	0.10	0.10	8.17	62.4	6.07		3.30	
10/11/2005	LACSD	RA1	<	0.10	0.10	0.10	8.58	71.6	2.75		1.20	
10/25/2005	LACSD	RA1	<	0.10	0.10	0.10	8.46	63.2	3.46		1.98	
11/1/2005	LACSD	RA1	<	0.10	0.10	0.10	8.67	66.7	2.33		1.23	
11/15/2005	LACSD	RA1	<	0.10	0.10	0.10	8.44	66.9	3.59		1.80	
11/21/2005	LACSD	RA1	<	0.10	0.10	0.10	8.82	62.2	1.78		1.13	
11/29/2005	LACSD	RA1	<	0.10	0.10	0.10	8.53	53.4	3.03		2.50	
12/6/2005	LACSD	RA1	<	0.10	0.10	0.10	8.50	50.7	3.20		2.90	
12/13/2005	LACSD	RA1		0.10	0.10	0.10	8.76	58.6	1.98		1.42	
12/19/2005	LACSD	RA1	<	0.10	0.10	0.10	8.39	52.7	3.96		3.25	
12/28/2005	LACSD	RA1	<	0.10	0.10	0.10	8.63	57.4	2.51		1.83	
1/5/2006	LACSD	RA1	<	0.10	0.10	0.10	8.36	65.3	4.20		2.18	
1/10/2006	LACSD	RA1	<	0.10	0.10	0.10	8.64	62.4	2.46		1.51	
1/17/2006	LACSD	RA1	<	0.10	0.10	0.10	8.22	48.0	5.51		5.10	
1/24/2006	LACSD	RA1	<	0.10	0.10	0.10	8.55	53.1	2.91		2.45	
1/31/2006	LACSD	RA1	<	0.10	0.10	0.10	8.60	57.7	2.65		1.91	
2/7/2006	LACSD	RA1	<	0.10	0.10	0.10	8.85	61.5	1.69		1.10	
2/14/2006	LACSD	RA1		0.20	0.20	0.10	8.57	60.4	2.80		1.82	
2/23/2006	LACSD	RA1		0.30	*	0.10	8.63	57.8	2.51		*	
2/27/2006	LACSD	RA1	<	0.10	0.20	0.10	8.40	57.9	3.88		2.23	
3/9/2006	LACSD	RA1	<	0.10	0.10	0.10	8.87	65.5	1.64		0.93	
3/14/2006	LACSD	RA1	<	0.10	0.10	0.10	8.56	57.0	2.86		2.09	
3/23/2006	LACSD	RA1	<	0.10	*	0.10	8.63	59.4	2.51		*	
3/27/2006	LACSD	RA1	<	0.10	0.10	0.10	9.02	68.9	1.28		1.18	
4/3/2006	LACSD	RA1		0.14	0.14	0.10	8.62	61.7	2.55		1.60	
4/10/2006	LACSD	RA1	<	0.10	0.10	0.10	8.98	67.6	1.37		0.73	

APPENDIX B - TABLE B1
COYOTE CREEK - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (F)	CMC (mg/L)	Does Sample Exceed CMC (1=Yes)	SSO Adjusted 4-Day Average CCC	Does Sample Exceed 4-Day CCC (1=Yes)
4/17/2006	LACSD	RA1		0.12	0.12	0.10	8.59	62.4	2.70		1.64	
4/25/2006	LACSD	RA1	<	0.10	0.10	0.10	9.17	72.9	1.03		0.46	
5/1/2006	LACSD	RA1		0.12	0.12	0.10	8.70	66.9	2.20		1.16	
5/9/2006	LACSD	RA1	<	0.10	0.10	0.10	8.99	68.7	1.34		0.69	
5/16/2006	LACSD	RA1	<	0.10	0.10	0.10	8.34	67.8	4.36		2.06	
5/25/2006	LACSD	RA1	<	0.10	0.10	0.10	8.79	84.7	1.88		0.53	
5/30/2006	LACSD	RA1	<	0.10	0.10	0.10	8.57	71.4	2.80		1.23	
6/6/2006	LACSD	RA1	<	0.10	0.10	0.10	8.47	72.0	3.39		1.42	
6/13/2006	LACSD	RA1	<	0.10	0.10	0.10	8.71	77.9	2.16		0.77	
6/20/2006	LACSD	RA1		0.10	0.10	0.10	8.50	76.6	3.20		1.15	
6/27/2006	LACSD	RA1		0.12	0.12	0.10	8.74	74.7	2.05		0.82	
7/5/2006	LACSD	RA1	<	0.10	0.10	0.10	9.09	91.0	1.16		0.27	
7/11/2006	LACSD	RA1	<	0.10	0.10	0.10	8.72	82.2	2.13		0.65	
7/20/2006	LACSD	RA1		0.17	0.17	0.10	8.92	90.9	1.51		0.35	
7/25/2006	LACSD	RA1		0.14	0.14	0.10	8.65	87.2	2.42		0.61	
8/1/2006	LACSD	RA1	<	0.10	0.10	0.10	8.84	78.6	1.72		0.61	
8/8/2006	LACSD	RA1		0.12	0.12	0.10	8.88	80.8	1.61		0.53	
8/15/2006	LACSD	RA1		0.11	0.11	0.10	8.56	69.4	2.86		1.34	
8/22/2006	LACSD	RA1	<	0.10	0.10	0.10	8.74	76.8	2.05		0.76	
8/29/2006	LACSD	RA1		0.14	0.14	0.10	8.69	75.7	2.24		0.86	
9/5/2006	LACSD	RA1	<	0.10	0.10	0.10	8.56	75.3	2.86		1.09	
9/12/2006	LACSD	RA1	<	0.10	0.10	0.10	8.47	61.7	3.39		2.06	
9/19/2006	LACSD	RA1	<	0.10	0.10	0.10	8.55	51.0	2.91		2.64	
10/24/2006	LACSD	RA1	<	0.10	0.10	0.10	8.57	66.9	2.80		1.44	
11/21/2006	LACSD	RA1		0.13	0.13	0.10	8.53	64.0	3.03		1.71	
12/14/2006	LACSD	RA1	<	0.10	0.10	0.10	8.56	61.2	2.86		1.80	
1/9/2007	LACSD	RA1	<	0.10	0.10	0.10	8.67	55.8	2.33		1.82	
2/22/2007	LACSD	RA1	<	0.10	0.10	0.10	8.42	56.7	3.74		2.68	

LACSD - Sanitation Districts of Los Angeles County

* - Data is used in calculation of a 4 day average

17 of 374 4-day averages exceed Site Specific Objective (SSO) Criterion Continuous Concentration (CCC)

2 of 382 samples exceed Site Specific Objective (SSO) Criterion Maximum Concentration (CMC)

ATTACHMENT B

APPENDIX C - TABLE C1

SANTA CLARA RIVER REACH 6 - COPPER

Sample Date	Source	Location	Qualifier	Total Copper (ug/L)	Dissolved Copper (ug/L)	PQL/RL (ug/L)	Method	Is Sample Usable? (1=Yes)	Conservative Dissolved Copper Concentration	4-Day Average Concentration	Hardness	Dissolved Copper CMC (ug/L)	Dissolved Copper CCC (ug/L)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed CCC (1=Yes)
10/28/2003	LACDPW	S29		13.50	3.55	5.00	EPA200.8	1	3.55	*	400	49.6	29.3		
10/31/2003	LACDPW	S29		30.40	10.60	5.00	EPA200.8	1	10.60	7.08	200	25.8	16.2		
12/25/2003	LACDPW	S29		53.30	4.88	5.00	EPA200.8	1	4.88	4.88	170	22.2	14.1		
1/1/2004	LACDPW	S29		10.20	7.36	5.00	EPA200.8	1	7.36	7.36	140	18.5	11.9		
1/13/2004	LACDPW	S29		5.96	3.54	5.00	EPA200.8	1	3.54	3.54	450	55.4	32.4		
1/14/2004	LACSD	RB	<	8.00	NA	8.00	EPA200.8	1	8.00	8.00	520	63.5	36.6		
2/11/2004	LACSD	RB	<	8.00	NA	8.00	EPA200.8	1	8.00	8.00	226***	28.2	17.6		
3/10/2004	LACSD	RB	<	8.00	NA	8.00	EPA200.8	1	8.00	8.00	226***	28.2	17.6		
4/14/2004	LACSD	RB	E	4.00	NA	8.00	EPA200.8	1	8.00	8.00	175	22.8	14.4		
5/12/2004	LACSD	RB	<	8.00	NA	8.00	EPA200.8	1	8.00	8.00	226***	28.2	17.6		
6/9/2004	LACSD	RB	<	8.00	NA	8.00	EPA200.8	1	8.00	8.00	226***	28.2	17.6		
7/14/2004	LACSD	RB	<	8.00	NA	8.00	EPA200.8	1	8.00	8.00	181	23.5	14.9		
8/11/2004	LACSD	RB	<	8.00	NA	8.00	EPA200.8	1	8.00	8.00	226***	28.2	17.6		
9/15/2004	LACSD	RB	E	3.00	NA	8.00	EPA200.8	1	8.00	8.00	226***	28.2	17.6		
10/13/2004	LACSD	RB	E	3.00	NA	8.00	EPA200.8	1	8.00	8.00	193	25.0	15.7		
10/17/2004	LACDPW	S29		15.70	5.90	5.00	EPA200.8	1	5.90	5.90	428	52.9	31.0		
10/26/2004	LACDPW	S29		28.00	22.60	5.00	EPA200.8	1	22.60	22.60	90	12.2	8.2	1	1
11/10/2004	LACSD	RB	E	6.00	NA	8.00	EPA200.8	1	8.00	8.00	226***	28.2	17.6		
12/16/2004	LACSD	RB		5.50	NA	0.50	EPA200.8	1	5.50	5.50	226***	28.2	17.6		
1/7/2005	LACDPW	S29		19.50	17.20	5.00	EPA200.8	1	17.20	17.20	110	14.7	9.7	1	1
2/2/2005	LACSD	RB		2.70	NA	0.50	EPA200.8	1	2.70	2.70	226***	28.2	17.6		
2/9/2005	LACSD	RB		2.90	NA	0.50	EPA200.8	1	2.90	2.90	243	31.0	19.1		
3/2/2005	LACSD	RA		28.00	NA	0.50	EPA200.8	1	28.00	28.00	292**	35.7	21.7		1
3/2/2005	LACSD	RB		1.90	NA	0.50	EPA200.8	1	1.90	1.90	261	33.2	20.3		
3/9/2005	LACDPW	S29		18.50	3.83	5.00	EPA200.8	1	3.83	3.83	460	56.6	33.0		
4/13/2005	LACSD	RA		29.00	NA	0.50	EPA200.8	1	29.00	29.00	433	53.5	31.3		
4/13/2005	LACSD	RB		3.60	NA	0.50	EPA200.8	1	3.60	3.60	276	35.0	21.3		
5/18/2005	LACSD	RB		1.80	NA	0.50	EPA200.8	1	1.80	1.80	251	32.0	19.7		
6/15/2005	LACSD	RB		3.20	NA	0.50	EPA200.8	1	3.20	3.20	220	28.2	17.6		
7/20/2005	LACSD	RB		6.40	NA	0.50	EPA200.8	1	6.40	6.40	204	26.3	16.5		
8/17/2005	LACSD	RB		3.70	NA	0.50	EPA200.8	1	3.70	3.70	226***	28.2	17.6		
9/14/2005	LACSD	RB		7.00	NA	0.50	EPA200.8	1	7.00	7.00	220	28.2	17.6		
10/17/2005	LACDPW	S29		37.30	8.17	5.00	EPA200.8	1	8.17	8.17	128	17.0	11.1		
10/26/2005	LACSD	RB		7.90	NA	0.50	EPA200.8	1	7.90	7.90	257	32.7	20.1		
11/29/2005	LACDPW	S29		7.40	2.36	5.00	EPA200.8	1	2.36	2.36	408	50.6	29.8		
11/30/2005	LACSD	RB		4.20	NA	0.50	EPA200.8	1	4.20	4.20	226***	28.2	17.6		
12/21/2005	LACSD	RB		4.20	NA	0.50	EPA200.8	1	4.20	4.20	226***	28.2	17.6		
12/31/2005	LACDPW	S29		10.80	4.59	5.00	EPA200.8	1	4.59	4.59	90	12.2	8.2		
1/14/2006	LACDPW	S29		10.00	6.04	5.00	EPA200.8	1	6.04	6.04	245	31.3	19.3		
1/18/2006	LACSD	RA		0.80	NA	0.50	EPA200.8	1	0.80	0.80	249	31.7	19.5		
1/18/2006	LACSD	RB		4.60	NA	0.50	EPA200.8	1	4.60	4.60	222	28.5	17.7		

ATTACHMENT B

APPENDIX C - TABLE C1

SANTA CLARA RIVER REACH 6 - COPPER

Sample Date	Source	Location	Qualifier	Total Copper (ug/L)	Dissolved Copper (ug/L)	PQL/RL (ug/L)	Method	Is Sample Usable? (1=Yes)	Conservative Dissolved Copper Concentration	4-Day Average Concentration	Hardness	Dissolved Copper CMC (ug/L)	Dissolved Copper CCC (ug/L)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed CCC (1=Yes)
2/15/2006	LACSD	RA		1.63	NA	0.50	EPA200.8	1	1.63	1.63	292**	35.7	21.7		
2/15/2006	LACSD	RB		7.21	NA	0.50	EPA200.8	1	7.21	7.21	226***	28.2	17.6		
2/17/2006	LACDPW	S29		7.33	3.32	5.00	EPA200.8	1	3.32	3.32	340	42.6	25.5		
3/15/2006	LACSD	RA		1.42	NA	0.50	EPA200.8	1	1.42	1.42	292**	35.7	21.7		
3/15/2006	LACSD	RB		3.75	NA	0.50	EPA200.8	1	3.75	3.75	226***	28.2	17.6		
4/19/2006	LACSD	RA		15.90	NA	0.50	EPA200.8	1	15.90	15.90	282	35.7	21.7		
4/19/2006	LACSD	RB		3.64	NA	0.50	EPA200.8	1	3.64	3.64	248	31.6	19.5		
4/25/2006	LACDPW	S29		33.50	2.52	5.00	EPA200.8	1	2.52	2.52	360	44.9	26.8		
5/17/2006	LACSD	RA		1.04	NA	0.50	EPA200.8	1	1.04	1.04	292**	35.7	21.7		
5/17/2006	LACSD	RB		4.67	NA	0.50	EPA200.8	1	4.67	4.67	226***	28.2	17.6		
6/21/2006	LACSD	RB		2.71	NA	0.50	EPA200.8	1	2.71	2.71	226***	28.2	17.6		
7/19/2006	LACSD	RA		0.80	NA	0.50	EPA200.8	1	0.80	0.80	319	40.1	24.1		
7/19/2006	LACSD	RB		2.10	NA	0.50	EPA200.8	1	2.10	2.10	195	25.2	15.8		
8/23/2006	LACSD	RA		1.10	NA	0.50	EPA200.8	1	1.10	1.10	292**	35.7	21.7		
8/23/2006	LACSD	RB		3.64	NA	0.50	EPA200.8	1	3.64	3.64	226***	28.2	17.6		
9/13/2006	LACSD	RB		3.60	NA	0.50	EPA200.8	1	3.60	3.60	226***	28.2	17.6		
10/18/2006	LACSD	RB		3.73	NA	0.50	EPA200.8	1	3.73	3.73	373	46.5	27.6		
10/31/2006	LACDPW	S29		22.40	2.19	5.00	EPA200.8	1	2.19	2.19	430	53.1	31.1		
11/15/2006	LACSD	RB		4.30	NA	0.50	EPA200.8	1	4.30	4.30	226***	28.2	17.6		
12/9/2006	LACDPW	S29		50.30	5.08	5.00	EPA200.8	1	5.08	5.08	250	31.9	19.6		
12/16/2006	LACDPW	S29		28.30	4.99	5.00	EPA200.8	1	4.99	4.99	370	46.1	27.4		
12/20/2006	LACSD	RB		5.92	NA	0.50	EPA200.8	1	5.92	5.92	226***	28.2	17.6		
1/30/2007	LACDPW	S29		38.20	6.10	5.00	EPA200.8	1	6.10	6.10	310	39.0	23.5		
2/14/2007	LACSD	RB		8.99	NA	0.50	EPA200.8	1	8.99	8.99	232	29.7	18.4		
2/19/2007	LACDPW	S29		31.90	4.68	5.00	EPA200.8	1	4.68	*	210	27.0	16.9		
2/22/2007	LACDPW	S29		50.50	5.13	5.00	EPA200.8	1	5.13	4.91	160	20.9	13.4		
2/28/2007	LACSD	RB		8.03	NA	0.50	EPA200.8	1	8.03	8.03	226***	28.2	17.6		
3/14/2007	LACSD	RB		6.26	NA	0.50	EPA200.8	1	6.26	6.26	226***	28.2	17.6		
4/2/2007	LACDPW	S29		22.10	2.88	5.00	EPA200.8	1	2.88	2.88	440	54.3	31.8		
4/11/2007	LACSD	RB		6.43	NA	0.50	EPA200.8	1	6.43	6.43	235	30.1	18.6		

LACSD - Sanitation Districts of Los Angeles County
LACDPW - Los Angeles County Department of Public Works
* - Data is used in calculation of a 4-day average
** - Average RA hardness used when concurrent hardness was unavailable
*** - Average RB hardness used when concurrent hardness was unavailable

3 of 69 4-day averages exceed Criterion Continuous Concentration (CCC)

2 of 71 samples exceed Criterion Maximum Concentration (CMC)

ATTACHMENT B

APPENDIX D - TABLE D1

SAN JOSE CREEK REACH 1 - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (C)	CMC (mg/L)	SSO Adjusted CCC (mg/L) No ELS	SSO Adjusted CCC (mg/L) with ELS	4-Day Average CCC	Is 4-Day Average Usable? (1=Yes)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed 4-Day CCC (1=Yes)
5/17/2004	LACSD	C2	<	0.10	*	0.10	7.48	24.0	20.49		3.62	*	*		*
5/18/2004	LACSD	C2		0.80	*	0.50	7.45	25.6	21.41		3.34	*	*		*
5/18/2004	LACSD	C1	<	0.10	0.10	0.10	8.29	21.7	4.81		1.46	1.46	1		
5/19/2004	LACSD	C2		0.90	*	0.50	7.56	25.7	18.15		3.02	*	*		*
5/21/2004	LACSD	C2		0.50	0.58	0.50	7.19	24.5	29.87		4.27	3.02	1		
6/8/2004	LACSD	C2		0.90	0.90	0.50	7.61	23.4	16.76		3.33	3.33	1		
6/8/2004	LACSD	C1		0.10	0.10	0.10	7.83	19.6	11.51		3.30	3.30	1		
7/20/2004	LACSD	C2		0.30	0.30	0.10	8.05	26.4	7.65		1.58	1.58	1		
7/20/2004	LACSD	C1	<	0.10	0.10	0.10	7.61	24.2	16.76		3.16	3.16	1		
8/17/2004	LACSD	RD		0.20	0.20	0.10	9.11	32.4	1.12		0.20	0.20	1		
8/17/2004	LACSD	RC	<	0.10	0.10	0.10	8.91	25.5	1.53		0.41	0.41	1		
8/17/2004	LACSD	RA		0.10	0.10	0.10	10.53	26.2	0.44		0.12	0.12	1		
9/7/2004	LACSD	RD	<	0.10	0.10	0.10	8.62	28.2	2.55		0.55	0.55	1		
9/7/2004	LACSD	RC		0.40	0.40	0.10	8.60	21.7	2.65		0.87	0.87	1		
9/7/2004	LACSD	RA		1.10	1.10	0.10	8.36	26.8	4.20		0.94	0.94	1		1
9/15/2004	LACSD	C2		2.00	2.00	0.10	7.53	26.8	19.01		2.88	2.88	1		
9/15/2004	LACSD	C1		0.60	0.60	0.10	8.15	20.3	6.31		2.00	2.00	1		
9/22/2004	LACSD	C2		1.40	1.40	0.10	7.50	24.3	19.89		3.48	3.48	1		
10/6/2004	LACSD	C2		1.00	1.00	0.10	8.07	22.8	7.36	1.93		1.93	1		
10/6/2004	LACSD	C1		0.50	0.50	0.10	8.34	17.2	4.36	1.80		1.80	1		
10/12/2004	LACSD	C2		0.70	0.70	0.10	9.11	20.7	1.12	0.42		0.42	1		1
10/12/2004	LACSD	RD		0.10	0.10	0.10	9.66	26.1	0.61	0.17		0.17	1		
10/12/2004	LACSD	RC		0.10	0.10	0.10	9.36	24.7	0.81	0.24		0.24	1		
10/12/2004	LACSD	RA		1.20	1.20	0.10	7.86	27.0	10.90	1.98		1.98	1		
11/8/2004	LACSD	C2		0.30	*	0.10	8.16	17.1	6.19	2.43		*	*		*
11/9/2004	LACSD	C2		0.30	*	0.10	8.20	19.8	5.73	1.92		*	*		*
11/10/2004	LACSD	C2		0.10	*	0.10	8.22	13.7	5.51	2.74		*	*		*
11/11/2004	LACSD	C2		0.30	*	0.10	8.86	20.0	1.66	0.63		*	*		*
11/12/2004	LACSD	C2		0.40	0.28	0.10	8.02	17.1	8.10	3.00		2.14	1		
11/13/2004	LACSD	C2		0.60	0.34	0.10	9.10	21.8	1.14	0.40		1.74	1		
11/14/2004	LACSD	C2		0.40	0.36	0.10	8.97	22.1	1.39	0.47		1.45	1		
11/15/2004	LACSD	C2		0.20	0.38	0.10	7.92	13.5	9.76	4.36		1.77	1		
11/16/2004	LACSD	C2		0.30	0.38	0.10	7.86	18.8	10.90	3.35		2.32	1		
11/16/2004	LACSD	RD	<	0.10	0.10	0.10	9.36	17.7	0.81	0.38		0.38	1		

ATTACHMENT B

APPENDIX D - TABLE D1

SAN JOSE CREEK REACH 1 - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (C)	CMC (mg/L)	SSO Adjusted CCC (mg/L) No ELS	SSO Adjusted CCC (mg/L) with ELS	4-Day Average CCC	Is 4-Day Average Usable? (1=Yes)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed 4-Day CCC (1=Yes)
11/16/2004	LACSD	RC	<	0.10	0.10	0.10	8.82	16.7	1.78	0.84		0.84	1		
11/16/2004	LACSD	RA		1.50	1.50	0.10	7.81	22.6	11.92	2.80		2.80	1		
11/17/2004	LACSD	C2	<	0.10	0.32	0.10	8.23	13.9	5.40	2.66		2.01	1		
11/17/2004	LACSD	C1	<	0.10	0.10	0.10	8.28	13.7	4.90	2.49		2.49	1		
11/18/2004	LACSD	C2		0.10	0.22	0.10	7.91	18.2	9.95	3.26		2.41	1		
11/19/2004	LACSD	C2	<	0.10	0.16	0.10	8.11	13.7	6.82	3.26		2.89	1		
11/20/2004	LACSD	C2	<	0.10	0.14	0.10	8.00	15.7	8.41	3.38		3.01	1		
11/21/2004	LACSD	C2		0.70	0.22	0.10	7.41	18.4	22.66	5.49		3.58	1		
11/22/2004	LACSD	C2		2.80	0.76	0.10	7.42	20.9	22.34	4.62		4.00	1		
11/23/2004	LACSD	C2		0.90	0.92	0.10	7.81	16.0	11.92	4.29		4.21	1		
11/24/2004	LACSD	C2		0.40	0.98	0.10	8.00	19.4	8.41	2.67		4.09	1		
11/25/2004	LACSD	C2	<	0.30	1.02	0.10	7.86	19.1	10.90	3.29		4.07	1		
11/26/2004	LACSD	C2		0.40	0.96	0.10	7.67	18.0	15.19	4.43		3.86	1		
11/27/2004	LACSD	C2	<	0.10	0.42	0.10	8.22	12.9	5.51	2.89		3.52	1		
11/28/2004	LACSD	C2	<	0.10	0.26	0.10	8.04	11.5	7.79	4.18		3.49	1		
11/29/2004	LACSD	C2		0.30	0.24	0.10	8.29	13.3	4.81	2.52		3.46	1		
11/30/2004	LACSD	C2		0.30	0.24	0.10	7.96	13.2	9.06	4.20		3.65	1		
12/1/2004	LACSD	C2	<	0.10	0.18	0.10	8.31	8.9	4.62	3.22		3.40	1		
12/2/2004	LACSD	C2	<	0.10	0.18	0.10	8.11	8.8	6.82	4.47		3.72	1		
12/3/2004	LACSD	C2		0.40	0.24	0.10	7.57	14.5	17.86	6.15		4.11	1		
12/4/2004	LACSD	C2		0.50	0.28	0.10	8.08	9.0	7.22	4.63		4.54	1		
12/5/2004	LACSD	C2	<	0.10	0.24	0.10	7.70	11.3	14.44	6.62		5.02	1		
12/6/2004	LACSD	C2		0.40	0.30	0.10	7.82	13.9	11.71	4.83		5.34	1		
12/7/2004	LACSD	C2		0.20	0.32	0.10	8.02	15.7	8.10	3.28		5.10	1		
12/15/2004	LACSD	C2	<	0.10	0.10	0.10	8.12	11.8	6.69	3.64		3.64	1		
12/15/2004	LACSD	C1	<	0.10	0.10	0.10	8.20	11.7	5.73	3.22		3.22	1		
12/16/2004	LACSD	RD	<	0.10	0.10	0.10	7.42	16.5	22.34	6.16		6.16	1		
12/16/2004	LACSD	RC		0.10	0.10	0.10	8.95	14.2	1.43	0.80		0.80	1		
12/20/2004	LACSD	C2		0.20	0.20	0.10	7.77	15.1	12.80	4.77		4.77	1		
12/27/2004	LACSD	C2		0.40	0.40	0.10	7.68	15.0	14.94	5.32		5.32	1		
1/4/2005	LACSD	RA		1.70	1.70	0.10	7.39	18.2	23.29	5.64		5.64	1		
1/11/2005	LACSD	RA		1.20	1.20	0.10	7.32	16.7	25.56	6.52		6.52	1		
1/18/2005	LACSD	RD	<	0.10	0.10	0.10	8.92	21.4	1.51	0.53		0.53	1		
1/18/2005	LACSD	RC	<	0.10	0.10	0.10	9.34	22.0	0.83	0.29		0.29	1		

APPENDIX D - TABLE D1
SAN JOSE CREEK REACH 1 - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (C)	CMC (mg/L)	SSO Adjusted CCC (mg/L) No ELS	SSO Adjusted CCC (mg/L) with ELS	4-Day Average CCC	Is 4-Day Average Usable? (1=Yes)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed 4-Day CCC (1=Yes)
1/18/2005	LACSD	RA		0.20	0.20	0.10	9.24	22.2	0.94	0.32		0.32	1		
1/19/2005	LACSD	C2		0.40	0.40	0.10	8.10	14.6	6.95	3.13		3.13	1		
1/19/2005	LACSD	C1	<	0.10	0.10	0.10	8.22	11.7	5.51	3.12		3.12	1		
1/25/2005	LACSD	C2	<	0.10	0.10	0.10	8.24	15.8	5.30	2.33		2.33	1		
1/25/2005	LACSD	RA		1.00	*	0.10	8.02	20.9	8.10	2.35		*	*		*
1/27/2005	LACSD	RA		0.80	*	0.10	7.92	20.9	9.76	2.70		*	*		*
1/28/2005	LACSD	RA		0.80	0.87	0.10	8.09	20.0	7.08	2.24		2.43	1		
1/31/2005	LACSD	RA		1.30	0.97	0.10	7.58	19.8	17.58	4.33		3.09	1		
2/2/2005	LACSD	C2	<	0.10	0.10	0.10	8.40	12.1	3.88	2.26		2.26	1		
2/9/2005	LACSD	C2	<	0.10	0.10	0.10	8.55	13.0	2.91	1.66		1.66	1		
2/15/2005	LACSD	C2	<	0.10	0.10	0.10	7.43	18.5	22.03	5.37		5.37	1		
2/15/2005	LACSD	C1		0.70	0.70	0.10	8.32	13.9	4.53	2.30		2.30	1		
2/15/2005	LACSD	RD	<	0.10	0.10	0.10	8.65	17.5	2.42	1.05		1.05	1		
2/15/2005	LACSD	RC		0.40	0.40	0.10	8.64	17.7	2.46	1.05		1.05	1		
2/15/2005	LACSD	RA		1.20	1.20	0.10	7.72	20.4	13.96	3.58		3.58	1		
3/2/2005	LACSD	C2	<	0.10	0.10	0.10	8.23	14.5	5.40	2.57		2.57	1		
3/9/2005	LACSD	C2	<	0.10	0.10	0.10	8.31	15.9	4.62	2.05		2.05	1		
3/15/2005	LACSD	RD	<	0.10	0.10	0.10	9.23	22.5	0.95	0.32		0.32	1		
3/15/2005	LACSD	RC	<	0.10	0.10	0.10	9.13	16.3	1.09	0.54		0.54	1		
3/15/2005	LACSD	RA		1.10	1.10	0.10	8.11	21.2	6.82	2.01		2.01	1		
3/16/2005	LACSD	C2		0.80	0.80	0.10	7.56	18.5	18.15	4.80		4.80	1		
3/16/2005	LACSD	C1	<	0.10	0.10	0.10	8.02	12.6	8.10	4.01		4.01	1		
3/21/2005	LACSD	C2		1.30	1.30	0.10	7.85	20.9	11.10	2.96		2.96	1		
3/30/2005	LACSD	C2		0.40	0.40	0.10	7.47	19.7	20.79	4.80		4.80	1		
4/6/2005	LACSD	C2		0.90	*	0.10	7.59	20.9	17.31		4.00	*	*		*
4/6/2005	LACSD	RA		1.70	1.70	0.10	8.03	22.6	7.94		2.07	2.07	1		
4/7/2005	LACSD	C2		0.90	0.90	0.10	7.43	21.1	22.03		4.54	3.31	1		
4/12/2005	LACSD	RA		1.80	1.80	0.10	8.05	22.0	7.65		2.10	2.10	1		
4/13/2005	LACSD	C2	<	0.10	0.10	0.10	8.68	17.9	2.29		0.87	0.87	1		
4/13/2005	LACSD	C1	<	0.10	0.10	0.10	8.02	15.0	8.10		2.55	2.55	1		
4/19/2005	LACSD	RD	<	0.10	0.10	0.10	8.48	21.1	3.33		1.11	1.11	1		
4/19/2005	LACSD	RC	<	0.10	0.10	0.10	8.81	15.1	1.81		0.70	0.70	1		
4/19/2005	LACSD	RA		1.00	1.00	0.10	7.74	18.3	13.48		3.68	3.68	1		
4/20/2005	LACSD	C2	<	0.10	0.10	0.10	8.60	17.6	2.65		0.99	0.99	1		

ATTACHMENT B

APPENDIX D - TABLE D1

SAN JOSE CREEK REACH 1 - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (C)	CMC (mg/L)	SSO Adjusted CCC (mg/L) No ELS	SSO Adjusted CCC (mg/L) with ELS	4-Day Average CCC	Is 4-Day Average Usable? (1=Yes)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed 4-Day CCC (1=Yes)
4/26/2005	LACSD	RA		1.00	1.00	0.10	8.42	22.6	3.74		1.11	1.11	1		
4/27/2005	LACSD	C2		0.20	0.20	0.10	8.04	18.5	7.79		2.47	2.47	1		
5/3/2005	LACSD	RA	<	0.10	0.10	0.10	8.37	26.2	4.12		0.96	0.96	1		
5/4/2005	LACSD	C2		0.90	0.90	0.10	7.51	22.5	19.59		3.88	3.88	1		
5/9/2005	LACSD	RA		0.50	0.50	0.10	8.02	22.3	8.10		2.15	2.15	1		
5/11/2005	LACSD	C2		1.30	1.30	0.10	7.80	21.8	12.14		2.98	2.98	1		
5/11/2005	LACSD	C1	<	0.10	0.10	0.10	8.42	16.8	3.74		1.34	1.34	1		
5/17/2005	LACSD	RD		0.20	0.20	0.10	8.75	24.3	2.01		0.57	0.57	1		
5/17/2005	LACSD	RC	<	0.10	0.10	0.10	9.31	21.8	0.86		0.31	0.31	1		
5/17/2005	LACSD	RA		0.60	0.60	0.10	8.84	24.6	1.72		0.49	0.49	1		1
5/18/2005	LACSD	C2	<	0.10	0.10	0.10	8.71	20.4	2.16		0.78	0.78	1		
5/24/2005	LACSD	RA		0.20	0.20	0.10	8.68	20.3	2.29		0.83	0.83	1		
5/25/2005	LACSD	C2		0.60	0.60	0.10	7.35	24.4	24.58		3.88	3.88	1		
5/31/2005	LACSD	RA		0.60	0.60	0.10	8.31	25.3	4.62		1.12	1.12	1		
6/1/2005	LACSD	C2		0.90	0.90	0.10	7.57	24.7	17.86		3.18	3.18	1		
6/7/2005	LACSD	RA		1.10	1.10	0.10	8.02	23.5	8.10		1.99	1.99	1		
6/8/2005	LACSD	C2		0.50	0.50	0.10	7.68	21.6	14.94		3.49	3.49	1		
6/14/2005	LACSD	RD	<	0.10	0.10	0.10	8.29	30.6	4.81		0.82	0.82	1		
6/14/2005	LACSD	RC	<	0.10	0.10	0.10	9.01	26.0	1.30		0.34	0.34	1		
6/14/2005	LACSD	RA		0.90	0.90	0.10	8.27	27.4	5.00		1.05	1.05	1		
6/15/2005	LACSD	C2		0.90	0.90	0.10	7.57	24.3	17.86		3.27	3.27	1		
6/15/2005	LACSD	C1		0.20	0.20	0.10	8.05	20.0	7.65		2.38	2.38	1		
6/21/2005	LACSD	RA	<	0.10	0.10	0.10	10.25	33.2	0.46		0.08	0.08	**		**
6/22/2005	LACSD	C2		1.00	1.00	0.10	7.50	24.3	19.89		3.49	3.49	1		
6/29/2005	LACSD	C2		0.20	0.20	0.10	8.14	21.0	6.43		1.95	1.95	1		
7/5/2005	LACSD	RA		0.10	0.10	0.10	10.68	31.3	0.43		0.09	0.09	**		**
7/6/2005	LACSD	C2		0.40	0.40	0.10	8.06	22.5	7.50		2.00	2.00	1		
7/12/2005	LACSD	RA	<	0.10	0.10	0.10	9.61	21.9	0.64		0.23	0.23	1		
7/13/2005	LACSD	C2		0.90	0.90	0.10	7.66	26.4	15.44		2.60	2.60	1		
7/13/2005	LACSD	C1		0.30	0.30	0.10	8.14	22.8	6.43		1.73	1.73	1		
7/19/2005	LACSD	RD	<	0.10	0.10	0.10	8.35	30.9	4.28		0.73	0.73	1		
7/19/2005	LACSD	RC		0.10	0.10	0.10	8.00	29.1	8.41		1.43	1.43	1		
7/19/2005	LACSD	RA		0.10	0.10	0.10	10.17	30.2	0.47		0.10	0.10	1		
7/20/2005	LACSD	C2		0.80	0.80	0.10	7.35	26.9	24.58		3.32	3.32	1		

ATTACHMENT B

APPENDIX D - TABLE D1

SAN JOSE CREEK REACH 1 - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (C)	CMC (mg/L)	SSO Adjusted CCC (mg/L) No ELS	SSO Adjusted CCC (mg/L) with ELS	4-Day Average CCC	Is 4-Day Average Usable? (1=Yes)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed 4-Day CCC (1=Yes)
7/26/2005	LACSD	RA		0.20	0.20	0.10	9.80	25.3	0.56		0.16	0.16	1		1
7/27/2005	LACSD	C2		0.60	0.60	0.10	8.00	26.2	8.41		1.72	1.72	1		
8/2/2005	LACSD	RA		0.20	0.20	0.10	10.43	24.8	0.45		0.14	0.14	1		1
8/3/2005	LACSD	C2		0.80	0.80	0.10	7.57	26.0	17.86		2.93	2.93	1		
8/9/2005	LACSD	RA		0.30	0.30	0.10	9.67	25.4	0.61		0.18	0.18	1		1
8/10/2005	LACSD	C2		0.60	0.60	0.10	7.61	23.9	16.76		3.23	3.23	1		
8/10/2005	LACSD	C1		0.30	0.30	0.10	8.02	21.2	8.10		2.30	2.30	1		
8/16/2005	LACSD	RD	<	0.10	0.10	0.10	9.25	24.4	0.93		0.28	0.28	1		
8/16/2005	LACSD	RC	<	0.10	0.10	0.10	9.24	23.2	0.94		0.30	0.30	1		
8/16/2005	LACSD	RA	<	0.10	0.10	0.10	9.82	22.4	0.55		0.19	0.19	1		
8/17/2005	LACSD	C2		0.40	0.40	0.10	7.94	23.3	9.41		2.26	2.26	1		
8/23/2005	LACSD	RA	<	0.10	0.10	0.10	9.54	20.9	0.68		0.26	0.26	1		
8/24/2005	LACSD	C2		0.10	0.10	0.10	8.08	19.1	7.22		2.33	2.41	1		
8/30/2005	LACSD	RA	<	0.10	0.10	0.10	9.48	23.2	0.72		0.24	0.24	1		
8/31/2005	LACSD	C2		0.30	0.30	0.10	8.03	20.8	7.94		2.34	2.34	1		
9/7/2005	LACSD	C2		0.70	0.70	0.10	8.16	20.6	6.19		1.94	1.94	1		
9/14/2005	LACSD	C2		0.40	0.40	0.10	8.55	19.5	2.91		1.08	1.08	1		
9/14/2005	LACSD	C1		0.30	0.30	0.10	8.33	17.5	4.45		1.56	1.56	1		
9/23/2005	LACSD	C2		0.70	0.70	0.10	7.64	24.4	15.96		3.03	3.03	1		
9/23/2005	LACSD	RA		1.40	1.40	0.10	8.00	26.9	8.41		1.65	1.65	1		
9/27/2005	LACSD	RD	<	0.10	0.10	0.10	9.03	24.0	1.26		0.38	0.38	1		
9/27/2005	LACSD	RC	<	0.10	0.10	0.10	8.91	20.0	1.53		0.59	0.59	1		
9/27/2005	LACSD	RA		1.30	1.30	0.10	8.23	26.5	5.40		1.18	1.18	1		1
9/28/2005	LACSD	C2		0.50	0.50	0.10	9.01	20.3	1.30		0.50	0.50	1		
10/4/2005	LACSD	RA		1.30	1.30	0.10	8.48	23.0	3.33	0.98		0.98	1		1
10/5/2005	LACSD	C2		0.40	0.40	0.10	8.64	18.9	2.46	0.97		0.97	1		
10/11/2005	LACSD	RA		0.90	0.90	0.10	7.68	20.4	14.94	3.76		3.76	1		
10/12/2005	LACSD	C2		0.30	0.30	0.10	8.48	19.5	3.33	1.23		1.23	1		
10/25/2005	LACSD	RD	<	0.10	0.10	0.10	8.89	18.3	1.58	0.68		0.68	1		
10/25/2005	LACSD	RC	<	0.10	0.10	0.10	9.26	19.1	0.92	0.39		0.39	1		
10/25/2005	LACSD	RA		1.00	1.00	0.10	8.22	25.5	5.51	1.28		1.28	1		
10/26/2005	LACSD	C2		0.60	0.60	0.10	7.97	20.8	8.90	2.55		2.55	1		
10/26/2005	LACSD	C1		0.20	0.20	0.10	8.31	14.9	4.62	2.20		2.20	1		
11/1/2005	LACSD	RA		1.30	1.30	0.10	7.97	24.0	8.90	2.07		2.07	1		

APPENDIX D - TABLE D1

SAN JOSE CREEK REACH 1 - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (C)	CMC (mg/L)	SSO Adjusted CCC (mg/L) No ELS	SSO Adjusted CCC (mg/L) with ELS	4-Day Average CCC	Is 4-Day Average Usable? (1=Yes)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed 4-Day CCC (1=Yes)
11/2/2005	LACSD	C2		1.10	1.10	0.10	7.62	24.5	16.49	3.07		3.07	1		
11/8/2005	LACSD	RA		1.10	1.10	0.10	8.41	23.8	3.81	1.05		1.05	1		1
11/9/2005	LACSD	C2		0.80	0.80	0.10	7.79	22.2	12.36	2.94		2.94	1		
11/15/2005	LACSD	RD		0.20	0.20	0.10	9.06	19.8	1.21	0.48		0.48	1		
11/15/2005	LACSD	RC		0.10	0.10	0.10	9.31	21.1	0.86	0.32		0.32	1		
11/15/2005	LACSD	RA		1.90	1.90	0.10	8.32	23.8	4.53	1.22		1.22	1		1
11/16/2005	LACSD	C2		1.00	1.00	0.10	8.09	22.3	7.08	1.94		1.94	1		
11/16/2005	LACSD	C1		0.10	0.10	0.10	8.43	14.1	3.66	1.89		1.89	1		
11/21/2005	LACSD	C2		0.20	0.20	0.10	8.55	14.5	2.91	1.50		1.50	1		
11/21/2005	LACSD	RA		0.50	0.50	0.10	9.37	23.7	0.80	0.25		0.25	1		1
11/29/2005	LACSD	RA		0.10	0.10	0.10	8.46	10.7	3.46	2.24		2.24	1		
11/30/2005	LACSD	C2	<	0.10	0.10	0.10	8.11	13.1	6.82	3.39		3.39	1		
12/6/2005	LACSD	RA		0.70	0.70	0.10	7.79	14.7	12.36	4.77		4.77	1		
12/7/2005	LACSD	C2	<	0.10	0.10	0.10	9.25	14.3	0.93	0.53		0.53	1		
12/13/2005	LACSD	RD	<	0.10	0.10	0.10	9.22	13.7	0.96	0.57		0.57	1		
12/13/2005	LACSD	RC	<	0.10	0.10	0.10	9.00	13.4	1.32	0.79		0.79	1		
12/13/2005	LACSD	RA		0.90	0.90	0.10	7.92	16.1	9.76	3.69		3.69	1		
12/14/2005	LACSD	C2		0.40	0.40	0.10	8.09	14.9	7.08	3.12		3.12	1		
12/20/2005	LACSD	RA		0.40	0.40	0.10	8.74	21.8	2.05	0.68		0.68	1		
12/21/2005	LACSD	C2		0.60	0.60	0.10	7.89	17.8	10.32	3.45		3.45	1		
12/21/2005	LACSD	C1		0.20	0.20	0.10	8.64	13.2	2.46	1.40		1.40	1		
12/28/2005	LACSD	C2		0.60	0.60	0.10	7.76	17.2	13.02	4.21		4.21	1		
1/5/2006	LACSD	C2	<	0.10	0.10	0.10	8.22	13.1	5.51	2.85		2.85	1		
1/11/2006	LACSD	C2		0.60	0.60	0.10	7.65	16.9	15.70	4.87		4.87	1		
1/11/2006	LACSD	C1		0.10	0.10	0.10	8.47	11.4	3.39	2.10		2.10	1		
1/17/2006	LACSD	RD	<	0.10	0.10	0.10	9.02	13.7	1.28	0.75		0.75	1		
1/17/2006	LACSD	RC		0.10	0.10	0.10	8.95	13.2	1.43	0.85		0.85	1		
1/17/2006	LACSD	RA		0.80	0.80	0.10	7.70	21.3	14.44	3.46		3.46	1		
1/18/2006	LACSD	C2	<	0.10	0.10	0.10	8.26	10.6	5.10	3.14		3.14	1		
1/25/2006	LACSD	C2		0.10	0.10	0.10	7.97	10.4	8.90	4.98		4.98	1		
2/1/2006	LACSD	C2		0.60	0.60	0.10	7.30	16.0	26.21	6.93		6.93	1		
2/1/2006	LACSD	C1		0.10	0.10	0.10	8.25	12.7	5.20	2.79		2.79	1		
2/8/2006	LACSD	C2		0.70	0.70	0.10	7.47	14.6	20.79	6.68		6.68	1		
2/15/2006	LACSD	C2		0.50	0.50	0.10	7.73	17.8	13.72	4.21		4.21	1		

ATTACHMENT B

APPENDIX D - TABLE D1

SAN JOSE CREEK REACH 1 - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (C)	CMC (mg/L)	SSO Adjusted CCC (mg/L) No ELS	SSO Adjusted CCC (mg/L) with ELS	4-Day Average CCC	Is 4-Day Average Usable? (1=Yes)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed 4-Day CCC (1=Yes)
2/21/2006	LACSD	RD	<	0.10	0.10	0.10	9.11	15.8	1.12	0.58		0.58	1		
2/21/2006	LACSD	RC	<	0.10	0.10	0.10	9.41	12.5	0.77	0.50		0.50	1		
2/21/2006	LACSD	RA		0.90	0.90	0.10	7.98	20.9	8.73	2.49		2.49	1		
2/22/2006	LACSD	C2	<	0.10	0.10	0.10	7.91	10.8	9.95	5.25		5.25	1		
2/27/2006	LACSD	C2		0.40	0.40	0.10	7.76	16.9	13.02	4.30		4.30	1		
3/9/2006	LACSD	C2		1.20	1.20	0.10	7.57	20.3	17.86	4.24		4.24	1		
3/15/2006	LACSD	C2		1.30	1.30	0.10	7.66	19.6	15.44	4.04		4.04	1		
3/15/2006	LACSD	C1		0.20	0.20	0.10	8.23	12.5	5.40	2.92		2.92	1		
3/23/2006	LACSD	C2	<	0.10	*	0.10	9.16	15.8	1.05	0.54		*	*		*
3/23/2006	LACSD	RD	<	0.10	0.10	0.10	9.99	26.4	0.51	0.14		0.14	1		
3/23/2006	LACSD	RC		0.30	0.30	0.10	9.80	24.8	0.56	0.17		0.17	1		1
3/23/2006	LACSD	RA		1.20	1.20	0.10	8.88	24.9	1.61	0.45		0.45	1		1
3/27/2006	LACSD	C2		0.20	0.15	0.10	9.26	16.9	0.92	0.44		0.45	1		
4/3/2006	LACSD	C2		0.17	0.17	0.10	9.00	16.3	1.32		0.52	0.52	1		
4/12/2006	LACSD	C2	<	0.10	0.10	0.10	9.24	16.8	0.94		0.38	0.38	1		
4/18/2006	LACSD	RD		0.11	0.11	0.10	9.33	22.5	0.84		0.29	0.29	1		
4/18/2006	LACSD	RC	<	0.10	0.10	0.10	9.52	18.7	0.69		0.29	0.29	1		
4/18/2006	LACSD	RA		0.62	0.62	0.10	8.65	21.7	2.42		0.80	0.80	1		
4/19/2006	LACSD	C2		0.64	0.64	0.10	7.69	21.5	14.69		3.46	3.46	1		
4/19/2006	LACSD	C1	<	0.10	0.10	0.10	8.32	16.0	4.53		1.59	1.59	1		
4/25/2006	LACSD	RA		0.74	0.74	0.10	8.62	22.5	2.55		0.80	0.80	1		
4/26/2006	LACSD	C2	<	0.10	0.10	0.10	8.94	17.9	1.46		0.57	0.57	1		
5/2/2006	LACSD	RA		0.11	0.11	0.10	9.01	19.1	1.30		0.52	0.52	1		
5/3/2006	LACSD	C2		0.14	0.14	0.10	8.71	20.7	2.16		0.77	0.77	1		
5/9/2006	LACSD	RA	<	0.10	0.10	0.10	9.01	18.1	1.30		0.52	0.52	1		
5/10/2006	LACSD	C2		0.40	0.40	0.10	7.69	23.1	14.69		3.12	3.12	1		
5/17/2006	LACSD	C2		0.44	0.44	0.10	8.02	21.2	8.10		2.31	2.31	1		
5/17/2006	LACSD	C1	<	0.10	0.10	0.10	8.42	20.5	3.74		1.27	1.27	1		
5/25/2006	LACSD	C2		0.17	0.17	0.10	7.94	22.4	9.41		2.39	2.39	1		
5/30/2006	LACSD	RD		0.16	0.16	0.10	9.01	32.2	1.30		0.23	0.23	1		
5/30/2006	LACSD	RC		0.15	0.15	0.10	9.27	23.0	0.90		0.30	0.30	1		
5/30/2006	LACSD	RA		1.10	1.10	0.10	7.88	26.7	10.51		1.96	1.96	1		
5/31/2006	LACSD	C2		0.49	0.49	0.10	7.66	20.5	15.44		3.81	3.81	1		
6/7/2006	LACSD	C2		0.44	0.44	0.10	7.35	24.5	24.58		3.87	3.87	1		

ATTACHMENT B

APPENDIX D - TABLE D1

SAN JOSE CREEK REACH 1 - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (C)	CMC (mg/L)	SSO Adjusted CCC (mg/L) No ELS	SSO Adjusted CCC (mg/L) with ELS	4-Day Average CCC	Is 4-Day Average Usable? (1=Yes)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed 4-Day CCC (1=Yes)
6/7/2006	LACSD	C1		1.30	1.30	0.10	8.02	20.5	8.10		2.41	2.41	1		
6/14/2006	LACSD	C2		0.17	0.17	0.10	8.18	16.6	5.95		1.99	1.99	1		
6/20/2006	LACSD	RD		0.14	0.14	0.10	9.60	30.3	0.64		0.13	0.13	1		1
6/20/2006	LACSD	RC		0.15	0.15	0.10	9.39	24.4	0.79		0.24	0.24	1		
6/21/2006	LACSD	C2		0.18	0.18	0.10	8.05	19.0	7.65		2.44	2.44	1		
6/28/2006	LACSD	C2		0.52	0.52	0.10	7.57	23.7	17.86		3.39	3.39	1		
7/5/2006	LACSD	C2		0.76	0.76	0.10	7.62	24.9	16.49		3.00	3.00	1		
7/12/2006	LACSD	C2		0.74	0.74	0.10	7.74	23.6	13.48		2.86	2.86	1		
7/12/2006	LACSD	C1		0.24	0.24	0.10	8.28	32.1	4.90		0.76	0.76	1		
7/18/2006	LACSD	RD	<	0.10	0.10	0.10	9.08	33.7	1.17		0.19	0.19	1		
7/18/2006	LACSD	RC	<	0.10	0.10	0.10	9.11	28.3	1.12		0.26	0.26	1		
7/19/2006	LACSD	C2		1.10	1.10	0.10	7.19	27.7	29.87		3.47	3.47	1		
7/26/2006	LACSD	C2		0.73	0.73	0.10	7.60	26.1	17.03		2.84	2.84	1		
8/2/2006	LACSD	C2		0.74	0.74	0.10	7.76	25.3	13.02		2.50	2.50	1		
8/9/2006	LACSD	C2		0.16	0.16	0.10	7.82	24.5	11.71		2.45	2.45	1		
8/16/2006	LACSD	C2		0.62	0.62	0.10	7.89	23.5	10.32		2.38	2.38	1		
8/16/2006	LACSD	C1		0.12	0.12	0.10	8.65	21.8	2.42		0.79	0.79	1		
8/23/2006	LACSD	C2		0.33	0.33	0.10	7.75	23.9	13.25		2.77	2.77	1		
8/23/2006	LACSD	RD	<	0.10	0.10	0.10	9.61	29.6	0.64		0.14	0.14	1		
8/23/2006	LACSD	RC	<	0.10	0.10	0.10	9.03	23.9	1.26		0.38	0.38	1		
8/30/2006	LACSD	C2		0.42	0.42	0.10	7.87	23.5	10.70		2.45	2.45	1		
9/6/2006	LACSD	C2		0.76	0.76	0.10	7.41	27.8	22.66		2.99	2.99	1		
9/13/2006	LACSD	C2		0.41	0.41	0.10	7.89	25.8	10.32		2.05	2.05	1		
9/13/2006	LACSD	C1		0.93	0.93	0.10	8.27	20.7	5.00		1.62	1.62	1		
9/20/2006	LACSD	C2		0.50	0.50	0.10	8.25	9.7	5.20		1.78	1.78	1		
9/27/2006	LACSD	RD		0.10	0.10	0.10	8.72	25.8	2.13		0.55	0.55	1		
9/27/2006	LACSD	RC	<	0.10	0.10	0.10	8.74	20.9	2.05		0.73	0.73	1		
10/4/2006	LACSD	RD	<	0.10	0.10	0.10	8.87	24.0	1.64	0.48		0.48	1		
10/4/2006	LACSD	RC	<	0.10	0.10	0.10	8.88	21.0	1.61	0.58		0.58	1		
10/11/2006	LACSD	C2		0.74	0.74	0.10	7.68	20.7	14.94	3.68		3.68	1		
10/11/2006	LACSD	C1		0.17	0.17	0.10	8.45	16.7	3.53	1.54		1.54	1		
10/18/2006	LACSD	C2		0.58	0.58	0.10	7.68	22.1	14.94	3.36		3.36	1		
11/1/2006	LACSD	C2		0.40	0.40	0.10	7.55	19.0	18.43	4.69		4.69	1		
11/1/2006	LACSD	RD		0.14	0.14	0.10	9.46	18.7	0.73	0.32		0.32	1		

ATTACHMENT B

APPENDIX D - TABLE D1

SAN JOSE CREEK REACH 1 - AMMONIA

Sample Date	Source	Location	Qualifier	Ammonia (mg/L)	4-Day Ammonia Average (mg/L)	RL (mg/L)	pH	Temp (C)	CMC (mg/L)	SSO Adjusted CCC (mg/L) No ELS	SSO Adjusted CCC (mg/L) with ELS	4-Day Average CCC	Is 4-Day Average Usable? (1=Yes)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed 4-Day CCC (1=Yes)
11/1/2006	LACSD	RC		0.12	0.12	0.10	9.25	18.2	0.93	0.41		0.41	1		
11/8/2006	LACSD	C2		0.88	0.88	0.10	7.48	22.8	20.49	3.91		3.91	1		
11/8/2006	LACSD	C1		0.37	0.37	0.10	8.08	15.8	7.22	2.99		2.99	1		
11/15/2006	LACSD	C2		0.32	0.32	0.10	7.62	18.5	16.49	4.52		4.52	1		
11/22/2006	LACSD	C2		0.23	0.23	0.10	7.43	19.7	22.03	4.96		4.96	1		
11/29/2006	LACSD	C2		1.02	1.02	0.10	7.50	20.9	19.89	4.34		4.34	1		
12/6/2006	LACSD	C2		0.29	0.29	0.10	7.71	12.5	14.20	6.05		6.05	1		
12/6/2006	LACSD	RD	<	0.10	0.10	0.10	9.12	15.4	1.11	0.58		0.58	1		
12/6/2006	LACSD	RC	<	0.10	0.10	0.10	8.41	13.8	3.81	2.00		2.00	1		
12/13/2006	LACSD	C2		0.82	0.82	0.10	7.40	21.5	22.97	4.53		4.53	1		
12/13/2006	LACSD	C1		0.20	0.20	0.10	8.03	11.7	7.94	4.19		4.19	1		
12/20/2006	LACSD	C2		1.12	1.12	0.10	7.35	19.3	24.58	5.40		5.40	1		
1/3/2007	LACSD	C2		0.44	0.44	0.10	7.89	13.6	10.32	4.51		4.51	1		
1/3/2007	LACSD	RD	<	0.10	0.10	0.10	9.26	13.8	0.92	0.54		0.54	1		
1/3/2007	LACSD	RC	<	0.10	0.10	0.10	8.85	13.4	1.69	0.99		0.99	1		
1/3/2007	LACSD	RA		0.39	0.39	0.10	8.79	18.6	1.88	0.78		0.78	1		
1/10/2007	LACSD	C1	<	0.10	0.10	0.10	8.86	11.6	1.66	1.09		1.09	1		
1/24/2007	LACSD	C2		1.25	*	0.10	7.23	19.5	28.54	5.77		*	*		*
1/25/2007	LACSD	C2		1.09	1.17	0.10	7.34	19.8	24.90	5.29		5.53	1		
2/7/2007	LACSD	C2		0.86	0.86	0.10	7.34	18.3	24.90	5.82		5.82	1		
2/7/2007	LACSD	RD	<	0.10	0.10	0.10	9.61	18.9	0.64	0.28		0.28	1		
2/7/2007	LACSD	RC	<	0.10	0.10	0.10	9.44	17.4	0.75	0.36		0.36	1		
2/14/2007	LACSD	C1		0.12	0.12	0.10	8.05	11.7	7.65	4.08		4.08	1		
2/21/2007	LACSD	C2		1.59	1.59	0.10	7.21	21.4	29.21	5.16		5.16	1		

LACSD - Sanitation Districts of Los Angeles County
* - Data used in calculation of a 4 day average
** - Not usable - Non-detect with RL greater than the CCC
SSO - Site Specific Objective
ELS - Early Life Stages

14 of 282 4-day averages exceed Site Specific Objective (SSO) Criterion Continuous Concentration (CCC)

0 of 296 samples exceed Criterion Maximum Concentration (CMC)

ATTACHMENT B

APPENDIX E - TABLE E1

SANTA CLARA RIVER REACH 6 - CHLORPYRIFOS

Sample Date	Source	Location	Qualifier	Chlorpyrifos (ug/L)	Method	PQL/RL (ug/L)	QA/QC	Fish and Game 4-Day CCC	Is Sample Usable? (1=Yes)	Qualifier	4-Day Average Concentration (ug/L)	Does 4-Day Average Exceed CCC? (1=Yes)
10/31/2001	SWAMP	SCTBQT		0.059	ELISA	0.05	Pass	0.05	1		0.059	1
10/31/2001	SWAMP	SCTBQT	<	0.05	EPA 8141A	0.05	Fail	0.05			**	
11/15/2001	SWAMP	SCTBQT		0.077	ELISA	0.05	Pass	0.05	1		0.077	1
EPA ceased sale of all indoor and outdoor residential products containing chlorpyrifos on December 31, 2001.												
8/5/2002	SWAMP	SCTBQT		0.068	ELISA	0.05	Fail	0.05			**	
8/5/2002	SWAMP	SCTBQT		0.053	ELISA	0.05	Fail	0.05			**	
8/20/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
8/28/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
8/28/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
9/4/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
9/4/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
9/19/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
9/19/2002	SWAMP	SCTBQT		0.055	ELISA	0.05	Fail	0.05			**	
10/4/2002	SWAMP	SCTBQT		0.051	ELISA	0.05	Fail	0.05			**	
10/4/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
10/10/2002	LACDPW	S29	<	0.05	EPA 505	0.05	Pass	0.05	1	<	0.05	
10/19/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
10/19/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
11/7/2002	SWAMP	SCTBQT		0.061	ELISA	0.05	Fail	0.05			**	
11/8/2002	LACDPW	S29	<	0.05	EPA 501	0.05	Pass	0.05	1	<	0.05	
11/18/2002	SWAMP	SCTBQT		0.067	ELISA	0.05	Fail	0.05			**	
12/3/2002	SWAMP	SCTBQT		0.061	ELISA	0.05	Fail	0.05			**	
12/16/2002	LACDPW	S29	<	0.05	EPA 502	0.05	Pass	0.05	1	<	0.05	
12/18/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
12/18/2002	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
1/2/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
1/2/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
1/13/2003	SWAMP	SCTBQT	<	0.05	EPA 8141A	0.05	Fail	0.05			**	
1/17/2003	SWAMP	SCTBQT		0.051	ELISA	0.05	Fail	0.05			**	
1/17/2003	SWAMP	SCTBQT		0.062	ELISA	0.05	Fail	0.05			**	
2/1/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
2/1/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
2/11/2003	LACDPW	S29	<	0.05	EPA 503	0.05	Pass	0.05	1	<	0.05	
2/16/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
2/16/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
3/3/2003	SWAMP	SCTBQT		0.096	ELISA	0.05	Fail	0.05			**	
3/3/2003	SWAMP	SCTBQT		0.07	ELISA	0.05	Fail	0.05			**	
3/15/2003	LACDPW	S29	<	0.05	EPA 504	0.05	Pass	0.05	1	<	0.05	
3/18/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
4/2/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
4/2/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
4/17/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
4/17/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
4/30/2003	LACDPW	S29	<	0.05	EPA 506	0.05	Pass	0.05	1	<	0.05	
5/2/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
5/2/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
5/17/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
5/17/2003	SWAMP	SCTBQT	<	0.05	ELISA	0.05	Fail	0.05			**	
10/28/2003	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
10/31/2003	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1		*	
12/25/2003	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
1/1/2004	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
1/13/2004	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
10/17/2004	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
10/26/2004	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
1/7/2005	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
3/9/2005	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
10/17/2005	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
11/29/2005	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
12/31/2005	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
1/14/2006	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
2/17/2006	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
4/25/2006	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
10/31/2006	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
12/9/2006	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	

APPENDIX E - TABLE E1

SANTA CLARA RIVER REACH 6 - CHLORPYRIFOS

Sample Date	Source	Location	Qualifier	Chlorpyrifos (ug/L)	Method	PQL/RL (ug/L)	QA/QC	Fish and Game 4-Day CCC	Is Sample Usable? (1=Yes)	Qualifier	4-Day Average Concentration (ug/L)	Does 4-Day Average Exceed CCC? (1=Yes)
12/16/2006	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
1/30/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
2/19/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1		*	
2/22/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
4/2/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
9/21/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
11/25/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1		*	
11/29/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
12/6/2007	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	
4/9/2008	LACDPW	S29	<	0.05	EPA 507	0.05	Pass	0.05	1	<	0.05	

* = Data averaged for 4-Day average
** = Data failed QAPP provisions
LACDPW - Los Angeles County Department of Public Works
SWAMP - Surface Water Ambient Monitoring Program
Fish and Game - California Department of Fish and Game

0 of 30 4-day averages since EPA ban on residential sales exceed Criterion Continuous Concentration (CCC)

ATTACHMENT B
APPENDIX G - TABLE G1
SANTA CLARA RIVER REACH 6 - DIAZINON

Date	Source	Location	Qualifier	Diazinon (ug/L)	Method	PQL/RL (ug/L)	QA/QC	Is Sample Usable? (1=Yes)	CMC (ug/L)	Exceeds CMC (1 = Yes)	Qualifier	4-day Average (ug/L)	CCC (ug/L)	Exceeds CCC (1 = Yes)
10/31/2001	SWAMP	403STCBQT		2	ELISA	0.03	Pass	1	0.16			2	0.1	1
10/31/2001	SWAMP	403STCBQT		2.25	EPA 8141A	0.02	Fail		0.16			**	0.1	
11/15/2001	SWAMP	403STCBQT		1.69	ELISA	0.03	Pass	1	0.16			1.69	0.1	1
8/5/2002	SWAMP	403STCBQT		4.29	ELISA	0.03	Fail		0.16			**	0.1	
8/5/2002	SWAMP	403STCBQT		4.14	ELISA	0.03	Fail		0.16			**	0.1	
8/20/2002	SWAMP	403STCBQT		6.7	ELISA	0.03	Fail		0.16			**	0.1	
8/28/2002	SWAMP	403BQT104		0.858	ELISA	0.03	Fail		0.16			**	0.1	
8/28/2002	SWAMP	403BQT105		0.435	ELISA	0.03	Fail		0.16			**	0.1	
8/28/2002	SWAMP	403BQT106		4.07	ELISA	0.03	Fail		0.16			**	0.1	
8/28/2002	SWAMP	403BQT106		3.98	ELISA	0.03	Fail		0.16			**	0.1	
8/28/2002	SWAMP	403BQT109		0.862	ELISA	0.03	Fail		0.16			**	0.1	
8/28/2002	SWAMP	403STCBQT		5.74	ELISA	0.03	Fail		0.16			**	0.1	
8/28/2002	SWAMP	403STCBQT		5.75	ELISA	0.03	Fail		0.16			**	0.1	
9/4/2002	SWAMP	403STCBQT		6.05	ELISA	0.03	Fail		0.16			**	0.1	
9/4/2002	SWAMP	403STCBQT		5.57	ELISA	0.03	Fail		0.16			**	0.1	
9/19/2002	SWAMP	403STCBQT		1.29	ELISA	0.03	Fail		0.16			**	0.1	
9/19/2002	SWAMP	403STCBQT		1.23	ELISA	0.03	Fail		0.16			**	0.1	
10/4/2002	SWAMP	403STCBQT		1.52	ELISA	0.03	Fail		0.16			**	0.1	
10/10/2002	LADPW	S29	<	0.01	EPA505	0.01	Pass	1	0.16		<	0.01	0.1	
10/19/2002	SWAMP	403STCBQT		2.67	ELISA	0.03	Fail		0.16			**	0.1	
10/19/2002	SWAMP	403STCBQT		2.55	ELISA	0.03	Fail					**	0.1	
11/7/2002	SWAMP	403STCBQT		0.813	ELISA	0.03	Fail		0.16			**	0.1	
11/8/2002	LADPW	S29		0.43	EPA501	0.01	Pass	1	0.16	1		0.43	0.1	1
11/18/2002	SWAMP	403STCBQT		1.07	ELISA	0.03	Fail		0.16			**	0.1	
12/3/2002	SWAMP	403STCBQT		0.479	ELISA	0.03	Fail		0.16			**	0.1	
12/16/2002	LADPW	S29	<	0.01	EPA502	0.01	Pass	1	0.16		<	0.01	0.1	
12/18/2002	SWAMP	403STCBQT		1.67	ELISA	0.03	Fail		0.16			**	0.1	
12/18/2002	SWAMP	403STCBQT		1.57	ELISA	0.03	Fail		0.16			**	0.1	
1/2/2003	SWAMP	403STCBQT		0.499	ELISA	0.03	Fail		0.16			**	0.1	
1/2/2003	SWAMP	403STCBQT		0.382	ELISA	0.03	Fail		0.16			**	0.1	
1/13/2003	SWAMP	403STCBQT		0.4	EPA 8141A	0.02	Fail		0.16			**	0.1	
1/17/2003	SWAMP	403STCBQT		0.321	ELISA	0.03	Fail		0.16			**	0.1	
1/17/2003	SWAMP	403STCBQT		0.277	ELISA	0.03	Fail		0.16			**	0.1	
2/1/2003	SWAMP	403STCBQT		0.805	ELISA	0.03	Fail		0.16			**	0.1	
2/1/2003	SWAMP	403STCBQT		0.718	ELISA	0.03	Fail		0.16			**	0.1	
2/11/2003	LADPW	S29		0.265	EPA503	0.01	Pass	1	0.16	1		0.265	0.1	1
2/16/2003	SWAMP	403STCBQT		0.623	ELISA	0.03	Fail		0.16			**	0.1	
2/16/2003	SWAMP	403STCBQT		0.556	ELISA	0.03	Fail		0.16			**	0.1	
3/3/2003	SWAMP	403STCBQT		5.52	ELISA	0.03	Fail		0.16			**	0.1	
3/3/2003	SWAMP	403STCBQT		4.97	ELISA	0.03	Fail		0.16			**	0.1	
3/15/2003	LADPW	S29		0.05	EPA504	0.01	Pass	1	0.16			0.05	0.1	
3/18/2003	SWAMP	403STCBQT		0.054	ELISA	0.03	Fail		0.16			**	0.1	
4/2/2003	SWAMP	403STCBQT		0.979	ELISA	0.03	Fail		0.16			**	0.1	
4/2/2003	SWAMP	403STCBQT		0.947	ELISA	0.03	Fail		0.16			**	0.1	
4/17/2003	SWAMP	403STCBQT		0.315	ELISA	0.03	Fail		0.16			**	0.1	
4/17/2003	SWAMP	403STCBQT		0.35	ELISA	0.03	Fail		0.16			**	0.1	
4/30/2003	LADPW	S29		0.023	EPA506	0.01	Pass	1	0.16			0.023	0.1	
5/2/2003	SWAMP	403STCBQT		0.512	ELISA	0.03	Fail		0.16			**	0.1	
5/2/2003	SWAMP	403STCBQT		0.499	ELISA	0.03	Fail		0.16			**	0.1	
5/17/2003	SWAMP	403STCBQT		1.32	ELISA	0.03	Fail		0.16			**	0.1	
5/17/2003	SWAMP	403STCBQT		1.33	ELISA	0.03	Fail		0.16			**	0.1	
10/28/2003	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16			*	0.1	
10/31/2003	LADPW	S29		0.082	EPA507	0.01	Pass	1	0.16		<	0.05	0.1	
12/25/2003	LADPW	S29		0.021	EPA507	0.01	Pass	1	0.16			0.021	0.1	
1/1/2004	LADPW	S29		0.028	EPA507	0.01	Pass	1	0.16			0.028	0.1	
1/7/2004	LACSD	RB		0.39	SW8141	0.05	Pass	1	0.16	1		0.39	0.1	1
1/13/2004	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
4/14/2004	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
10/17/2004	LADPW	S29		0.41	EPA507	0.01	Pass	1	0.16	1		0.41	0.1	1
10/26/2004	LADPW	S29		0.03	EPA507	0.01	Pass	1	0.16			0.03	0.1	
11/1/2004	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
12/22/2004	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
EPA ceased sale of all indoor and outdoor non-agricultural products containing diazinon on December 31, 2004.														
1/7/2005	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
1/17/2005	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
2/7/2005	LACSD	RB		0.51	SW8141	0.05	Pass	1	0.16	1		0.51	0.1	1
2/9/2005	LACSD	RA	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
3/9/2005	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
4/13/2005	LACSD	RA	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
4/13/2005	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	

ATTACHMENT B

APPENDIX G - TABLE G1

SANTA CLARA RIVER REACH 6 - DIAZINON

Date	Source	Location	Qualifier	Diazinon (ug/L)	Method	PQL/RL (ug/L)	QA/QC	Is Sample Usable? (1=Yes)	CMC (ug/L)	Exceeds CMC (1 = Yes)	Qualifier	4-day Average (ug/L)	CCC (ug/L)	Exceeds CCC (1 = Yes)
7/6/2005	LACSD	RB	<	0.1	SW8141	0.1	Pass	1	0.16		<	0.1	0.1	
10/3/2005	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
10/17/2005	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
11/29/2005	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
12/31/2005	LADPW	S29		0.01	EPA507	0.01	Pass	1	0.16			0.01	0.1	
1/9/2006	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
1/14/2006	LADPW	S29		0.11	EPA507	0.01	Pass	1	0.16			0.11	0.1	1
2/17/2006	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
4/17/2006	LACSD	RA	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
4/17/2006	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
4/20/2006	LACSD	RA	<	0.05	SW8141	0.05	Pass	1	0.16			*	0.1	
4/25/2006	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
7/5/2006	LACSD	RA	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
7/5/2006	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
10/16/2006	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
10/31/2006	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
12/9/2006	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
12/16/2006	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
1/3/2007	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
1/30/2007	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
2/19/2007	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
2/22/2007	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16			*	0.1	
4/2/2007	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
4/2/2007	LADPW	S29	<	0.01	EPA507	0.01	Pass	1	0.16		<	0.01	0.1	
7/16/2007	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
9/21/2007	LADPW	S29	<	0.05	EPA 507	0.01	Pass	1	0.16		<	0.05	0.1	
10/15/2007	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
11/25/2007	LADPW	S29	<	0.05	EPA 507	0.01	Pass	1	0.16			*	0.1	
11/29/2007	LADPW	S29	<	0.05	EPA 507	0.01	Pass	1	0.16		<	0.05	0.1	
12/6/2007	LADPW	S29	<	0.05	EPA 507	0.01	Pass	1	0.16		<	0.05	0.1	
1/9/2008	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
4/7/2008	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	
4/9/2008	LADPW	S29	<	0.05	EPA 507	0.01	Pass	1	0.16		<	0.05	0.1	
7/14/2008	LACSD	RB	<	0.05	SW8141	0.05	Pass	1	0.16		<	0.05	0.1	

* = Data averaged for 4-Day average
** = Data failed QAPP provisions
LADPW - Los Angeles Department of Public Works
SWAMP - Surface Water Ambient Monitoring Program
LACSD - Sanitation Districts of Los Angeles County

2 of 29 4-day averages from January 1, 2005 to April 2, 2007 exceed Criterion Continuous Concentration (CCC)

1 of 31 samples from January 1, 2005 to April 2, 2007 exceed Criterion Maximum Concentration (CMC)

ATTACHMENT B
APPENDIX H - TABLE H1
COYOTE CREEK - DIAZINON

Date	Source	Location	Qualifier	Diazinon (ug/L)	Method	PQL/RL (ug/L)	CMC (ug/L)	Exceeds CMC (1 = Yes)	Is Sample Usable? (1=Yes)	Qualifier	4-day Average (ug/L)	CCC (ug/L)	Exceeds CCC (1 = Yes)
10/28/2003	LACDPW	S13		0.181	EPA507	0.01	0.16	1	1		*	0.1	
10/31/2003	LACDPW	S13		0	EPA507	0.01	0.16		1		0.0905	0.1	
12/2/2003	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
12/2/2003	LACSD	RA1	E	0.03	SW8141	0.05	0.16		1	E	0.03	0.1	
12/25/2003	LACDPW	S13		0	EPA507	0.01	0.16		1		0	0.1	
1/1/2004	LACDPW	S13		0.104	EPA507	0.01	0.16		1		0.104	0.1	1
1/7/2004	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
1/7/2004	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
1/13/2004	LACDPW	S13		0	EPA507	0.01	0.16		1		0	0.1	
4/5/2004	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
4/5/2004	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
7/12/2004	LACSD	RA1		0.24	SW8141	0.05	0.16	1	1		0.24	0.1	1
7/16/2004	LACSD	RA		0.39	SW8141	0.05	0.16	1	1		0.39	0.1	1
7/16/2004	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
10/4/2004	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
10/4/2004	LACSD	RA1		0.14	SW8141	0.05	0.16		1		0.14	0.1	1
10/17/2004	LACDPW	S13		0.065	EPA507	0.01	0.16		1		0.065	0.1	
10/26/2004	LACDPW	S13		0.06	EPA507	0.01	0.16		1		0.06	0.1	
11/16/2004	LACDPW	S13		ND	EPA507	0.01	0.16		1		ND	0.1	
12/5/2004	LACDPW	S13		0.079	EPA507	0.01	0.16		1		0.079	0.1	
EPA ceased sale of all indoor and outdoor non-agricultural products containing diazinon on December 31, 2004.													
1/7/2005	LACDPW	S13		ND	EPA507	0.01	0.16		1		ND	0.1	
1/17/2005	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
1/17/2005	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
3/9/2005	LACDPW	S13		ND	EPA507	0.01	0.16		1		ND	0.1	
4/4/2005	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
4/4/2005	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
6/23/2005	LACSD	RA		0.19	SW8141	0.05	0.16	1	1		0.19	0.1	1
7/18/2005	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
7/18/2005	LACSD	RA1		0.19	SW8141	0.05	0.16	1	1		0.19	0.1	1
10/10/2005	LACSD	RA		0.096	SW8141	0.05	0.16		1		0.096	0.1	
10/10/2005	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
10/17/2005	LACDPW	S13		0	EPA507	0.01	0.16		1		0	0.1	
12/31/2005	LACDPW	S13		0	EPA507	0.01	0.16		1		0	0.1	
1/5/2006	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
1/5/2006	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
1/14/2006	LACDPW	S13		0	EPA507	0.01	0.16		1		0	0.1	
1/24/2006	LACDPW	S13		0	EPA507	0.01	0.16		1		0	0.1	
2/17/2006	LACDPW	S13		0	EPA507	0.01	0.16		1		0	0.1	
3/3/2006	LACDPW	S13		0	EPA507	0.01	0.16		1		0	0.1	
4/10/2006	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
4/10/2006	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
4/25/2006	LACDPW	S13		0	EPA507	0.01	0.16		1		0	0.1	
7/12/2006	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
7/12/2006	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
10/11/2006	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
10/11/2006	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
11/1/2006	LACDPW	S13		ND	EPA507	0.01	0.16		1		ND	0.1	
12/9/2006	LACDPW	S13		ND	EPA507	0.01	0.16		1		ND	0.1	
1/8/2007	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
1/8/2007	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
2/10/2007	LACDPW	S13		ND	EPA507	0.01	0.16		1		ND	0.1	
2/19/2007	LACDPW	S13		ND	EPA507	0.01	0.16		1		*	0.1	
2/22/2007	LACDPW	S13		ND	EPA507	0.01	0.16		1		ND	0.1	
4/2/2007	LACDPW	S13		0.147	EPA507	0.01	0.16		1		0.147	0.1	1
4/11/2007	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
4/11/2007	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
7/9/2007	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
7/9/2007	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
9/21/2007	LACDPW	S13		ND	EPA507	0.01	0.16		1		ND	0.1	
10/8/2007	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
10/8/2007	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
10/12/2007	LACDPW	S13		ND	EPA507	0.01	0.16		1		ND	0.1	
11/25/2007	LACDPW	S13		ND	EPA507	0.01	0.16		1		*	0.1	
11/29/2007	LACDPW	S13		ND	EPA507	0.01	0.16		1		ND	0.1	
12/6/2007	LACDPW	S13		ND	EPA507	0.01	0.16		1		ND	0.1	
12/18/2007	LACDPW	S13		ND	EPA507	0.01	0.16		1		ND	0.1	
1/9/2008	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	

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COYOTE CREEK - DIAZINON

Date	Source	Location	Qualifier	Diazinon (ug/L)	Method	PQL/RL (ug/L)	CMC (ug/L)	Exceeds CMC (1 = Yes)	Is Sample Usable? (1=Yes)	Qualifier	4-day Average (ug/L)	CCC (ug/L)	Exceeds CCC (1 = Yes)
1/9/2008	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
4/9/2008	LACDPW	S13		ND	EPA507	0.01	0.16		1		ND	0.1	
4/14/2008	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
4/14/2008	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
7/7/2008	LACSD	RA	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	
7/7/2008	LACSD	RA1	<	0.05	SW8141	0.05	0.16		1	<	0.05	0.1	

* = Data averaged for 4-Day average

3 of 51 4-day averages from January 1, 2005 to July 7, 2008 exceed Criterion Continuous Concentration (CCC)

LACDPW - Los Angeles County Department of Public Works
LACSD - Sanitation Districts of Los Angeles County

2 of 53 samples from January 1, 2005 to July 7, 2008 exceed Criterion Maximum Concentration (CMC)

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APPENDIX I - TABLE I1
COYOTE CREEK - COPPER

Sample Date	Source	Location	Qualifier	Total Copper (ug/L)	Qualifier	Dissolved Copper (ug/L)	PQL/RL (ug/L)	Method	4-Day Average Concentration (ug/L)	Hardness	Dissolved Copper CMC (ug/L)	4-Day Dissolved CCC (ug/L)	Is Sample Usable for CCC? (1=Yes)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed CCC (1=Yes)
8/5/1998	LACSD	R9E	<	10	<	10	10	EPA200.8	10	235	30.1	18.6	1		
8/5/1998	LACSD	RA	<	10	<	10	10	EPA200.8	10	293.3	37.0	22.5	1		
10/14/1998	LACDPW	S13		7.5	<	5.0	5	A220.1	5.0	400	49.6	29.3	1		
11/8/1998	LACDPW	S13		12.3		6.2	5	A220.1	6.2	102	13.7	9.1	1		
11/28/1998	LACDPW	S13		44.1		7.0	5	A220.1	*	140	18.5	*	*		*
12/1/1998	LACDPW	S13		13.7		7.5	5	A220.1	7.3	82	11.1	9.7	1		
12/6/1998	LACDPW	S13		10.9	<	5.0	5	A220.1	5.0	195	25.2	15.8	1		
1/12/1999	LACDPW	S13		11.7		7.4	5	A220.1	7.4	400	49.6	29.3	1		
1/21/1999	LACDPW	S13		16.2	<	5.0	5	A220.1	*	176	22.9	*	*		*
1/25/1999	LACDPW	S13		9.3		5.0	5	A220.1	5.0	90	12.2	11.4	1		
2/2/1999	LACDPW	S13		9.9	<	5.0	5	A220.1	5.0	78	10.6	7.2	1		
2/7/1999	LACDPW	S13		15.4		6.7	5	A220.1	*	140	18.5	*	*		*
2/10/1999	LACDPW	S13		14.1	<	5.0	5	A220.1	5.9	210	27.0	14.4	1		
8/10/1999	LACSD	R9E	<	10	<	10	10	EPA200.8	10	329.2	41.3	24.8	1		
8/10/1999	LACSD	RA	<	10	<	10	10	EPA200.8	10	293.3	37.0	22.5	1		
11/8/1999	LACDPW	S13		5.45		5.5	5	A220.1	5.5	192.7	24.9	15.7	1		
12/31/1999	LACDPW	S13		19.1		16.4	5	A220.1	16.4	175	22.8	14.4	1		1
1/25/2000	LACDPW	S13		14.5		10.4	5	A220.1	10.4	90	12.2	8.2	1		1
1/30/2000	LACDPW	S13		16		12.2	5	A220.1	12.2	105	14.1	9.3	1		1
2/10/2000	LACDPW	S13		14.5		5.1	5	A220.1	*	112	15.0	*	*		*
2/12/2000	LACDPW	S13		6.6	<	5.0	5	A220.1	5.1	84	11.4	8.8	1		
2/16/2000	LACDPW	S13		5.9	<	5.0	5	A220.1	*	70	9.6	6.6	*		*
2/20/2000	LACDPW	S13		9.3	<	5.0	5	A220.1	5.0	56.8	7.9	5.5	1		
2/23/2000	LACDPW	S13		9.3	<	5.0	5	A220.1	*	104	13.9	*	*		*
2/27/2000	LACDPW	S13		12.9		5.4	5	A220.1	5.2	114	15.2	9.6	1		
3/5/2000	LACDPW	S13	<	5	<	5.0	5	A220.1	*	70	9.6	*	*		*
3/8/2000	LACDPW	S13		8.1	<	5.0	5	A220.1	5.0	80	10.9	7.0	1		
8/1/2000	LACSD	R9E		10		10	10	EPA200.8	10	329.2	41.3	24.8	1		
8/1/2000	LACSD	RA	<	10	<	10	10	EPA200.8	10	293.3	37.0	22.5	1		
10/12/2000	LACDPW	S13		8.3		6.2	5	A220.1	6.2	230	29.5	18.2	1		
10/28/2000	LACDPW	S13		11.9	<	5.0	5	A220.1	*	130	17.2	*	*		*
10/30/2000	LACDPW	S13		10.7		7.4	5	A220.1	6.2	51.2	7.2	8.1	1	1	
1/11/2001	LACDPW	S13		8.93		6.3	5	A220.1	6.3	60	8.3	5.8	1		1
1/25/2001	LACDPW	S13		13		7.7	5	A220.1	7.7	87.5	11.9	8.0	1		
2/1/2001	LACDPW	S13		8.45	<	5.0	5	A220.1	5.0	60	8.3	5.8	1		
2/14/2001	LACDPW	S13		5.73	<	5.0	5	A220.1	5.0	110	14.7	9.7	1		

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2/20/2001	LACDPW	S13		9.78		5.1	5	A220.1	5.1	60	8.3	5.8	1		
2/28/2001	LACDPW	S13		8.18	<	5.0	5	A220.1	5.0	65	9.0	6.2	1		
3/6/2001	LACDPW	S13		6.53	<	5.0	5	A220.1	5.0	275	34.9	21.3	1		
8/8/2001	LACSD	RA1	E	4.23	E	4.23	8	EPA200.8	4.23	400	49.6	29.3	1		
8/14/2001	LACSD	R9E	<	8	<	8	8	EPA200.8	8	329.2	41.3	24.8	1		
8/14/2001	LACSD	RA		9		9	8	EPA200.8	9	293.3	37.0	22.5	1		
9/10/2001	LACSD	RA1	E	6.64	E	6.64	8	EPA200.8	6.64	400	49.6	29.3	1		
10/2/2001	LACSD	RA1	E	7.35	E	7.35	8	EPA200.8	7.35	400	49.6	29.3	1		
11/7/2001	LACSD	RA1	E	4.8	E	4.8	8	EPA200.8	4.8	400	49.6	29.3	1		
11/12/2001	LACDPW	S13		8.79		3.6	0.5	EPA200.8	3.6	150	19.7	12.7	1		
11/24/2001	LACDPW	S13		14.7		8.4	0.5	EPA200.8	8.4	105	14.1	9.3	1		
11/29/2001	LACDPW	S13		22.3		15.6	0.5	EPA200.8	15.6	140	18.5	11.9	1		1
12/3/2001	LACDPW	S13		24.1		15.1	0.5	EPA200.8	15.1	95	12.8	8.6	1	1	1
12/6/2001	LACSD	RA1	E	4.2	E	4.2	8	EPA200.8	4.2	400	49.6	29.3	1		
1/17/2002	LACSD	RA1	E	6	E	6	8	EPA200.8	6	400	49.6	29.3	1		
1/28/2002	LACDPW	S13		14.6		4.9	0.5	EPA200.8	4.9	83.2	11.3	7.7	1		
2/20/2002	LACSD	RA1	E	7.2	E	7.2	8	EPA200.8	7.2	400	49.6	29.3	1		
3/6/2002	LACSD	RA1	E	6.4	E	6.4	8	EPA200.8	6.4	396	49.1	29.0	1		
4/4/2002	LACSD	RA1		8		8	8	EPA200.8	8	372	46.3	27.5	1		
5/13/2002	LACSD	RA1	<	8	<	8	8	EPA200.8	8	249	31.7	19.5	1		
6/11/2002	LACSD	RA1	E	3.5	E	3.5	8	EPA200.8	3.5	312	39.3	23.7	1		
7/8/2002	LACSD	RA1	E	4.2	E	4.2	8	EPA200.8	4.2	311	39.1	23.6	1		
8/13/2002	LACSD	RA1	E	6.8	E	6.8	8	EPA200.8	6.8	388	48.2	28.5	1		
8/27/2002	LACSD	R9E	<	8	<	8	8	EPA200.8	8	329.2	41.3	24.8	1		
8/27/2002	LACSD	RA		9		9	8	EPA200.8	9	293.3	37.0	22.5	1		
9/10/2002	LACSD	RA	E	5	E	5	8	EPA200.8	5	293.3	37.0	22.5	1		
9/10/2002	LACSD	RA1	E	4.6	E	4.6	8	EPA200.8	4.6	400.0	49.6	29.3	1		
10/9/2002	LACSD	RA		10		10	8	EPA200.8	10	298	37.6	22.8	1		
10/9/2002	LACSD	RA1	E	5	E	5	8	EPA200.8	5	313	39.4	23.7	1		
10/10/2002	LACDPW	S13		9.94		4.0	5	EPA200.8	4.0	195	25.2	15.8	1		
10/21/2002	LACSD	R9E		84		84	8	EPA200.8	84	260	33.1	20.3	1	1	1
11/8/2002	LACDPW	S13		45.9		11.7	5	EPA200.8	11.7	130	17.2	11.2	1		1
11/20/2002	LACSD	RA	E	4	E	4	8	EPA200.8	4	293.3	37.0	22.5	1		
11/20/2002	LACSD	RA1	E	6	E	6	8	EPA200.8	6	400	49.6	29.3	1		
12/16/2002	LACDPW	S13		9.91		4.2	5	EPA200.8	4.2	60	8.3	5.8	1		
12/23/2002	LACSD	RA1	E	6	E	6	8	EPA200.8	6	400	49.6	29.3	1		
12/30/2002	LACSD	RA	E	5	E	5	8	EPA200.8	5	293.3	37.0	22.5	1		
1/6/2003	LACSD	RA	E	7	E	7	8	EPA200.8	7	293.3	37.0	22.5	1		
1/6/2003	LACSD	RA1	E	5	E	5	8	EPA200.8	5	400.0	49.6	29.3	1		
1/21/2003	LACSD	R9E	E	2	E	2	8	EPA200.8	2	332	41.6	25.0	1		
2/10/2003	LACSD	RA	E	5	E	5	8	EPA200.8	5	293.3	37.0	22.5	1		
2/10/2003	LACSD	RA1		10		10	8	EPA200.8	10	400.0	49.6	29.3	1		

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2/11/2003	LACDPW	S13		17.9		4.8	5	EPA200.8	4.8	180	23.4	14.8	1		
3/3/2003	LACSD	RA	E	4	E	4	8	EPA200.8	4	293.3	37.0	22.5	1		
3/3/2003	LACSD	RA1	E	5	E	5	8	EPA200.8	5	400.0	49.6	29.3	1		
3/15/2003	LACDPW	S13		12.1		4.8	5	EPA200.8	4.8	45.6	6.4	4.6	1		1
4/1/2003	LACSD	R9E		13		13	8	EPA200.8	13	351	43.9	26.2	1		
4/3/2003	LACDPW	S13		10.1		6.9	5	EPA200.8	6.9	340	42.6	25.5	1		
4/10/2003	LACSD	RA		10		10	8	EPA200.8	10	293.3	37.0	22.5	1		
4/10/2003	LACSD	RA1	E	6	E	6	8	EPA200.8	6	400.0	49.6	29.3	1		
5/15/2003	LACSD	RA	E	5	E	5	8	EPA200.8	5	293.3	37.0	22.5	1		
5/15/2003	LACSD	RA1	<	8	<	8	8	EPA200.8	8	400.0	49.6	29.3	1		
6/11/2003	LACSD	RA	E	7	E	7	8	EPA200.8	7	293.3	37.0	22.5	1		
6/11/2003	LACSD	RA1	E	6	E	6	8	EPA200.8	6	400.0	49.6	29.3	1		
7/8/2003	LACSD	R9E	<	8	<	8	8	EPA200.8	8	351	43.9	26.2	1		
7/14/2003	LACSD	RA	<	8	<	8	8	EPA200.8	8	222	28.5	17.7	1		
7/14/2003	LACSD	RA1		9		9	8	EPA200.8	9	400	49.6	29.3	1		
8/13/2003	LACSD	RA	E	7	E	7	8	EPA200.8	7	293.3	37.0	22.5	1		
8/13/2003	LACSD	RA1	E	6	E	6	8	EPA200.8	6	400.0	49.6	29.3	1		
9/8/2003	LACSD	RA	E	3	E	3	8	EPA200.8	3	293.3	37.0	22.5	1		
9/8/2003	LACSD	RA1		11		11	8	EPA200.8	11	400.0	49.6	29.3	1		
10/7/2003	LACSD	R9E	E	7	E	7	8	EPA200.8	7	258	32.8	20.1	1		
10/15/2003	LACSD	RA	<	8	<	8	8	EPA200.8	8	293.3	37.0	22.5	1		
10/15/2003	LACSD	RA1	E	5	E	5	8	EPA200.8	5	400.0	49.6	29.3	1		
10/31/2003	LACDPW	S13		97.5		5.6	5	EPA200.8	5.6	250	31.9	19.6	1		
11/11/2003	LACSD	RA	<	8	<	8	8	EPA200.8	8	293.3	37.0	22.5	1		
11/11/2003	LACSD	RA1	<	8	<	8	8	EPA200.8	8	400.0	49.6	29.3	1		
12/10/2003	LACSD	RA	E	7	E	7	8	EPA200.8	7	293.3	37.0	22.5	1		
12/10/2003	LACSD	RA1		9		9	8	EPA200.8	9	400.0	49.6	29.3	1		
12/25/2003	LACDPW	S13		21.6		7.4	5	EPA200.8	7.4	190	24.6	15.5	1		
1/1/2004	LACDPW	S13		17.6		11.0	5	EPA200.8	11.0	140	18.5	11.9	1		
1/6/2004	LACSD	R9E	E	6	E	8.0	8	EPA200.8	8.0	310	39.0	23.5	1		
1/8/2004	LACSD	RA	<	8	<	8.0	8	EPA200.8	8.0	309	38.9	23.5	1		
1/8/2004	LACSD	RA1	<	8	<	8.0	8	EPA200.8	8.0	400	49.6	29.3	1		
1/13/2004	LACDPW	S13		8.58		6.4	5	EPA200.8	6.4	200	25.8	16.2	1		
2/10/2004	LACSD	RA	E	4	E	8.0	8	EPA200.8	8.0	195	25.2	15.8	1		
2/10/2004	LACSD	RA1	<	8	<	8.0	8	EPA200.8	8.0	400	49.6	29.3	1		
3/9/2004	LACSD	RA	E	3	E	8.0	8	EPA200.8	8.0	265	33.7	20.6	1		
3/9/2004	LACSD	RA1	E	5	E	8.0	8	EPA200.8	8.0	400	49.6	29.3	1		
4/6/2004	LACSD	R9E	E	7	E	8.0	8	EPA200.8	8.0	288	36.4	22.1	1		
4/6/2004	LACSD	RA		8		8.0	8	EPA200.8	8.0	274	34.7	21.2	1		
4/6/2004	LACSD	RA1		9		9.0	8	EPA200.8	9.0	383	47.6	28.2	1		
5/11/2004	LACSD	RA	E	5	E	8.0	8	EPA200.8	8.0	278	35.2	21.5	1		
5/11/2004	LACSD	RA1		10		10.0	8	EPA200.8	10.0	382	47.5	28.1	1		

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6/8/2004	LACSD	RA	<	8	<	8.0	8	EPA200.8	8.0	391	48.6	28.7	1		
6/8/2004	LACSD	RA1	<	8	<	8.0	8	EPA200.8	8.0	400	49.6	29.3	1		
7/6/2004	LACSD	R9E		31		31.0	8	EPA200.8	31.0	400	49.6	29.3	1		1
7/13/2004	LACSD	RA		16		16.0	8	EPA200.8	16.0	285	36.1	21.9	1		
7/13/2004	LACSD	RA1	E	4	E	8.0	8	EPA200.8	8.0	382	47.5	28.1	1		
8/10/2004	LACSD	RA	<	8	<	8.0	8	EPA200.8	8.0	302	38.1	23.0	1		
8/10/2004	LACSD	RA1	<	8	<	8.0	8	EPA200.8	8.0	388	48.2	28.5	1		
9/14/2004	LACSD	RA	E	6	E	8.0	8	EPA200.8	8.0	342	42.8	25.6	1		
9/14/2004	LACSD	RA1	E	5	E	8.0	8	EPA200.8	8.0	214	27.5	17.2	1		
10/4/2004	LACSD	R9E	<	8	<	8.0	8	EPA200.8	8.0	204	26.3	16.5	1		
10/4/2004	LACSD	RA	<	8	<	8.0	8	EPA200.8	8.0	202	26.1	16.3	1		
10/4/2004	LACSD	RA1	E	5	E	8.0	8	EPA200.8	8.0	352	44.0	26.2	1		
10/17/2004	LACDPW	S13		23.3		7.3	5	EPA200.8	7.3	391	48.6	28.7	1		
10/26/2004	LACDPW	S13		16.8		7.0	5	EPA200.8	*	371	46.2	*	*		*
10/28/2004	LACDPW	S13		16.6		8.6	5	EPA200.8	7.8	294	37.1	22.5	1		
11/15/2004	LACSD	RA	E	5	E	8.0	8	EPA200.8	8.0	297	37.5	22.7	1		
11/15/2004	LACSD	RA1	<	8	<	8.0	8	EPA200.8	8.0	400	49.6	29.3	1		
11/16/2004	LACDPW	S13		11.2		4.4	5	EPA200.8	4.4	380	47.3	28.0	1		
12/5/2004	LACDPW	S13		44.5		5.9	5	EPA200.8	5.9	334	41.9	25.1	1		
12/7/2004	LACSD	RA	<	8	<	8.0	8	EPA200.8	8.0	224	28.7	17.8	1		
12/7/2004	LACSD	RA1	<	8	<	8.0	8	EPA200.8	8.0	365	45.5	27.1	1		
1/7/2005	LACDPW	S13		22.5		6.4	5	EPA200.8	6.4	265	33.7	20.6	1		
1/25/2005	LACSD	R9E		3.6		3.6	0.5	EPA200.8	3.6	393	48.8	28.8	1		
1/25/2005	LACSD	RA		3.1		3.1	0.5	EPA200.8	3.1	356	44.5	26.5	1		
1/25/2005	LACSD	RA1		7		7.0	0.5	EPA200.8	7.0	400	49.6	29.3	1		
2/14/2005	LACSD	RA		2.9		2.9	0.5	EPA200.8	2.9	362	45.2	26.9	1		
2/14/2005	LACSD	RA1		3.7		3.7	0.5	EPA200.8	3.7	400	49.6	29.3	1		
3/9/2005	LACDPW	S13		11.7		5.4	5	EPA200.8	5.4	342	42.8	25.6	1		
3/22/2005	LACSD	RA		2.2		2.2	0.5	EPA200.8	2.2	391	48.6	28.7	1		
3/22/2005	LACSD	RA1		4.1		4.1	0.5	EPA200.8	4.1	400	49.6	29.3	1		
4/12/2005	LACSD	R9E	E	5	E	8.0	8	EPA200.8	8.0	371	46.2	27.5	1		
4/12/2005	LACSD	RA		2.3		2.3	0.5	EPA200.8	2.3	400	49.6	29.3	1		
4/12/2005	LACSD	RA1		3.3		3.3	0.5	EPA200.8	3.3	400	49.6	29.3	1		
5/17/2005	LACSD	RA		2.9		2.9	0.5	EPA200.8	2.9	296	37.4	22.6	1		
5/17/2005	LACSD	RA1		6.2		6.2	0.5	EPA200.8	6.2	400	49.6	29.3	1		
6/21/2005	LACSD	RA		5.6		5.6	0.5	EPA200.8	*	315	39.6	*	*		*
6/21/2005	LACSD	RA1		5.5		5.5	0.5	EPA200.8	5.5	380	47.3	28.0	1		
6/23/2005	LACSD	RA		5.7		5.7	0.5	EPA200.8	*	400	49.6	*	*		*
6/23/2005	LACSD	RA		3.3		3.3	0.5	EPA200.8	4.9	400	49.6	27.5	1		
7/19/2005	LACSD	R9E		8.2		8.2	0.5	EPA200.8	8.2	294	37.1	22.5	1		
7/19/2005	LACSD	RA		8.6		8.6	0.5	EPA200.8	8.6	260	33.1	20.3	1		
7/19/2005	LACSD	RA1		9.7		9.7	0.5	EPA200.8	9.7	400	49.6	29.3	1		

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8/9/2005	LACSD	RA		7.8		7.8	0.5	EPA200.8	7.8	291	36.8	22.3	1		
8/9/2005	LACSD	RA1		8.4		8.4	0.5	EPA200.8	8.4	400	49.6	29.3	1		
9/6/2005	LACSD	RA		2.4		2.4	0.5	EPA200.8	2.4	250	31.9	19.6	1		
9/6/2005	LACSD	RA1		5.3		5.3	0.5	EPA200.8	5.3	400	49.6	29.3	1		
10/11/2005	LACSD	R9E		1.9		1.9	0.5	EPA200.8	1.9	235	30.1	18.6	1		
10/11/2005	LACSD	RA		2.3		2.3	0.5	EPA200.8	2.3	294	37.1	22.5	1		
10/11/2005	LACSD	RA1		4.5		4.5	0.5	EPA200.8	4.5	400	49.6	29.3	1		
10/17/2005	LACDPW	S13		63.2		10.7	5	EPA200.8	10.7	250	31.9	19.6	1		
11/15/2005	LACSD	RA		2.6		2.6	0.5	EPA200.8	2.6	292	36.9	22.4	1		
11/15/2005	LACSD	RA1		4.5		4.5	0.5	EPA200.8	4.5	400	49.6	29.3	1		
12/13/2005	LACSD	RA		2.8		2.8	0.5	EPA200.8	2.8	275	34.9	21.3	1		
12/13/2005	LACSD	RA1		4.8		4.8	0.5	EPA200.8	4.8	400	49.6	29.3	1		
12/31/2005	LACDPW	S13		7.52		6.8	5	EPA200.8	6.8	270	34.3	20.9	1		
1/10/2006	LACSD	R9E	<	5	<	5.0	5	EPA200.8	5.0	326	40.9	24.6	1		
1/10/2006	LACSD	RA		1.8		1.8	0.5	EPA200.8	1.8	295	37.2	22.6	1		
1/10/2006	LACSD	RA1		3.4		3.4	0.5	EPA200.8	3.4	400	49.6	29.3	1		
1/14/2006	LACDPW	S13		13.7		12.5	5	EPA200.8	12.5	252	32.1	19.7	1		
1/24/2006	LACDPW	S13		9.13		6.0	5	EPA200.8	6.0	234	29.9	18.5	1		
2/7/2006	LACSD	RA		1.36		1.4	0.5	EPA200.8	1.4	263	33.4	20.5	1		
2/7/2006	LACSD	RA1		4.63		4.6	0.5	EPA200.8	4.6	400	49.6	29.3	1		
2/17/2006	LACDPW	S13		16.7		5.3	5	EPA200.8	5.3	260	33.1	20.3	1		
3/3/2006	LACDPW	S13		56.9		4.3	5	EPA200.8	4.3	303	38.2	23.1	1		
3/9/2006	LACSD	RA		1.57		1.6	0.5	EPA200.8	1.6	232	29.7	18.4	1		
3/9/2006	LACSD	RA1		3.98		4.0	0.5	EPA200.8	4.0	400	49.6	29.3	1		
4/17/2006	LACSD	R9E	<	5	<	5.0	5	EPA200.8	5.0	380	47.3	28.0	1		
4/17/2006	LACSD	RA		2.4		2.4	0.5	EPA200.8	2.4	278	35.2	21.5	1		
4/17/2006	LACSD	RA1		4.05		4.1	0.5	EPA200.8	4.1	400	49.6	29.3	1		
4/25/2006	LACDPW	S13		18.8		5.7	5	EPA200.8	5.7	251	32.0	19.7	1		
5/16/2006	LACSD	RA		2.31		2.3	0.5	EPA200.8	2.3	250	31.9	19.6	1		
5/16/2006	LACSD	RA1		4.19		4.2	0.5	EPA200.8	4.2	388	48.2	28.5	1		
6/20/2006	LACSD	RA		1.99		2.0	0.5	EPA200.8	2.0	216	27.8	17.3	1		
6/20/2006	LACSD	RA1		4.11		4.1	0.5	EPA200.8	4.1	400	49.6	29.3	1		
6/26/2006	LACSD	RA		2.7		2.7	0.5	EPA200.8	*	269	34.1	*	*		*
6/26/2006	LACSD	RA		2.73		2.7	0.5	EPA200.8	*	269	34.1	*	*		*
6/26/2006	LACSD	RA		2.76		2.8	0.5	EPA200.8	*	269	34.1	*	*		*
6/26/2006	LACSD	RA		3.31		3.3	0.5	EPA200.8	2.9	269	34.1	20.9	1		
7/20/2006	LACSD	R9E		5.9		5.0	5	EPA200.8	5.0	334	41.9	25.1	1		
7/20/2006	LACSD	RA		4.23		4.2	0.5	EPA200.8	4.2	282	35.7	21.7	1		
7/20/2006	LACSD	RA1		5.53		5.5	0.5	EPA200.8	5.5	311	39.1	23.6	1		
8/22/2006	LACSD	RA		4.78		4.8	0.5	EPA200.8	4.8	400	49.6	29.3	1		
8/22/2006	LACSD	RA1		4.99		5.0	0.5	EPA200.8	5.0	400	49.6	29.3	1		
9/19/2006	LACSD	RA		3.9		3.9	0.5	EPA200.8	3.9	288	36.4	22.1	1		

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9/19/2006	LACSD	RA1		5.5		5.5	0.5	EPA200.8	5.5	391	48.6	28.7	1		
10/24/2006	LACSD	RA		3.74		3.7	0.5	EPA200.8	3.7	252	32.1	19.7	1		
10/24/2006	LACSD	RA1		4.37		4.4	0.5	EPA200.8	4.4	391	48.6	28.7	1		
11/1/2006	LACDPW	S13		28.3		4.2	5	EPA200.8	4.2	240	30.7	18.9	1		
11/21/2006	LACSD	RA		5.42		5.4	0.5	EPA200.8	5.4	234	29.9	18.5	1		
11/21/2006	LACSD	RA1		7.48		7.5	0.5	EPA200.8	7.5	400	49.6	29.3	1		
12/9/2006	LACDPW	S13		66.6		11.5	5	EPA200.8	11.5	400	49.6	29.3	1		
12/14/2006	LACSD	RA		2.85		2.9	0.5	EPA200.8	2.9	250	31.9	19.6	1		
12/14/2006	LACSD	RA1		5.22		5.2	0.5	EPA200.8	5.2	400	49.6	29.3	1		
1/9/2007	LACSD	RA		2.84		2.8	0.5	EPA200.8	2.8	186	24.1	15.2	1		
1/9/2007	LACSD	RA1		5.1		5.1	0.5	EPA200.8	5.1	400	49.6	29.3	1		
2/10/2007	LACDPW	S13		73.2		8.0	5	EPA200.8	8.0	400	49.6	29.3	1		
2/19/2007	LACDPW	S13		50.3		13.3	5	EPA200.8	*	382	47.5	*	*		*
2/22/2007	LACSD	RA		4.21		4.2	0.5	EPA200.8	4.2	260	33.1	20.3	1		
2/22/2007	LACSD	RA1		9.37		9.4	0.5	EPA200.8	9.4	400	49.6	29.3	1		
2/22/2007	LACDPW	S13		45.3		11.0	5	EPA200.8	12.2	388	48.2	28.3	1		
3/8/2007	LACSD	RA		4.43		4.4	0.5	EPA200.8	4.4	303	38.2	23.1	1		
3/8/2007	LACSD	RA1		6.96		7.0	0.5	EPA200.8	7.0	383	47.6	28.2	1		
4/2/2007	LACDPW	S13		28.7		7.0	5	EPA200.8	7.0	400	49.6	29.3	1		
4/12/2007	LACSD	RA		3.05		3.1	0.5	EPA200.8	3.1	260	33.1	20.3	1		
4/12/2007	LACSD	RA1		3.79		3.8	0.5	EPA200.8	3.8	361	45.0	26.8	1		

LACSD - Sanitation Districts of Los Angeles County
LACDPW - Los Angeles County Department of Public Works
* - Data is used in calculation of a 4-day average
** - Result Non-Detect with Detection Limit Greater than the CCC

10 of 210 4-day averages exceed Criterion Continuous Concentration (CCC)

3 of 225 samples exceed Criterion Maximum Concentration (CMC)

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APPENDIX J - TABLE J1

COYOTE CREEK - LEAD

Sample Date	Source	Location	Qualifier	Total Lead (ug/L)	Dissolved Lead (ug/L)	PQL/RL (ug/L)	Method	Conservative Dissolved Lead (ug/L)	Is Sample Usable for CCC? (1=Yes)	4-Day Average Concentration	Hardness	Dissolved Lead CMC (ug/L)	Dissolved Lead CCC (ug/L)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed CCC (1=Yes)
6/14/1995	LACDPW	S13			ND	5	A239.2	5	1	5	490	345.4	13.5		
8/3/1995	LACSD	R9E	<	20	NA	20	EPA200.8	20		**	328*****	233.3	9.1		
8/3/1995	LACSD	RA	<	20	NA	20	EPA200.8	20		**	293***	202.1	7.9		
11/7/1995	LACDPW	S13			ND	5	A239.2	5	1	5	470	331.1	12.9		
12/12/1995	LACDPW	S13			ND	5	A239.2	5		**	110	71.6	2.8		
12/23/1995	LACDPW	S13			ND	5	A239.2	5		**	135	89.4	3.5		
1/9/1996	LACDPW	S13			ND	5	A239.2	5	1	5	315	219.4	8.6		
1/21/1996	LACDPW	S13			ND	5	A239.2	5		**	141	93.7	3.7		
1/31/1996	LACDPW	S13			ND	5	A239.2	5		**	90	57.6	2.2		
2/3/1996	LACDPW	S13			ND	5	A239.2	5	1	5	200	136.1	5.3		
2/6/1996	LACSD	R9E	<	20	NA	20	EPA200.8	20		**	328*****	233.3	9.1		
2/6/1996	LACSD	RA	<	20	NA	20	EPA200.8	20		**	293***	202.1	7.9		
2/6/1996	LACSD	RA1	<	20	NA	20	EPA200.8	20		**	293***	202.1	7.9		
2/19/1996	LACDPW	S13			ND	5	A239.2	5		**	40	23.5	0.9		
3/5/1996	LACDPW	S13			ND	5	A239.2	5		**	162	108.7	4.2		
3/19/1996	LACDPW	S13			ND	5	A239.2	5	1	5	400	280.8	10.9		
5/14/1996	LACDPW	S13			ND	5	A239.2	5	1	5	359	251.3	9.8		
7/9/1996	LACDPW	S13			ND	5	A239.2	5	1	5	400	280.8	10.9		
8/5/1996	LACSD	R9E	<	20	NA	20	EPA200.8	20		**	328*****	233.3	9.1		
8/5/1996	LACSD	RA	<	20	NA	20	EPA200.8	20		**	293***	202.1	7.9		
10/30/1996	LACDPW	S13			ND	1	A239.2	1	1	1	110	71.6	2.8		
11/21/1996	LACDPW	S13			ND	1	A239.2	1	1	1	60	36.9	1.4		
12/9/1996	LACDPW	S13			2.0	1	A239.2	2	1	2	76.4	48.1	1.9		1
1/23/1997	LACDPW	S13			ND	1	A239.2	1	1	1	52	31.5	1.2		
8/5/1997	LACSD	R9E	<	20	NA	20	EPA200.8	20		**	328*****	233.3	9.1		
8/5/1997	LACSD	RA	<	20	NA	20	EPA200.8	20		**	293***	202.1	7.9		
8/5/1997	LACSD	RA1	<	20	NA	20	EPA200.8	20		**	293***	202.1	7.9		
11/11/1997	LACDPW	S13			ND	5	A239.2	5	1	*	270	186.8	*		
11/14/1997	LACDPW	S13			ND	5	A239.2	5	1	5	156	104.4	5.7		
11/27/1997	LACDPW	S13			38.0	5	A239.2	38	1	38	150	100.1	3.9		1
12/1/1997	LACDPW	S13			20.2	5	A239.2	20.2	1	20.2	50	30.1	1.2		1
12/6/1997	LACDPW	S13			11.0	5	A239.2	11	1	11	70	43.7	1.7		1
12/19/1997	LACDPW	S13			17.6	5	A239.2	17.6	1	17.6	50	30.1	1.2		1
1/3/1998	LACDPW	S13			ND	5	A239.2	5		**	150	100.1	3.9		
1/5/1998	LACDPW	S13			ND	5	A239.2	5		**	110	71.6	2.8		
1/10/1998	LACDPW	S13			14.4	5	A239.2	14.4	1	14.4	50	30.1	1.2		1
8/5/1998	LACSD	R9E	<	20	NA	20	EPA200.8	20		**	328*****	233.3	9.1		
8/5/1998	LACSD	RA	<	20	NA	20	EPA200.8	20		**	293***	202.1	7.9		
10/14/1998	LACDPW	S13			ND	5	A239.2	5	1	5	420	295.2	11.5		
11/8/1998	LACDPW	S13			ND	5	A239.2	5		**	102	66.0	2.6		
11/28/1998	LACDPW	S13			ND	5	A239.2	5		**	140	93.0	3.6		
12/1/1998	LACDPW	S13			ND	5	A239.2	5		**	82	52.0	2.0		
12/6/1998	LACDPW	S13			ND	5	A239.2	5	1	5	196	133.3	5.2		
1/12/1999	LACDPW	S13			ND	5	A239.2	5	1	5	440	309.6	12.1		
1/20/1999	LACDPW	S13			ND	5	A239.2	5		**	176	118.8	4.6		
1/25/1999	LACDPW	S13			ND	5	A239.2	5		**	90	57.6	2.2		
1/31/1999	LACDPW	S13			ND	5	A239.2	5		**	78	49.2	1.9		

ATTACHMENT B

APPENDIX J - TABLE J1

COYOTE CREEK - LEAD

Sample Date	Source	Location	Qualifier	Total Lead (ug/L)	Dissolved Lead (ug/L)	PQL/RL (ug/L)	Method	Conservative Dissolved Lead (ug/L)	Is Sample Usable for CCC? (1=Yes)	4-Day Average Concentration	Hardness	Dissolved Lead CMC (ug/L)	Dissolved Lead CCC (ug/L)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed CCC (1=Yes)
2/6/1999	LACDPW	S13			ND	5	A239.2	5		**	140	93.0	3.6		
2/9/1999	LACDPW	S13			ND	5	A239.2	5	1	5	210	143.4	5.6		
3/20/1999	LACDPW	S13			ND	5	A239.2	5	1	5	210	143.4	5.6		
3/25/1999	LACDPW	S13			ND	5	A239.2	5	1	5	400	280.8	10.9		
4/6/1999	LACDPW	S13			ND	5	A239.2	5		**	92	59.0	2.3		
4/8/1999	LACDPW	S13			ND	5	A239.2	5	1	5	210	143.4	5.6		
4/11/1999	LACDPW	S13			ND	5	A239.2	5		**	51.2	30.9	1.2		
8/10/1999	LACSD	R9E	<	20	NA	20	EPA200.8	20		**	328*****	233.3	9.1		
8/10/1999	LACSD	RA	<	20	NA	20	EPA200.8	20		**	293***	202.1	7.9		
8/10/1999	LACSD	RA1		0	NA	20	EPA200.8	0	1	0	293***	202.1	7.9		
11/8/1999	LACDPW	S13			ND	5	A239.2	5		**	176	118.8	2.9		
12/31/1999	LACDPW	S13			ND	5	A239.2	5		**	175	118.1	4.6		
1/25/2000	LACDPW	S13			ND	5	A239.2	5		**	90	57.6	2.2		
1/30/2000	LACDPW	S13			ND	5	A239.2	5		**	105	68.1	2.7		
2/10/2000	LACDPW	S13			ND	5	A239.2	5		**	112	73.0	2.8		
2/12/2000	LACDPW	S13			ND	5	A239.2	5		**	84	53.4	2.1		
2/16/2000	LACDPW	S13			ND	5	A239.2	5		**	70	43.7	1.7		
2/20/2000	LACDPW	S13			ND	5	A239.2	5		**	56.8	34.7	1.4		
2/23/2000	LACDPW	S13			ND	5	A239.2	5		**	104	67.4	2.6		
2/27/2000	LACDPW	S13			ND	5	A239.2	5		**	114	74.5	2.9		
3/5/2000	LACDPW	S13			ND	5	A239.2	5		**	70	43.7	1.7		
3/8/2000	LACDPW	S13			ND	5	A239.2	5		**	80	50.6	2.0		
8/1/2000	LACSD	R9E	<	20	NA	20	EPA200.8	20		**	328*****	233.3	9.1		
8/1/2000	LACSD	RA	<	20	NA	20	EPA200.8	20		**	293***	202.1	7.9		
10/13/2000	LACDPW	S13			ND	5	A239.2	5	1	5	230	157.9	6.2		
10/29/2000	LACDPW	S13			ND	5	A239.2	5		**	130	85.8	3.3		
10/31/2000	LACDPW	S13			ND	5	A239.2	5		**	51.2	30.9	1.2		
1/12/2001	LACDPW	S13			ND	5	A239.2	5		**	60	36.9	1.4		
1/26/2001	LACDPW	S13			ND	5	A239.2	5		**	87.5	55.8	2.2		
2/2/2001	LACDPW	S13			ND	5	A239.2	5		**	60	36.9	1.4		
2/15/2001	LACDPW	S13			ND	5	A239.2	5		**	110	71.6	2.8		
2/21/2001	LACDPW	S13			ND	5	A239.2	5		**	60	36.9	1.4		
3/1/2001	LACDPW	S13			ND	5	A239.2	5		**	65	40.3	1.6		
3/7/2001	LACDPW	S13			ND	5	A239.2	5	1	5	275	190.5	7.4		
7/12/2001	LACSD	RA1	E	3.92	NA	10	EPA200.8	10	1	10	325	230.6	9.0		1
8/8/2001	LACSD	RA1	E	4.11	NA	10	EPA200.8	10	1	10	419	318.7	12.4		
8/14/2001	LACSD	R9E	<	10	NA	10	EPA200.8	10		**	328*****	233.3	9.1		
8/14/2001	LACSD	RA	<	10	NA	10	EPA200.8	10		**	293***	202.1	7.9		
9/10/2001	LACSD	RA1		2	NA	0.25	EPA200.8	2	1	2	442	341.1	13.3		
10/2/2001	LACSD	RA1		3	NA	2.5	EPA200.8	3	1	3	419	318.7	12.4		
11/7/2001	LACSD	RA1	E	1.9	NA	2.5	EPA200.8	2.5	1	2.5	424	323.5	12.6		
11/12/2001	LACDPW	S13			0.9	0.5	EPA200.8	0.86	1	0.86	150	100.1	3.9		
11/24/2001	LACDPW	S13			2.0	0.5	EPA200.8	1.95	1	1.95	105	68.1	2.7		
11/29/2001	LACDPW	S13			0.7	0.5	EPA200.8	*	1	*	140	93.0	*		
12/3/2001	LACDPW	S13			0.7	0.5	EPA200.8	0.7	1	0.72	95	61.1	3.0		
12/6/2001	LACSD	RA1		4	NA	2.5	EPA200.8	4	1	4	486	384.9	15.0		
1/17/2002	LACSD	RA1		2	NA	0.25	EPA200.8	2	1	2	408	308.1	12.0		

ATTACHMENT B

APPENDIX J - TABLE J1

COYOTE CREEK - LEAD

Sample Date	Source	Location	Qualifier	Total Lead (ug/L)	Dissolved Lead (ug/L)	PQL/RL (ug/L)	Method	Conservative Dissolved Lead (ug/L)	Is Sample Usable for CCC? (1=Yes)	4-Day Average Concentration	Hardness	Dissolved Lead CMC (ug/L)	Dissolved Lead CCC (ug/L)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed CCC (1=Yes)
1/28/2002	LACDPW	S13			ND	0.5	EPA200.8	0.5	1	0.5	83.2	52.8	2.1		
2/20/2002	LACSD	RA1		2	NA	0.25	EPA200.8	2	1	2	400	300.4	11.7		
3/6/2002	LACSD	RA1		2	NA	0.25	EPA200.8	2	1	2	396	296.6	11.6		
4/4/2002	LACSD	RA1		3	NA	2.5	EPA200.8	3	1	3	372	273.9	10.2		
5/13/2002	LACSD	RA1	E	1.7	NA	2.5	EPA200.8	2.5	1	2.5	249	164.3	6.4		
6/11/2002	LACSD	RA1		3	NA	2.5	EPA200.8	3	1	3	312	218.9	8.5		
7/8/2002	LACSD	RA1		3	NA	2.5	EPA200.8	3	1	3	311	218.0	8.5		
8/13/2002	LACSD	RA1		3	NA	2.5	EPA200.8	3	1	3	388	289.0	11.3		
8/27/2002	LACSD	R9E	<	10	NA	10	EPA200.8	10		**	328*****	233.3	9.1		
8/27/2002	LACSD	RA	<	10	NA	10	EPA200.8	10		**	293***	202.1	7.9		
9/10/2002	LACSD	RA	E	1	NA	2.5	EPA200.8	2.5	1	2.5	293***	202.1	7.9		
9/10/2002	LACSD	RA1	E	1.86	NA	2.5	EPA200.8	2.5	1	2.5	432**	331.3	12.9		
10/9/2002	LACSD	RA	E	1.5	NA	2.5	EPA200.8	2.5	1	2.5	298	206.5	8.1		
10/9/2002	LACSD	RA1	E	1.73	NA	2.5	EPA200.8	2.5	1	2.5	308	215.4	8.4		
10/10/2002	LACDPW	S13			ND	5	EPA200.8	5	1	5	195	132.5	5.2		
10/21/2002	LACSD	R9E		38	NA	2.5	EPA200.8	38	1	38	260	173.6	7.0		1
11/8/2002	LACDPW	S13			ND	5	EPA200.8	5		**	130	85.8	3.3		
11/20/2002	LACSD	RA	E	1	NA	2.5	EPA200.8	2.5	1	2.5	293***	202.1	7.9		
11/20/2002	LACSD	RA1	E	1	NA	2.5	EPA200.8	2.5	1	2.5	473	371.9	14.5		
12/16/2002	LACDPW	S13			0.6	5	EPA200.8	0.62	1	0.62	60	36.9	1.4		
12/23/2002	LACSD	RA1	E	1.9	NA	2.5	EPA200.8	2.5	1	2.5	487	385.9	15.0		
12/30/2002	LACSD	RA	E	2	NA	2.5	EPA200.8	2.5	1	2.5	293***	202.1	7.9		
1/6/2003	LACSD	RA	E	1	NA	2.5	EPA200.8	2.5	1	2.5	293***	202.1	7.9		
1/6/2003	LACSD	RA1	E	1	NA	2.5	EPA200.8	2.5	1	2.5	432**	331.3	12.9		
1/21/2003	LACSD	R9E	E	1	NA	2.5	EPA200.8	2.5	1	2.5	332	237.0	9.2		
2/10/2003	LACSD	RA	E	1.7	NA	2.5	EPA200.8	2.5	1	2.5	293***	202.1	7.9		
2/10/2003	LACSD	RA1		3	NA	2.5	EPA200.8	3	1	3	432**	331.3	12.9		
2/11/2003	LACDPW	S13			0.6	5	EPA200.8	0.58	1	0.58	180	121.7	4.7		
3/3/2003	LACSD	RA		2	NA	0.25	EPA200.8	2	1	2	293***	202.1	7.9		
3/3/2003	LACSD	RA1		2	NA	0.25	EPA200.8	2	1	2	432**	331.3	12.9		
3/15/2003	LACDPW	S13			ND	5	EPA200.8	5		**	45.6	27.2	1.1		
4/1/2003	LACSD	R9E		3	NA	2.5	EPA200.8	3	1	3	351	254.4	9.9		
4/10/2003	LACSD	RA	E	1.6	NA	2.5	EPA200.8	2.5	1	2.5	293***	202.1	7.9		
4/10/2003	LACSD	RA1	E	1.7	NA	2.5	EPA200.8	2.5	1	2.5	432**	331.3	12.9		
4/30/2003	LACDPW	S13			ND	5	EPA200.8	5	1	5	340	237.5	9.3		
5/15/2003	LACSD	RA		3	NA	2.5	EPA200.8	3	1	3	293***	202.1	7.9		
5/15/2003	LACSD	RA1		2	NA	0.25	EPA200.8	2	1	2	432**	331.3	12.9		
6/11/2003	LACSD	RA		4	NA	2.5	EPA200.8	4	1	4	293***	202.1	7.9		
6/11/2003	LACSD	RA1		2	NA	0.25	EPA200.8	2	1	2	432**	331.3	12.9		
7/8/2003	LACSD	R9E		3	NA	2.5	EPA200.8	3	1	3	351	254.4	9.9		
7/14/2003	LACSD	RA		3	NA	2.5	EPA200.8	3	1	3	222	142.0	5.9		
7/14/2003	LACSD	RA1		6	NA	2.5	EPA200.8	6	1	6	433	332.3	12.9		
8/13/2003	LACSD	RA		2	NA	0.25	EPA200.8	2	1	2	293***	202.1	7.9		
8/13/2003	LACSD	RA1		2	NA	0.25	EPA200.8	2	1	2	420	319.6	11.5		
9/8/2003	LACSD	RA		2	NA	0.25	EPA200.8	2	1	2	293***	202.1	7.9		
9/8/2003	LACSD	RA1		5	NA	2.5	EPA200.8	5	1	5	432**	331.3	12.9		
10/7/2003	LACSD	R9E	E	1	NA	2.5	EPA200.8	2.5	1	2.5	258	171.9	6.9		

ATTACHMENT B
APPENDIX J - TABLE J1
COYOTE CREEK - LEAD

Sample Date	Source	Location	Qualifier	Total Lead (ug/L)	Dissolved Lead (ug/L)	PQL/RL (ug/L)	Method	Conservative Dissolved Lead (ug/L)	Is Sample Usable for CCC? (1=Yes)	4-Day Average Concentration	Hardness	Dissolved Lead CMC (ug/L)	Dissolved Lead CCC (ug/L)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed CCC (1=Yes)
10/15/2003	LACSD	RA	E	1	NA	2.5	EPA200.8	2.5	1	2.5	293***	202.1	7.9		
10/15/2003	LACSD	RA1	E	1	NA	2.5	EPA200.8	2.5	1	2.5	432**	331.3	12.9		
10/28/2003	LACDPW	S13			ND	5	EPA200.8	5	1	*	325	226.7	*		
10/31/2003	LACDPW	S13			ND	5	EPA200.8	5	1	5	225	154.2	7.4		
11/11/2003	LACSD	RA	E	1	NA	2.5	EPA200.8	2.5	1	2.5	293***	202.1	7.9		
11/11/2003	LACSD	RA1	E	1.6	NA	2.5	EPA200.8	2.5	1	2.5	432**	331.3	12.9		
12/10/2003	LACSD	RA	E	1	NA	2.5	EPA200.8	2.5	1	2.5	293***	202.1	7.9		
12/10/2003	LACSD	RA1		2	NA	0.25	EPA200.8	2	1	2	432**	331.3	12.9		
12/25/2003	LACDPW	S13			1.0	5	EPA200.8	0.96	1	0.96	92.8	59.5	2.3		
1/1/2004	LACDPW	S13			1.5	5	EPA200.8	1.5	1	1.5	112	73.0	2.8		
1/6/2004	LACSD	R9E	E	1	NA	2.5	EPA200.8	2.5	1	2.5	310	217.2	8.5		
1/8/2004	LACSD	RA	E	1	NA	2.5	EPA200.8	2.5	1	2.5	293***	202.1	7.9		
1/8/2004	LACSD	RA1	E	1	NA	2.5	EPA200.8	2.5	1	2.5	432**	331.3	12.9		
1/13/2004	LACDPW	S13			ND	5	EPA200.8	5	1	5	395	277.2	10.8		
2/10/2004	LACSD	RA	E	1	NA	2.5	EPA200.8	2.5	1	2.5	195	120.4	4.7		
2/10/2004	LACSD	RA1	E	3.7	NA	2.5	EPA200.8	3.7	1	3.7	453	352.0	13.7		
3/9/2004	LACSD	RA	E	1	NA	2.5	EPA200.8	2.5	1	2.5	265	177.9	6.9		
3/9/2004	LACSD	RA1		2	NA	0.25	EPA200.8	2	1	2	429	328.4	12.8		
4/6/2004	LACSD	R9E	E	1.6	NA	2.5	EPA200.8	2.5	1	2.5	288	197.7	7.7		
4/6/2004	LACSD	RA	E	1.7	NA	2.5	EPA200.8	2.5	1	2.5	274	185.6	7.2		
4/6/2004	LACSD	RA1	E	1	NA	2.5	EPA200.8	2.5	1	2.5	383	284.2	11.1		
5/11/2004	LACSD	RA		2	NA	0.25	EPA200.8	2	1	2	278	189.0	7.4		
5/11/2004	LACSD	RA1		4	NA	2.5	EPA200.8	4	1	4	382	283.3	11.0		
6/8/2004	LACSD	RA		2	NA	0.25	EPA200.8	2	1	2	391	291.8	11.4		
6/8/2004	LACSD	RA1		2	NA	0.25	EPA200.8	2	1	2	435	334.2	13.0		
7/6/2004	LACSD	R9E		3	NA	2.5	EPA200.8	3.0	1	3.0	588	490.6	19.1		
7/13/2004	LACSD	RA		5	NA	0.25	EPA200.8	5	1	5	285	195.1	7.6		
7/13/2004	LACSD	RA1	E	1.8	NA	2.5	EPA200.8	2.5	1	2.5	382	283.3	11.0		
8/10/2004	LACSD	RA	E	1.5	NA	2.5	EPA200.8	2.5	1	2.5	302	210.0	8.2		
8/10/2004	LACSD	RA1	E	1.9	NA	2.5	EPA200.8	2.5	1	2.5	388	289.0	11.3		
9/14/2004	LACSD	RA	E	1	NA	2.5	EPA200.8	2.5	1	2.5	342	246.1	9.6		
9/14/2004	LACSD	RA1	E	1.6	NA	2.5	EPA200.8	2.5	1	2.5	214	135.5	5.3		
10/4/2004	LACSD	R9E	E	1	NA	2.5	EPA200.8	2.5	1	2.5	204	127.5	5.0		
10/4/2004	LACSD	RA	E	1	NA	2.5	EPA200.8	2.5	1	2.5	202	125.9	4.9		
10/4/2004	LACSD	RA1	E	1.9	NA	2.5	EPA200.8	2.5	1	2.5	352	255.3	9.9		
10/17/2004	LACDPW	S13			ND	5	EPA200.8	5	1	5	200	136.1	5.3		
10/26/2004	LACDPW	S13			ND	5	EPA200.8	5		**	50	30.1	1.2		
11/15/2004	LACSD	RA	E	0.5	NA	2.5	EPA200.8	2.5	1	2.5	297	205.6	8.0		
11/15/2004	LACSD	RA1	E	1	NA	2.5	EPA200.8	2.5	1	2.5	410	310.0	12.1		
11/16/2004	LACDPW	S13			ND	5	EPA200.8	5	1	5	410	288.0	11.2		
12/5/2004	LACDPW	S13			ND	5	EPA200.8	5		**	110	71.6	2.8		
12/7/2004	LACSD	RA	E	0.3	NA	2.5	EPA200.8	2.5	1	2.5	224	143.6	5.6		
12/7/2004	LACSD	RA1	E	0.5	NA	2.5	EPA200.8	2.5	1	2.5	365	267.3	10.4		
1/7/2005	LACDPW	S13			1.7	5	EPA200.8	1.67	1	1.67	64	39.6	1.5		1
1/25/2005	LACSD	R9E		0.76	NA	0.25	EPA200.8	0.8	1	0.8	393	293.7	11.4		
1/25/2005	LACSD	RA		0.54	NA	0.25	EPA200.8	0.54	1	0.54	356	259.0	10.1		
1/25/2005	LACSD	RA1		2	NA	0.25	EPA200.8	2	1	2	622	526.9	20.5		

ATTACHMENT B
APPENDIX J - TABLE J1
COYOTE CREEK - LEAD

Sample Date	Source	Location	Qualifier	Total Lead (ug/L)	Dissolved Lead (ug/L)	PQL/RL (ug/L)	Method	Conservative Dissolved Lead (ug/L)	Is Sample Usable for CCC? (1=Yes)	4-Day Average Concentration	Hardness	Dissolved Lead CMC (ug/L)	Dissolved Lead CCC (ug/L)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed CCC (1=Yes)
2/14/2005	LACSD	RA		0.39	NA	0.25	EPA200.8	0.39	1	0.39	362	264.5	10.3		
2/14/2005	LACSD	RA1		0.45	NA	0.25	EPA200.8	0.45	1	0.45	514	413.4	16.1		
3/9/2005	LACDPW	S13			ND	5	EPA200.8	5	1	5	520	366.8	14.3		
3/22/2005	LACSD	RA		0.33	NA	0.25	EPA200.8	0.33	1	0.33	391	291.8	11.4		
3/22/2005	LACSD	RA1		0.26	NA	0.25	EPA200.8	0.26	1	0.26	574	475.7	18.5		
4/12/2005	LACSD	R9E	E	0.6	NA	2.5	EPA200.8	2.5	1	2.5	371	273.0	10.6		
4/12/2005	LACSD	RA	E	0.14	NA	0.25	EPA200.8	0.25	1	0.25	405	305.2	11.9		
4/12/2005	LACSD	RA1	E	0.25	NA	0.25	EPA200.8	0.25	1	0.25	531	430.8	16.8		
5/17/2005	LACSD	RA		0.37	NA	0.25	EPA200.8	0.37	1	0.37	296	204.8	8.0		
5/17/2005	LACSD	RA1		0.76	NA	0.25	EPA200.8	0.76	1	0.76	491	390.0	15.2		
6/21/2005	LACSD	RA		1.2	NA	0.25	EPA200.8	1.2	*	*	315	221.6	*		*
6/21/2005	LACSD	RA1		1	NA	0.25	EPA200.8	1	1	1	380	281.4	11.0		
6/23/2005	LACSD	RA		0.8	NA	0.25	EPA200.8	0.8	*	*	491	390.0	*		*
6/23/2005	LACSD	RA	<	0.25	NA	0.25	EPA200.8	0.25	1	0.8	491	390.0	13.0		
7/19/2005	LACSD	R9E		3.5	NA	2.5	EPA200.8	3.5	1	3.5	294	203.0	7.9		
7/19/2005	LACSD	RA		3	NA	0.25	EPA200.8	3	1	3	260	173.6	6.8		
7/19/2005	LACSD	RA1		3.6	NA	0.25	EPA200.8	3.6	1	3.6	436	335.2	13.1		
8/9/2005	LACSD	RA		3.4	NA	0.25	EPA200.8	3.4	1	3.4	291	200.4	7.8		
8/9/2005	LACSD	RA1		3.4	NA	0.25	EPA200.8	3.4	1	3.4	432	331.3	12.9		
9/6/2005	LACSD	RA		0.39	NA	0.25	EPA200.8	0.39	1	0.39	250	165.1	6.4		
9/6/2005	LACSD	RA1		0.84	NA	0.25	EPA200.8	0.84	1	0.84	441	340.1	13.3		
10/11/2005	LACSD	R9E	<	0.25	NA	0.25	EPA200.8	0.25	1	0.25	235	152.6	5.9		
10/11/2005	LACSD	RA	<	0.25	NA	0.25	EPA200.8	0.25	1	0.25	294	203.0	7.9		
10/11/2005	LACSD	RA1		0.29	NA	0.25	EPA200.8	0.29	1	0.29	482	380.9	14.8		
10/17/2005	LACDPW	S13			0.6	5	EPA200.8	0.64	1	0.64	210	143.4	5.6		
11/15/2005	LACSD	RA	<	0.25	NA	0.25	EPA200.8	0.25	1	0.25	292	201.2	7.8		
11/15/2005	LACSD	RA1		0.59	NA	0.25	EPA200.8	0.59	1	0.59	516	415.4	16.2		
12/13/2005	LACSD	RA	<	2.5	NA	2.5	EPA200.8	2.5	1	2.5	275	186.4	7.3		
12/13/2005	LACSD	RA1	<	2.5	NA	2.5	EPA200.8	2.5	1	2.5	505	404.2	15.7		
12/31/2005	LACDPW	S13			ND	5	EPA200.8	5		**	180	121.7	4.7		
1/10/2006	LACSD	R9E	<	2.5	NA	2.5	EPA200.8	2.5	1	2.5	326	231.5	9.0		
1/10/2006	LACSD	RA	<	0.25	NA	0.25	EPA200.8	0.25	1	0.25	295	203.9	7.9		
1/10/2006	LACSD	RA1		0.39	NA	0.25	EPA200.8	0.39	1	0.39	545	445.4	17.4		
1/14/2006	LACDPW	S13			ND	5	EPA200.8	5		**	170	114.5	4.5		
1/24/2006	LACDPW	S13			0.5	5	EPA200.8	0.5	1	0.5	420	295.2	11.5		
2/7/2006	LACSD	RA	<	0.25	NA	0.25	EPA200.8	0.25	1	0.25	263	176.1	6.9		
2/7/2006	LACSD	RA1		1.24	NA	0.25	EPA200.8	1.24	1	1.24	460	358.9	14.0		
2/17/2006	LACDPW	S13			ND	5	EPA200.8	5	1	5	380	266.4	10.4		
3/3/2006	LACDPW	S13			0.8	5	EPA200.8	0.77	1	0.77	88	56.2	2.2		
3/9/2006	LACSD	RA	<	0.25	NA	0.25	EPA200.8	0.25	1	0.25	232	150.2	5.9		
3/9/2006	LACSD	RA1		0.31	NA	0.25	EPA200.8	0.31	1	0.31	477	375.9	14.6		
4/17/2006	LACSD	R9E	<	2.5	NA	2.5	EPA200.8	2.5	1	2.5	380	281.4	11.0		
4/17/2006	LACSD	RA	<	0.25	NA	0.25	EPA200.8	0.25	1	0.25	278	189.0	7.4		
4/17/2006	LACSD	RA1	<	0.25	NA	0.25	EPA200.8	0.25	1	0.25	492	391.0	15.2		
4/25/2006	LACDPW	S13			ND	5	EPA200.8	5	1	5	370	259.2	10.1		
5/16/2006	LACSD	RA	<	0.25	NA	0.25	EPA200.8	0.25	1	0.25	250	165.1	6.4		
5/16/2006	LACSD	RA1	<	0.25	NA	0.25	EPA200.8	0.25	1	0.25	388	289.0	11.3		

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APPENDIX J - TABLE J1
COYOTE CREEK - LEAD

Sample Date	Source	Location	Qualifier	Total Lead (ug/L)	Dissolved Lead (ug/L)	PQL/RL (ug/L)	Method	Conservative Dissolved Lead (ug/L)	Is Sample Usable for CCC? (1=Yes)	4-Day Average Concentration	Hardness	Dissolved Lead CMC (ug/L)	Dissolved Lead CCC (ug/L)	Does Sample Exceed CMC (1=Yes)	Does Sample Exceed CCC (1=Yes)
6/20/2006	LACSD	RA		0.34	NA	0.25	EPA200.8	0.34	1	0.34	216	137.1	5.3		
6/20/2006	LACSD	RA1		0.62	NA	0.25	EPA200.8	0.62	1	0.62	421	320.6	12.5		
6/26/2006	LACSD	RA	E	0.15	NA	0.25	EPA200.8	0.25	*	*	269	181.3	*		*
6/26/2006	LACSD	RA	E	0.14	NA	0.25	EPA200.8	0.25	*	*	269	181.3	*		*
6/26/2006	LACSD	RA	E	0.2	NA	0.25	EPA200.8	0.25	*	*	269	181.3	*		*
6/26/2006	LACSD	RA		0.5	NA	0.25	EPA200.8	0.5	1	0.3	269	181.3	7.1		
7/20/2006	LACSD	R9E	E	0.7	NA	2.5	EPA200.8	2.5	1	2.5	334	238.8	9.3		
7/20/2006	LACSD	RA		0.47	NA	0.25	EPA200.8	0.47	1	0.47	282	192.5	7.5		
7/20/2006	LACSD	RA1		0.81	NA	0.25	EPA200.8	0.81	1	0.81	311	218.0	8.5		
8/22/2006	LACSD	RA		0.36	NA	0.25	EPA200.8	0.36	1	0.36	413	312.9	12.2		
8/22/2006	LACSD	RA1		0.36	NA	0.25	EPA200.8	0.36	1	0.36	403	303.3	11.8		
9/19/2006	LACSD	RA		0.42	NA	0.25	EPA200.8	0.42	1	0.42	288	197.7	7.7		
9/19/2006	LACSD	RA1		0.87	NA	0.25	EPA200.8	0.87	1	0.87	391	291.8	11.4		
10/24/2006	LACSD	RA		0.35	NA	0.25	EPA200.8	0.35	1	0.35	252	166.8	6.5		
10/24/2006	LACSD	RA1		0.6	NA	0.25	EPA200.8	0.6	1	0.6	391	291.8	11.4		
11/1/2006	LACDPW	S13			ND	5	EPA200.8	5	1	5	380	266.4	10.4		
11/21/2006	LACSD	RA		1.61	NA	0.25	EPA200.8	1.61	1	1.61	234	151.8	5.9		
11/21/2006	LACSD	RA1		2.64	NA	0.25	EPA200.8	2.64	1	2.64	415	314.8	12.3		
12/9/2006	LACDPW	S13			0.6	5	EPA200.8	0.62	1	0.62	250	172.3	6.7		
12/14/2006	LACSD	RA		0.29	NA	0.25	EPA200.8	0.29	1	0.29	250	165.1	6.4		
12/14/2006	LACSD	RA1		0.73	NA	0.25	EPA200.8	0.73	1	0.73	486	384.9	15.0		
1/9/2007	LACSD	RA		0.3	NA	0.25	EPA200.8	0.3	1	0.3	186	113.3	4.4		
1/9/2007	LACSD	RA1		0.47	NA	0.25	EPA200.8	0.47	1	0.47	486	384.9	15.0		
2/10/2007	LACDPW	S13			1.1	5	EPA200.8	1.1	1	1.1	190	128.9	5.0		
2/19/2007	LACDPW	S13			ND	5	EPA200.8	5		**	140	93.0	3.6		
2/22/2007	LACSD	RA		0.27	NA	0.25	EPA200.8	0.27	1	0.27	260	173.6	6.8		
2/22/2007	LACSD	RA1		0.44	NA	0.25	EPA200.8	0.44	1	0.44	452	351.0	13.7		
2/22/2007	LACDPW	S13			ND	5	EPA200.8	5		**	180	121.7	4.7		
3/8/2007	LACSD	RA	E	0.22	NA	0.25	EPA200.8	0.25	1	0.25	303	210.9	8.2		
3/8/2007	LACSD	RA1	E	0.23	NA	0.25	EPA200.8	0.23	1	0.23	383	284.2	11.1		
4/2/2007	LACDPW	S13			ND	5	EPA200.8	5	1	5	350	244.8	9.5		
4/12/2007	LACSD	RA	E	0.22	NA	0.25	EPA200.8	0.25	1	0.25	260	173.6	6.8		
4/12/2007	LACSD	RA1	E	0.16	NA	0.25	EPA200.8	0.16	1	0.16	361	263.6	10.3		

LACSD - Sanitation Districts of Los Angeles County
LACDPW - Los Angeles County Department of Public Works
* - Data is used in calculation of a 4-day average
** - non detect with detection limit greater than the CCC
*** - Concurrent hardness unavailable so average RA Hardness used
****- Concurrent hardness unavailable so average RA1 Hardness used
***** - Concurrent hardness unavailable so average R9E Hardness used

9 of 195 4-day averages exceed
Criterion Continuous Concentration (CCC)

0 of 267 samples exceed
Criterion Maximum Concentration (CMC)

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DOI: 10.1007/s00267-004-0035-8

A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams

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ABSTRACT / We developed a benthic macroinvertebrate index of biological integrity (B-IBI) for the semiarid and populous southern California coastal region. Potential reference sites were screened from a pool of 275 sites, first with quantitative GIS landscape analysis at several spatial scales and then with local condition assessments (in-stream and riparian) that quantified stressors acting on study reaches. We screened 61 candidate metrics for inclusion in the B-IBI based on three criteria: sufficient range for scoring, responsiveness to watershed and reach-scale disturbance gradients, and minimal correlation with other responsive metrics. Final metrics included: percent collector-gatherer + collector-filterer individuals, percent noninsect taxa, percent tolerant taxa, Coleoptera richness, predator richness, percent intolerant individuals, and EPT richness. Three metrics had lower scores in chaparral reference sites than in mountain reference sites and were scored on separate scales in the B-IBI. Metrics were scored and assembled into a composite B-IBI, which was then divided into five roughly equal condition categories. PCA analysis was used to demonstrate that the B-IBI was sensitive to composite stressor gradients; we also confirmed that the B-IBI scores were not correlated with elevation, season, or watershed area. Application of the B-IBI to an independent validation dataset (69 sites) produced results congruent with the development dataset and a separate repeatability study at four sites in the region confirmed that the B-IBI scoring is precise. The SoCal B-IBI is an effective tool with strong performance characteristics and provides a practical means of evaluating biotic condition of streams in southern coastal California.

Assemblages of freshwater organisms (e.g., fish, macroinvertebrates, and periphyton) are commonly used to assess the biotic condition of streams, lakes, and wetlands because the integrity of these assemblages provides a direct measure of ecological condition of these water bodies (Karr and Chu 1999). Both multimetric (Karr and others 1986; Kerans and Karr 1994; McCormick and others 2001; Klemm and others 2003) and multivariate (Wright and others 1983; Hawkins and others 2000; Reynoldson and others 2001) methods have been developed to characterize biotic condition and to establish thresholds of ecological impairment. In both approaches, the ability to recognize degradation at study sites relies on an understanding of the organismal assemblages expected in the absence of disturbance. Thus, the adoption of a consistent and quantifiable method for defining reference condition is fundamental to any biomonitoring program (Hughes 1995).

Southern California faces daunting challenges in the conservation of its freshwater resources due to its aridity, its rapidly increasing human population, and its role as one of the world's top agricultural producers. In recent years, several state and federal agencies have become increasingly involved in developing analytical tools that can be used to assess the biological and physical condition of California's streams and rivers. For example, the US Environmental Protection Agency (EPA), the US Forest Service (USFS), and California's state and regional Water Quality Control Boards (WQCBs) have collected fish, periphyton and benthic macroinvertebrates (BMIs) from California streams and rivers as a critical component of regional water

KEY WORDS: Benthic macroinvertebrates; B-IBI; Biomonitoring; Mediterranean climate

Published online May 10, 2005.

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quality assessment and management programs. Together, these agencies have sampled BMIs from thousands of sites in California, but no analysis of BMI assemblage datasets based on comprehensively defined regional reference conditions has yet been undertaken. In the only other large-scale study within the state, Hawkins and others (2000) developed a predictive model of biotic integrity for third- to fourth-order streams on USFS lands in three montane regions in northern California. This ongoing effort (Hawkins unpublished) is an important contribution to bioassessment in the state, but the emphasis of this work has been concentrated on logging impacts within USFS lands. The lack of a broadly defined context for interpretation of BMI-based bioassessment remains the single largest impediment to the development of biocriteria for the majority of California streams and rivers. This article presents a benthic index of biotic integrity (B-IBI) for wadeable streams in southern coastal California assembled from BMI data collected in the region by the USFS, EPA, and state and regional WQCBs between 2000 and 2003.

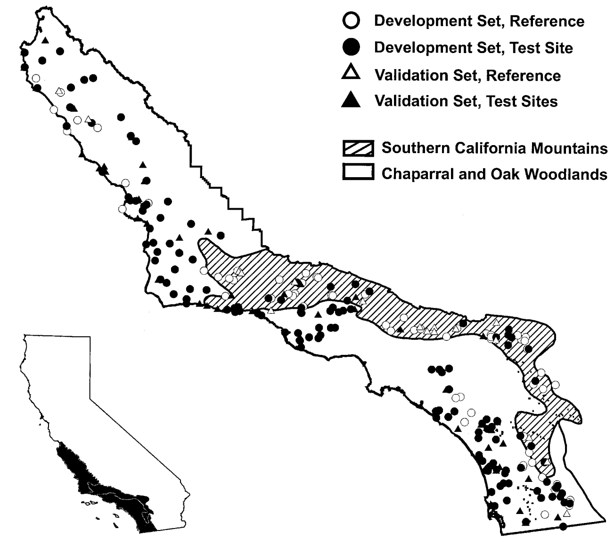

Figure 1. Map of study area showing the location of the study area within California, the distribution of test and reference sites and development and validation sites, and the boundaries of the two main ecoregions in the study area.

Methods

Study Area

The Southern Coastal California B-IBI (SoCal B-IBI) was developed for the region bounded by Monterey County in the north, the Mexican border in the south, and inland by the eastern extent of the southern Coast Ranges (Figure 1). This Mediterranean climate region comprises two Level III ecoregions (Figure 1; Omernik 1987) and shares a common geology (dominated by recently uplifted and poorly consolidated marine sediments) and hydrology (precipitation averages 10–20 in./year in the lower elevations and 20–30 in./year in upper elevations, reaching 30–40 in./year in the highest elevations and in some isolated coastal watersheds (Spatial Climate Analysis Service, Oregon State University, www.climatesource.com). The human population in the region was approximately 20 million in 2000 and is projected to exceed 28 million by 2025 (California Department of Finance, Demographic Research Unit, www.dof.ca.gov).

Field Protocols and Combining Datasets

The SoCal B-IBI is based on BMI and physical habitat data collected from 275 sites (Figure 1) using the 3 protocols described in the following subsections. Sites were sampled during base flow periods between April and October of 2000–2003.

California Stream Bioassessment Protocol (CSBP, 144 sites). Several of the regional WQCBs in southern coastal California have implemented biomonitoring programs in their respective jurisdictions and have collected BMIs according to the CSBP (Harrington 1999). At CSBP sites, three riffles within a 100-m reach were randomly selected for sampling. At each riffle, a transect was established perpendicular to the flow, from which three separate areas of 0.18 m^2 each were sampled upstream of a 0.3-m-wide D-frame net and composited by transect. A total of 1.82 m^2 of substrate was sampled per reach and 900 organisms were subsampled from this material (300 organisms were processed separately from each of 3 transects). Water chemistry data were collected in accordance with the protocols of the different regional WQCBs (Puckett 2002) and qualitative physical habitat characteristics were measured according to Barbour and others (1999) and Harrington (1999).

USFS (56 sites). The USFS sampled streams on national forest lands in southern California in 2000 and 2001 using the targeted riffle protocol of Hawkins and others (2001). All study reaches were selected nonrandomly as part of a program to develop an interpretive (reference) framework for the results of stream biomonitoring studies on national forests in California. BMIs were sampled at study reaches (containing at least four fast-water habitat units) by disturbing two separate 0.09-m^2 areas of substrate upstream of a 0.3-m-wide D-frame net in each of four separate fast-water units; a total of 0.72 m^2 was disturbed and all sample

DOC#1335294

material from a reach was composited. Field crews used a combination of qualitative and quantitative measures to collect physical habitat and water chemistry data (Hawkins and others 2001). A 500-organism subsample was processed from the composite sample and identified following methods described by Vinson and Hawkins (1996).

Environmental Monitoring and Assessment Program (EMAP, 75 sites). The EPA sampled study reaches in southern coastal California from 2000 through 2003 as part of its Western EMAP pilot project. A sampling reach was defined as 40 times the average stream width at the center of the reach, with a minimum reach length of 150-m and maximum length of 500-m. A BMI sample was collected at each site using the USFS methodology described earlier (Hawkins and others 2001) in addition to a standard EMAP BMI sample (not used in this analysis). A 500-organism subsample was processed in the laboratory according to EMAP standard taxonomic effort levels (Klemm and others 1990). Water chemistry samples were collected from the midpoint of each reach and analyzed using EMAP protocols (Klemm and Lazorchak 1994). Field crews recorded physical habitat data using EPA qualitative methods (Barbour and others 1999) and quantitative methods (Kaufmann and others 1999).

As part of a methods comparison study, 77 sites were sampled between 2000 and 2001 with both the CSBP and USFS protocols. The two main differences between the methods are the area sampled and the number of organisms subsampled (discussed earlier). To determine the effect of sampling methodology on assessment of biotic condition, we compared the average difference in a biotic index score between the two methods at each site. Biotic index scores were computed with seven commonly used biotic metrics (taxonomic richness, Ephemoptera, Plecoptera, and Trichoptera (EPT) richness, percent dominant taxon, sensitive EPT individuals, Shannon diversity, percent intolerant taxa, and percent scraper individuals) according to the following equation:

$$Score = \sum (x_i - \bar{x})/sem_i$$

where x_i is the site value for the *i*th metric, x is the overall mean for the *i*th metric, and SEM_i is the standard error of the mean for the *i*th metric. A score of zero is the mean value.

Because USFS-style riffle samples were collected at all EMAP sites, only two field methods were combined in this study. All EMAP and CSBP samples were collected and processed by the California Department of Fish and Game's Aquatic Bioassessment Laboratory (ABL) and all USFS samples were processed by the US Bureau of Land Management's Bug Lab in Logan, Utah. Taxonomic data from both labs were combined in an MS Access© database application that standardized BMI taxonomic effort levels and metric calculations, allowing us to minimize any differences between the two labs that processed samples. Taxonomic effort followed standards defined by the California Aquatic Macroinvertebrate Laboratory Network (CAMLnet 2002; www.dfg.ca.gov/cabw/camlnetste.pdf). Sites with fewer than 450 organisms sampled were omitted from the analyses.

Screening Reference Sites

We followed an objective and quantitative reference site selection procedure in which potential reference sites were first screened with quantitative Geographical Information System (GIS) land-use analysis at several spatial scales and then local condition assessments (instream and riparian) were used to quantify stressors acting within study reaches. We calculated the proportions of different land-cover classes and other measures of human activity upstream of each site at four spatial scales that give unique information about potential stressors acting on each site: (1) within polygons delimiting the entire watershed upstream of each sampling site, (2) within polygons representing local regions (defined as the intersection of a 5-km-radius circle around each site and the primary watershed polygon), (3) within a 120-m riparian zone on each side of all streams within each watershed, and (4) within a 120-m riparian zone in the local region. We used the ArcView® (ESRI 1999) extension ATtILA (Ebert and Wade 2002) to calculate the percentage of various land-cover classes (urban, agriculture, natural, etc.) and other measures of human activity (population density, road density, etc.) in each of the four spatial areas defined for each site. Two satellite imagery datasets from the mid-1990s were combined for the land-cover analyses: California Land Cover Mapping & Monitoring Program (LCMMP) vegetation data (CalVEG) and a recent dataset produced by the Central Coast Watershed Group (Newman and Watson 2003). Population data were derived from the 2000 migrated TIGER dataset (California Department of Forestry and Fire Protection, www.cdf.ca.gov). Stream layers were obtained from the US Geological Survey (USGS) National Hydrography Dataset (NHD). The road network was obtained from the California Spatial Information Library (CaSIL, gis.ca.gov) and elevation was based on the USGS National Elevation Dataset (NED). Frequency histograms of land-use percentages for all sites were used to establish subjective thresholds for elim-

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Table 1. List of minimum or maximum landuse thresholds used for rejecting potential reference sites

Stressor metric	Definition	Threshold
N_index_L	Percentage of natural land use at the local scale	≤ 95%
Purb_L	Percental of urban land use at the local scale	> 3%
Pagt_L	Percentage of total agriculture at the local scale	> 5%
Rddens_L	Road density at the local scale	> 2.0 km/km^2
PopDens_L	Population density (2000 census) at the local scale	> 150 indiv./km^2
N_index_W	Percentage of natural landuse at the watershed scale	≤ 95%
Purb_W	Percentage of urban landuse at the watershed scale	> 5%
Pagt_W	Percentage of total agriculture at the watershed scale	> 3%
Rddens_W	Road density at the watershed scale	> 2.0 km/km^2
PopDens_W	Population density (2000 census) at the watershed scale	> 150 indiv./km^2

inating sites from the potential reference pool (Table 1). Sites were further screened from the reference pool on the basis of reach-scale conditions (obvious bank instability or erosion/ sedimentation problems, evidence of mining, dams, grazing, recent fire, recent logging).

Eighty-eight sites passed all the land-use and local condition screens and were selected as reference sites, leaving 187 sites in the test group. We randomly divided the full set of sites into a development set (206 sites total: 66 reference/140 test) and a validation set (69 sites total: 22 reference/47 test). The development set was used to screen metrics and develop scoring ranges for component B-IBI metrics; the validation set was used for an independent evaluation of B-IBI performance.

Screening Metrics and Assembling the B-IBI

Sixty-one metrics were evaluated for possible use in the SoCal B-IBI (Table 2). A multistep screening process was used to evaluate each metric for (1) sufficient range to be used in scoring, (2) responsiveness to watershed-scale and reach-scale disturbance variables, and (3) lack of correlation with other responsive metrics.

Pearson correlations between all watershed-scale and reach-scale disturbance gradients were used to define the smallest suite of independent (nonredundant) disturbance variables against which to test biological metric response. Disturbance variables with correlation coefficients $|r| \geq 0.7$ were considered redundant. Responsiveness was assessed using visual inspection of biotic metric versus disturbance gradient scatterplots and linear regression coefficients. Metrics were selected as responsive if they showed either a linear or a "wedge-shaped" relationship with disturbance gradients. Biological metrics often show a "wedge-shaped" response rather than a linear response to single disturbance gradients because the single gradient only defines the upper boundary of the biological response; other independent disturbance gradients and natural limitations on species distributions might result in lower metric values than expected from response to the single gradient. Biotic metrics and disturbance gradients were log-transformed when necessary to improve normality and equalize variances. Metrics that passed the range and responsiveness tests were tested for redundancy. Pairs of metrics with product–moment correlation coefficients $|r| \geq 0.7$ were considered redundant and the least responsive metric of the pair was eliminated.

Scoring ranges were defined for each metric using techniques described in Hughes and others (1998), McCormick and others (2001), and Klemm and others (2003). Metrics were scored on a 0–10 scale using statistical properties of the raw metric values from both reference and nonreference sites to define upper and lower thresholds. For positive metrics (those that increase as disturbance decreases), any site with a metric value equal to or greater than the 80th percentile of reference sites received a score of 10; any site with a metric value equal to or less than the 10th percentile of the nonreference sites received a score of 0; these thresholds were reversed for negative metrics (20th percentile of reference and 90th percentile of nonreference). In both cases, the remaining range of intermediate metric values was divided equally and assigned scores of 1 through 9. Before assembling the B-IBI, we tested whether any of the final metrics were significantly different between chaparral and mountain reference sites in the southern California coastal region, in which case they would require separate scoring ranges in the B-IBI. Finally, an overall B-IBI score was calculated for each site by summing the constituent metric scores and adjusting the B-IBI to a 100-point scale.

Table 2. The 61 BMI metrics screened for use in the SoCal IBI

Candidate metrics	Disturbance variables										
	U_index_W	Pagt_W	Purb_L	RdDens_L	Channel Alteration	Bank Stability	Percent Fines	Total Dissolved Solids	Total Phosphorus	Total Nitrogen	Range Test
Taxonomic group metrics											
Coleoptera richness*	M	w	M	S	S	—	—	—	—	—	P
Crustacea + Mollusca richness	—	—	—	—	—	—	—	—	—	—	F
Diptera richness	—	—	—	—	—	—	—	—	—	—	P
Elmidae richness	w	—	w	M	S	M	S	M	—	—	F
Ephemerellidae richness					S	M	M	S	—	M	F
Ephemeroptera richness	S	S	M	S	w	M	S	S	—	S	P
EPT richness*	S	S	S	S	S	S	S	S	—	S	P
Hydropsychidae richness	—	—	w	—	S	—	—	—	—	—	F
Percent Amphipoda individuals	—	—	—	—	—	—	—	—	—	—	P
Percent Baetidae individuals	—	—	—	—	w	—	—	—	—	—	P
Percent Chironomidae individuals	—	—	—	—	—	—	—	—	M	—	P
Percent Corbicula individuals	—	—	—	—	—	—	—	—	—	—	P
Percent Crustacea individuals	—	—	—	—	—	—	—	—	—	—	P
Percent Diptera individuals	—	w	—	—	—	—	—	—	—	—	P
Percent Elmidae individuals	—	—	—	w	M	S	S	w	—	M	P
Percent Ephemeroptera individuals	—	w	w	—	M	w	—	—	—	—	P
Percent EPT individuals	—	—	M	M	M	M	—	—	—	—	P
Percent Gatropoda individuals	—	—	—	w	—	—	—	—	—	—	P
Percent Glossosomatidae individuals	—	—	—	—	w	—	—	—	—	M	F
Percent Hydropsychidae individuals	—	—	—	M	w	M	—	—	—	—	P
Percent Hydroptilidae individuals	—	—	—	M	—	w	—	—	—	—	F
Percent Mollusca individuals	—	—	—	w	w	—	—	—	—	—	P
Percent non-*Baetis/Fallceon* Ephemeroptera individuals	w	w	—	M	w	M	—	—	w	—	P
Percent non-*Hydropsyche* Hydropsychidae individuals	—	—	—	M	w	w	—	—	—	—	F
Percent non-*Hydropsyche/Cheumatopsyche* Trichoptera individuals	w	w	—	M	w	M	M	w	—	—	P
Percent non-insect Taxa*	M	w	M	M	w	—	—	—	w	M	F
Percent Oligochaeta individuals	—	—	—	—	w	—	—	—	—	—	P
Percent Perlodidae individuals	—	—	—	w	w	—	—	—	—	—	F
Percent Plecoptera individuals	—	—	—	M	M	M	M	M	w	S	P
Percent Rhyacophilidae individuals	—	—	—	w	S	S	w	—	—	M	F
Percent Simuliidae individuals	—	w	—	w	S	w	—	—		—	P
Percent Trichoptera	w	—	—	M	M	M	M	w	w	—	P
Plecoptera richness	M	S	w	M	w	w	M	S	—	S	F
Total taxa richness	M	M	w	S	w	w	w	w	w	M	P
Trichoptera richness	S	S	S	S	S	M	S	w	—	w	P

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Table 2. Continued.

Candidate metrics	Disturbance variables: U_index_W	Pagt_W	Purb_L	RdDens_L	Channel Alteration	Bank Stability	Percent Fines	Total Dissolved Solids	Total Phosphorus	Total Nitrogen	Range Test
Functional feeding metrics											
Collector (filterers) richness	w	—	M	S	S	M	w	—	—	—	F
Collector (gatherers) richness	—	—	—	—	—	—	—	—	—	w	P
Percent collector (filterer) + collector (gatherer) individuals*	M	—	—	S	—	w	—	M	w	M	P
Percent collector (filterer) individuals	—	—	—	w	M	M	w	—	—	—	P
Percent collector (gatherer) individuals	—	—	—	w	M	—	—	w	M	w	P
Percent predator individuals	—	—	—	w	M	—	—	—	—	—	P
Percent scraper individuals	w	w	—	M	M	w	w	—	—	—	P
Percent scraper minus snails individuals	—	—	—	w	—	w	—	—	—	—	P
Percent shredder individuals	—	—	—	w	w	—	—	—	—	—	P
Predator richness*	S	S	w	M	w	—	—	S	—	M	P
Scraper richness	S	M	M	S	S	S	S	S	—	S	P
Shredder richness	M	M	—	M	S	—	—	—	—	M	F
Tolerance metrics											
Average tolerance value	M	w	w	S	w	—	M	—	—	w	P
Intolerant EPT richness	M	w	w	M	S	—	S	S	—	S	P
Intolerant taxa richness	M	w	w	M	S	M	S	S	—	S	P
Percent intolerant Diptera individuals	—	—	—	—	—	—	—	—	—	—	F
Percent intolerant individuals*	M	w	—	M	S	M	M	S	—	M	P
Percent intolerant scraper individuals	—	—	—	w	M	w	w	w	—	—	P
Percent of intolerant Ephemeroptera individuals	—	—	—	w	w	—	w	w	—	—	P
Percent of intolerant Trichoptera individuals	—	w	—	—	w	w	w	w	—	—	P
Percent sensitive EPT individuals	w	w	—	M	M	M	M	M	w	M	P
Percent tolerant individuals	—	—	—	—	—	—	w	w	—	—	P
Percent tolerant taxa*	w	—	w	M	—	—	—	w	—	M	P
Tolerant taxa richness	—	—	—	—	—	M	—	—	—	—	P
Others											
Percent dominant taxon	—	—	—	—	—	—	—	—	—	—	P
Shannon Diversity Index	w	w	w	M	M	w	—	w	w	w	P

Note: Each metric is indicated as having either no response (—), weak response (w), moderate response (M), or strong response (S) to each of eleven minimally correlated disturbance variables and whether each metric passed (P) or failed (F) the range test. The final seven minimally correlated metrics are indicated with an asterisk (*).

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Table 3. Scoring ranges for seven component metrics in the SoCal B-IBI

Metric score	Coleoptera taxa (all sites)	EPT taxa		Predator taxa (all sites)	% Collector individuals		% Intolerant individuals		% Noninsect taxa (all sites)	% Tolerant taxa (all sites)
		6	8		6	8	6	8		
10	>5	>17	>18	>12	0–59	0–39	25–100	42–100	0–8	0–4
9		16–17	17–18	12	60–63	40–46	23–24	37–41	9–12	5–8
8	5	15	16	11	64–67	47–52	21–22	32–36	13–17	9–12
7	4	13–14	14–15	10	68–71	53–58	19–20	27–31	18–21	13–16
6		11–12	13	9	72–75	59–64	16–18	23–26	22–25	17–19
5	3	9–10	11–12	8	76–80	65–70	13–15	19–22	26–29	20–22
4	2	7–8	10	7	81–84	71–76	10–12	14–18	30–34	23–25
3		5–6	8–9	6	85–88	77–82	7–9	10–13	35–38	26–29
2	1	4	7	5	89–92	83–88	4–6	6–9	39–42	30–33
1		2–3	5–6	4	93–96	89–94	1–3	2–5	43–46	34–37
0	0	0–1	0–4	0–3	97–100	95–100	0	0–1	47–100	38–100

Note: Three metrics have separate scoring ranges for the two Omernik Level III ecoregions in southern coastal California region (6 = chaparral and oak woodlands, 8 = Southern California mountains).

Validation of B-IBI and Measurement of Performance Characteristics

To test whether the distribution of B-IBI scores in reference and test sites might have resulted from chance, we compared score distributions in the development set to those in the validation set. We also investigated a separate performance issue that ambient bioassessment studies often neglect: spatial variation at the reach scale. Although our use of a validation dataset tests whether the B-IBI scoring range is repeatable (Fore and others 1996; McCormick and others 2001), we designed a separate experiment to explicitly measure index precision. Four sites were resampled in May 2003. At each site, nine riffles were sampled following the CSBP, and material from randomly selected riffles was combined into three replicates of three riffles each. B-IBI scores were then calculated for each replicate. Variance among these replicates was used to calculate the minimum detectable difference (MDD) between two B-IBI scores based on a two-sample *t*-test model (Zar 1999). The index range can be divided by the MDD to estimate the number of stream condition categories detectable by the B-IBI (Doberstein and others 2000; Fore and others 2001).

Results

Combining Datasets

Unmodified CSBP samples (900 count) had significantly higher biotic condition scores ($t = -6.974$, $P < 0.0001$) than did USFS samples (500 count). However, there was no difference in biotic condition scores between USFS samples and CSBP samples that were randomly subsampled to reduce the 900 count to 500 ($t = -0.817$, $P = 0.416$). Thus, data from both targeted-riffle protocols were combined in B-IBI development.

Selected Metrics

Ten nonredundant stressor gradients were selected for metric screening: percent watershed unnatural, percent watershed in agriculture, percent local watershed in urban, road density in local watershed, qualitative channel alteration score, qualitative bank stability score, percent fine substrates, total dissolved solids, total nitrogen, and total phosphorous. Twenty-three biotic metrics that passed the first two screens (range and dose response) were analyzed for redundancy with Pearson product–moment correlation, and a set of seven minimally correlated metrics was selected for the B-IBI: percent collector-gatherer + collector-filterer individuals (% collectors), percent noninsect taxa, percent tolerant taxa, Coleoptera richness, predator richness, percent intolerant individuals, and EPT richness (Table 3). All metrics rejected as redundant were derived from taxa similar to those of selected metrics, but they had weaker relationships with stressor gradients. Dose–response relationships of the selected metrics to the 10 minimally correlated stressor variables are shown in Figure 2 and reasons for rejection or acceptance of all metrics are listed in Table 2. Regression coefficients were significant at the $P \leq 0.0001$ level among all seven selected metrics and at least two stressor gradients: percent watershed unnatural and road density in local watershed (Table 4). The final seven metrics included several metric types: richness, composition, tolerance measures, and func-

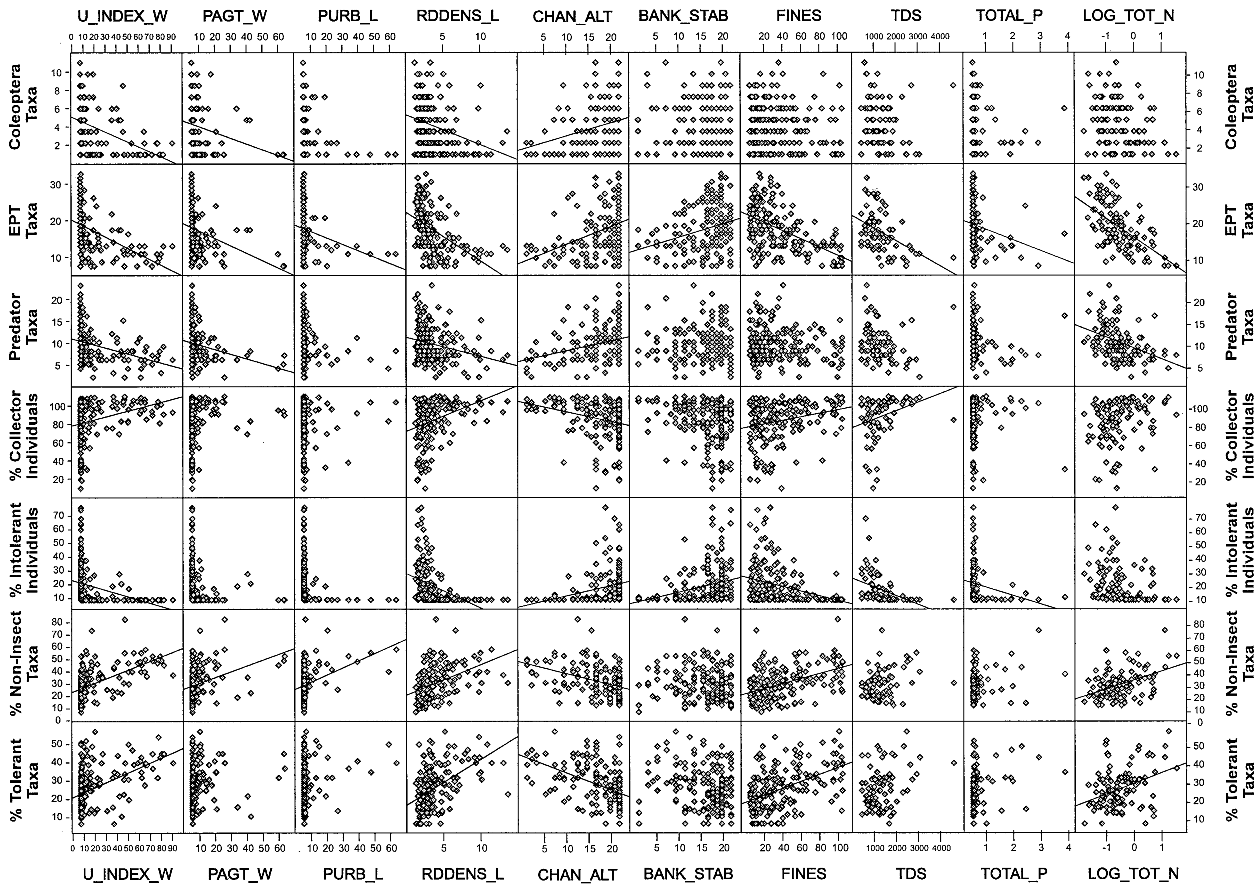

Figure 2. Scatterplots of dose–response relationships among 10 stressor gradients and 7 macroinvertebrate metrics (lines represent linear "best-fit" relationships; see text for abbreviations).

Table 4. Significance levels of linear regression relationships among 10 stressor metrics and 7 biological metrics

Metric	Coleoptera taxa	EPT taxa	Predator taxa	% Collector individuals	% Intolerant individuals	% Noninsect taxa	% Tolerant taxa
Bank Stability	0.813	**<0.0001**	0.3132	0.0009	0.0001	0.1473	0.0013
Fines	0.0017	**<0.0001**	0.0171	**0.0003**	**<0.0001**	**<0.0001**	**<0.0001**
Chan_Alt	**<0.0001**	**<0.0001**	**<0.0001**	**0.0003**	**<0.0001**	**<0.0001**	**<0.0001**
Log_U_Index_W	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Log_PAgT_W	**0.0007**	**<0.0001**	**0.0004**	0.0054	0.0014	**<0.0001**	0.0012
Log_PUrb_L	0.0367	**0.0007**	0.0344	0.6899	0.0045	**0.0002**	0.0215
Log RdDens_L	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**
Log_TDS	0.0094	**<0.0001**	0.0035	**0.0005**	**<0.0001**	0.0271	0.004
Log_Tot_N	0.0019	**<0.0001**	**<0.0001**	0.0078	0.0019	**<0.0001**	**<0.0001**
Log_Tot_P	0.062	**<0.0001**	0.0085	0.0162	**0.0001**	0.0018	0.0059

Note: Significant *P*-values corrected for 70 simultaneous comparisons ($P < 0.0007$) are highlighted in bold. Abbreviations are defined in Table 1 and in the text.

tional feeding groups. Because there are only seven metrics in the B-IBI, final scores calculated using this IBI are multiplied by 1.43 to adjust the scoring range to a 100-point scale.

The B-IBI scores were lower in chaparral reference sites than in mountain reference sites when calculated using unadjusted metric scores (Mann–Whitney *U*-test; $P = 0.02$). Although none of the final seven metrics

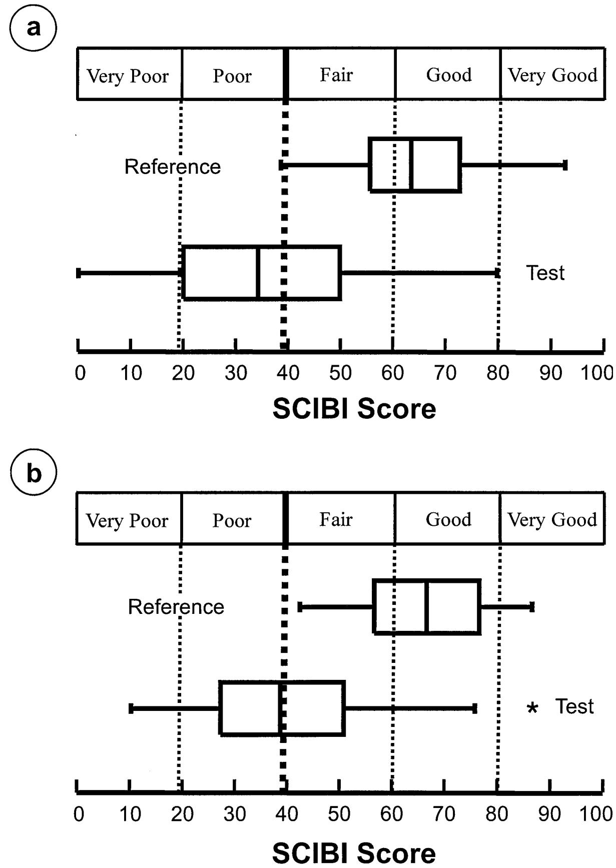

Figure 3. Box plots of B-IBI site scores for reference and test groups showing B-IBI scoring categories: (a) development sites and (b) validation sites. Dotted lines indicate condition category boundaries and heavy dotted lines indicate impairment thresholds.

were significantly different between chaparral reference sites and mountain reference sites at the $P = 0.05$ level ($P < 0.007$ after Bonferroni correction), scores for three metrics (EPT richness, percent collector-gatherer + collector-filterer individuals, and percent intolerant individuals) were substantially lower in chaparral reference sites than in mountain reference sites. We adjusted for this difference by creating separate scoring scales for the three metrics in the two ecoregions (Table 3). There was no difference in B-IBI scores between reference sites in the two ecoregions after the adjustment (Mann–Whitney *U*-test, $P = 0.364$).

Validation of B-IBI and Measurement of Performance Characteristics

The distribution of B-IBI scores at reference and nonreference sites was nearly identical between the development and validation data sets (Figure 3), indicating that our characterization of reference conditions and subsequent B-IBI scoring was repeatable and not likely due to chance. Based on a two-sample *t*-test model (setting $\alpha = 0.05$ and $\beta = 0.20$), the MDD for the SoCal IBI is 13.1. Thus, we have an 80% chance of detecting a 13.1-point difference between sites at the $P = 0.05$ level. Dividing the 100-point B-IBI scoring range by the MDD indicates that the SoCal B-IBI can detect a maximum of seven biological condition categories, a result similar to or more precise than other recent estimates of B-IBI precision (Barbour and others 1999; Fore and others 2001). We used a statistical criterion (two standard deviations below the mean reference site score) to define the boundary between "fair" and "poor" conditions, thereby setting B-IBI = 39 as an impairment threshold. The scoring range below 39 was divided into two equal condition categories, and the range above 39 was divided into three equal condition categories: 0–19 = "very poor", 20–39 = "poor", 40–59 = "fair", 60-79 = "good", and 80–100 = "very good" (Figure 3).

We ran two principle components analyses (PCAs) on the environmental stressor values used for testing metric responsiveness: 1 that included all 275 sites for which we calculated 4 watershed scale stressor values and another based on 124 sites for which we had measurements of 9 of the 10 minimally correlated stressor variables. We plotted B-IBI scores as a function of the first multivariate stressor axis from each PCA. We log-transformed percent watershed unnatural, percent watershed in agriculture, percent local watershed in urban, road density in local watershed, total nitrogen, and total phosphorous. Only PCA Axis 1 was significant in either analysis, having eigenvalues larger than those predicted from the broken-stick model (McCune and Grace 2002). In both PCAs, the B-IBI score decreased with increasing human disturbance (Figure 4) and was correlated (Spearman ρ) with PCA Axis 1 ($r = -0.652$, $P < 0.0001$ for all 275 sites; $r = -0.558$, $P \leq 0.0001$ for 124 sites). In the analysis of all 275 sites, all 4 watershed-scale stressors had high negative loadings, with percent watershed unnatural and local road density being the highest (Figure 5a). In the analysis of 124 sites, percent watershed unnatural, percent watershed in agriculture, and local road density had the highest negative loadings on the first axis, and channel alteration had the highest positive loading (Figure 4b).

Finally, we found no relationship between B-IBI scores and ecoregion (Mann–Whitney U, $P = 0.364$), Julian date ($R^2 = 0.01$, $P = 0.349$), watershed area ($R^2 = 0.002$, $P = 0.711$), or elevation ($R^2 = 0.01$, $P = 0.349$), indicating that the B-IBI scoring is robust with respect to these variables (Figure 5). Our ecoregion scoring adjustment probably corrects for the

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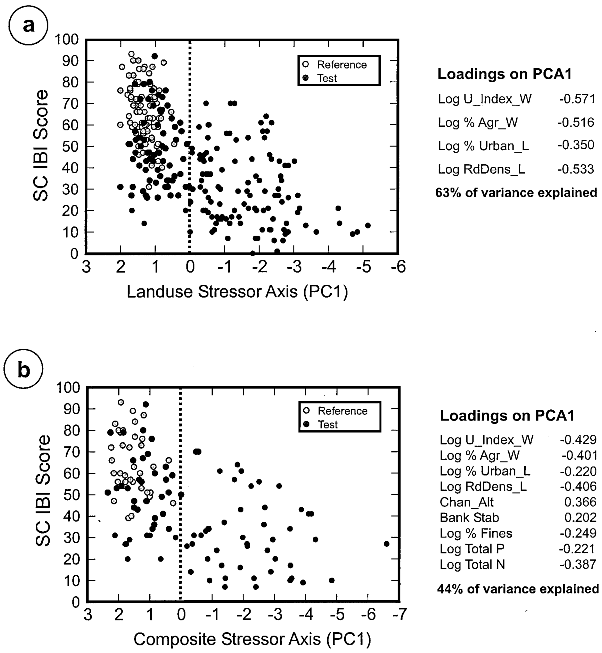

Figure 4. Scatterplots of SoCal B-IBI scores against two composite stressor axes from PCA: (a) values for all 275 sites; composite axis includes 4 land-use gradients; (b) values for 124 sites; composite axis includes 9 local and watershed scale stressor gradients.

strongest elevation effects, but there is no evidence that B-IBI scores are related to elevation differences within each ecoregion.

Discussion

The SoCal B-IBI is the most comprehensive assessment to date of freshwater biological integrity in California. As in other Mediterranean climate regions, the combination of aridity, geology, and high-amplitude cycles of seasonal flooding and drying in southern coastal California makes its streams and rivers particularly sensitive to disturbance (Gasith and Resh 1999). This sensitivity, coupled with the burgeoning human population and vast conversion of natural landscapes to agriculture and urban areas, has made it the focus of both state and federal attempts to maintain the ecological integrity of these strained aquatic resources.

Unfortunately, growing interest in biomonitoring is unmatched by financial resources available for this monitoring. Thus, combination of data among programs is very desirable, although this goal is rarely achieved in practice. We demonstrated that macroinvertebrate bioassessment data from multiple agencies could be successfully combined to produce a regional index that is useful to all agencies involved. This index is easy to apply, its fundamental assumptions are transparent, it provides precise condition assessments, and it is demonstrated to be responsive to a wide range of anthropogenic stressors. The index can also be applied throughout a long index period (mid-spring to mid-fall): Just as biotic factors tend to have more influence on assemblage structure during the summer dry period of Mediterranean climates than during the wet season when abiotic factors dominate (Cooper and others 1986; Gasith and Resh 1999), it is likely that our biotic index is more sensitive to anthropogenic stressors during the summer dry period. Because of these qualities, we expect the SoCal B-IBI to be a practical management tool for a wide range of water quality applications in the region.

This B-IBI is a regional adaptation of an approach to biotic assessment developed by Karr (1981) and subsequently extended and refined by many others (Kerans and Karr 1994; Barbour and others 1996; Fore and others 1996; Hughes and others 1998). We drew heavily upon recent refinements in multimetric index methodology that improve the objectivity and defensibility of these indices (McCormick and others 2001; Klemm and others 2003). A central goal of bioassessment is to select metrics that maximize the detection of anthropogenic stress while minimizing the noise of natural variation. One of the most important recent advances in B-IBI methods is the emphasis on quantitative screening tools for selecting appropriate metrics. We also minimized sources of redundancy in the analysis: (1) between watershed and local-scale stressor gradients for dose–response screening of biotic metrics and (2) in the final selection of metrics. The former guards against a B-IBI that is biased toward a set of highly correlated stressors and is, therefore, of limited sensitivity; the latter assures a compact B-IBI with component metrics that contribute independent information about stream condition. Combined with an assessment of responsiveness to specific regional disturbance gradients, these screening tools minimize the variability of B-IBI scores and improve its sensitivity.

The seven component metrics used in this B-IBI are similar to those selected for other B-IBIs (DeShon 1995; Barbour and others 1995, 1996; Fore and others 1996; Klemm and others 2003), but some of the metrics are either unique or are variations on other commonly used metrics. Like Klemm and others (2003), we found noninsect taxa to be responsive to human stressors, but richness was more responsive than percent of individuals. Some authors have separated the EPT metric into two or three metrics based on its component orders because the orders provided unique signals (Clements 1994; Fore and others 1996; Klemm

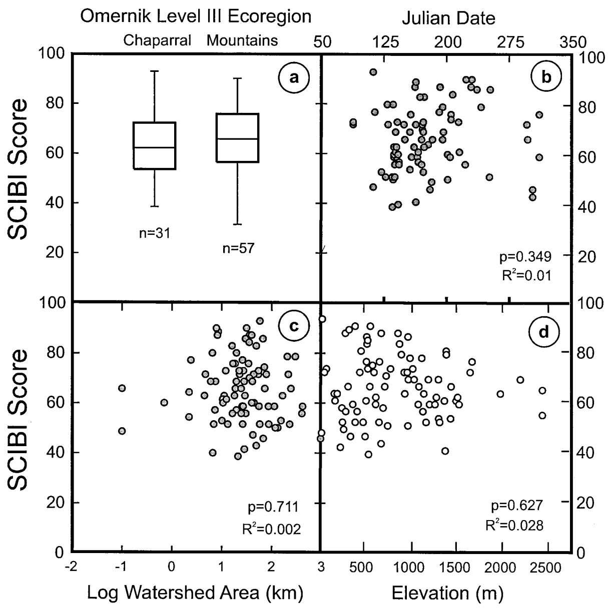

Figure 5. Relationship between B-IBI scores at 88 reference sites and (a) Omernik Level III ecoregion, (b) Julian date, (c) log watershed area, and (d) elevation.

and others 2003), but we found very similar patterns in these orders' response to various stressors we measured. To our knowledge, Coleoptera richness has not previously been included in a B-IBI, but beetle taxa might be a good indicator of the effects of fine sediments at impaired sites in this region (Brown 1973). A recent study of benthic assemblages in North Africa noted a high correspondence between EPT and EPTC (EPT + Coleoptera) (Beauchard and others 2003), but these orders were not highly correlated in our dataset. Feeding groups appear less often in B-IBIs than other metric types (Klemm and others 2003), but they were represented by two metrics in this B-IBI: predator richness and percent collectors (gatherers and filterers combined). Scraper richness was also responsive, but was rejected here because it was highly correlated with EPT richness.

The SoCal IBI should prove useful as a foundation for state and regional ambient water quality monitoring programs. Because the 75 EMAP sites were selected using a probabilistic statistical design, it will also be possible to use those samples to estimate the percentage of stream miles that are in "good", "fair", and "poor" condition in the southern California coastal region. These condition estimates, combined with stressor association techniques, have great potential to serve as a scientifically defensible basis for allocating precious monitoring resources in this region.

Acknowledgments

Major funding for this study was provided by David Gibson of the San Diego WQCB and Joseph Furnish of the USFS, with supplemental funding from other regional WQCBs in southern California. We thank James Harrington and other staff of California Department of Fish and Game's Aquatic Bioassessment Laboratory for efforts that contributed to the success of this project. Biologists Mike Dawson, Shawn McBride, and Jennifer York collected much of the field data; taxonomists Dan Pickard, Doug Post, Brady Richards, and Joe Slusark performed most of the taxonomy, except for the USFS samples, which were processed by the Bug Lab at Utah State University. Dan Heggem (US EPA, Landscape Ecology Branch), Mark Rosenberg (California Department of Forestry), and Mark Angelo (Central Coast WQCB) helped identify appropriate GIS land-use layers, and Glenn Sibbald (CDFG) assisted with watershed delineation. Mary Adams (Central Coast WQCB) collected invertebrate samples and provided local site condition data for sites in the Central Coast region. This manuscript was greatly improved by comments from Larry Brown, Joseph Furnish, Robert Hughes, Leska Fore, and three anonymous reviewers.

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ATTACHMENT B
APPENDIX 2

J. N. Am. Benthol. Soc., 2008, 27(4):967–985

DOI: 10.1899/08–051.1
Published online: 28 October 2008

Comparability of biological assessments derived from predictive models and multimetric indices of increasing geographic scope

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Abstract. The increasing demand for tools that can score biological condition from aquatic community data has spurred the creation of many predictive models (e.g., observed/expected [O/E] indices) and multimetric indices (MMIs). The geographic and environmental scopes of these indices vary widely, and coverages often overlap. If indices developed for large environmentally heterogeneous regions provide results equivalent to those developed for smaller regions, then regulatory entities could adopt indices developed for larger regions rather than fund the development of multiple indices within a region. We evaluated this potential by comparing the performance (precision, bias, responsiveness, and sensitivity) of benthic macroinvertebrate O/E indices and MMIs developed for California (CA) with that of indices developed for 2 large-scale condition assessments of US streams: the Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West) and the western portion of the Wadeable Streams Assessment (WSA-West). WSA-West and EMAP-West O/E scores were weakly correlated with CA O/E scores, had lower precision than CA O/E scores, were influenced by 2 related natural gradients (% slope and % fast-water habitat) that did not influence CA O/E scores, and disagreed with 21 to 22% of impairment decisions derived from the CA O/E index. The WSA-West O/E index produced many fewer impairment decisions than did the CA O/E index. WSA-West and EMAP-West MMI scores were strongly correlated with the CA MMI scores. However, the WSA-West and EMAP-West MMIs produced many fewer determinations of impairment than did the CA MMI. EMAP-West and WSA-West MMIs were biased and differed in responsiveness compared with CA MMI. Thus, they might produce estimates of regional condition different from those from indices calibrated to local conditions. The lower precision of the EMAP-West and WSA-West indices compromises their use in site-specific assessments where both precision and accuracy are important. However, the magnitude of differences in impairment decisions was sensitive to the thresholds used to define impaired conditions, so it might be possible to adjust some of the systematic differences among the models to make the large-scale models more suitable for local application. Future work should identify the geographic and environmental scales that optimize index performance, determine the factors that most strongly influence index performance, and identify ways to specify accurate reference condition from geographically extensive reference-site data sets.

Key words: bioindicators, bioassessment, geographic scale, spatial extent, predictive models, O/E indices, multimetric indices, benthic macroinvertebrates.

The widespread adoption of bioassessment techniques for assessing the ecological condition of bodies of water has generated many indices that are available to water resource managers (Reynoldson et al. 1997,

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Hughes et al. 1998, Barbour and Yoder 2000, Hawkins et al. 2000b, Van Sickle et al. 2005, Bonada et al. 2006). These tools were generated to meet different needs; thus, their geographic scopes differ widely and often overlap.

As the proliferation of new indices continues, end-users (e.g., regulatory entities developing numeric biocriteria; Yoder and Rankin 1995) will need guidance for selecting among these different indices and evaluating the number of different indices required for effective regional bioassessment. If local and regional assessments based on indices developed for broad geographical areas are equivalent to assessments based on indices developed for smaller areas, then regulatory entities could profit by adopting the large-scale indices and abandoning the development and maintenance of multiple smaller-scale indices. This potential is attractive because indices that apply to large geographic areas already have been developed for many regions of the world, e.g., UK (Moss et al. 1987), Australia (Simpson and Norris 2000), Europe (Statzner et al. 2001), and the US (Stoddard et al. 2006, 2008, Yuan et al. 2008). Widespread use of common indices would facilitate consistency in data interpretation among the users of indices of ecological condition (Bonada et al. 2006, Hawkins 2006).

However, indices developed for large geographic regions might have limitations that could restrict their value for both site- and regional-scale assessments. Such indices must account for natural variation that occurs within large regions. Performance characteristics of multimetric and predictive model indices are limited by the ability of the indices to account for variability among the reference sites used to develop indices (Moss et al. 1987, Hughes 1995, Reynoldson et al. 1997, Karr and Chu 1999, Hawkins et al. 2000b, Bailey et al. 2004, Bonada et al. 2006).

A central principle of ecology is that biological assemblages vary naturally along many environmental gradients (Andrewartha and Birch 1954, Hutchinson 1959, Hynes 1970). Therefore, the precision and accuracy of any index will depend on how well the mechanics of index calculation account for the effects of these natural gradients on assemblage structure (Johnson et al. 2004, 2007, Van Sickle et al. 2005, Hawkins 2006, Heino et al. 2007, Mykrä et al. 2007, 2008). If biological variation associated with local environmental gradients (e.g., reach slope or substrate size) is masked by environmental factors that vary over large spatial scales (e.g., climatic factors and geology), then indices developed from spatially restricted data sets might be required for site-specific assessments.

Recently derived biological indices developed for the US Environmental Protection Agency (EPA) national Wadeable Streams Assessment (WSA; western states only [WSA-West]) and the Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West) (Stoddard et al. 2005, 2006, USEPA 2006) presented an opportunity to evaluate the applicability of large-scale models to site- or regional-scale assessments. We compared performance metrics (precision, bias, responsiveness, and sensitivity) of indices from these large surveys with those of indices developed specifically for California (CA) (Ode et al. 2005, Rehn et al. 2005, CPH, unpublished data). The surveys varied in geographic extent and geoclimatic heterogeneity (geoclimatic scales: CA < EMAP-West < WSA-West). We assessed an independent set of evaluation (test) sites that had not been used to develop any of the indices. To the extent that our test data set permitted, we did parallel analyses with multimetric indices (MMI) and observed/expected (O/E) indices of benthic macroinvertebrate (BMI) assemblage condition.

Methods

O/E development

Three sets of predictive models were used to produce the O/E scores that we compared. All O/E indices were developed with the standardized process (Moss et al. 1987, Hawkins et al. 2000b, Clarke et al. 2003) described in the EMAP-West statistical summary (Stoddard et al. 2006). The process is: 1) sample BMIs at a set of environmentally diverse sites, 2) specify the sites to be used as reference sites, 3) apply a standard taxonomy (operational taxonomic units [OTUs]) to all samples, 4) cluster reference sites based on similarity of BMI assemblage composition, 5) calculate and screen candidate predictor variables, and 6) calibrate linear discriminant functions models for predicting assemblage composition at new sites. All models were developed with map-level predictor variables (except that reach slope measured in the field was used in 1 model) to enable universal applicability of models (Table 1). Aside from the specific combination of predictor variables used in the models, the major difference among models was the range of environmental heterogeneity or geographic extent encompassed by the reference sites used in each model. Models were based on data from targeted-riffle benthic samples (CA models) or a combination of targeted-riffle and reach-wide multiple-habitat samples (EMAP-West and WSA-West models). These 2 types of samples appear to be generally comparable for California streams (Rehn et al. 2007). Other aspects of model development were similar among models (Table 2).

WSA-West model.—A single western US model developed during the WSA (Yuan et al. 2008) encom-

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TABLE 1. Predictor variables used for California (CA), Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West), and the western portion of the Wadeable Stream Assessment (WSA-West) observed/expected predictive models. Only 1 EMAP-West model (model 2) for California uses predictor variables; the others are null models. Only 1 WSA-West model was developed.

CA model 1	CA model 2	CA model 3	EMAP-West model 2	WSA-West model
Watershed area	Watershed area	Watershed area	Watershed area	Watershed area
Longitude	Longitude	Temperature	Longitude	Longitude
Latitude	Precipitation		Elevation	Day of year
Temperature	Day of year		Precipitation	Minimum temperature
				Elevation
				Precipitation
				% slope

passed the most heterogeneous environmental conditions and the largest geographic scope ($\sim$2,500,000 km^2; Fig. 1). The WSA-West model was developed for aggregated mountainous (Western Mountain) and xeric (Xeric West) Omernik level III ecoregions (Omernik 1987) of the western US and excluded only plains ecoregions (USEPA 2006). WSA-West O/E was based on 519 reference sites clustered into 31 groups and 7 variables that predicted group membership (Table 1).

EMAP-West models.—The data used to construct the WSA-West model had been used previously to develop 5 separate ecotype-specific models (Stoddard et al. 2006, 2008). All sampled sites (reference and non-reference) were assigned to 1 of 5 broad ecotypes based on a *k*-means classification (MacQueen 1967) of long-term climatic (temperature and precipitation), geographic (latitude, longitude, and elevation), and topographic (watershed area and channel slope) variables. This preclassification of sites was designed to reduce the range of environmental heterogeneity encompassed by each model. The geographic scope of the models ranged from $\sim$200,000 km^2 to $\sim$1,800,000 km^2 (Fig. 2). Four of the 5 models developed for the EMAP-West study area (Stoddard et al. 2005, 2006) applied to geoclimatic conditions found in California. One model used predictor variables, whereas the other 3 were null models that predicted the same biota at all sites within a geoclimatic region (Van Sickle et al. 2005; Table 1).

CA models.—The 3rd model set included 3 models that were developed for 3 types of climatic conditions in California: cool-wet sites (mean monthly temperature [MMT] $<$9.3°C and mean monthly precipitation [MMP] $>$895 mm), warm-dry sites (MMT $>$9.3°C and MMP $<$895 mm), and cold-mesic sites (MMT $<$9.3°C) (Fig. 3). The 3 CA models (CPH, unpublished data) were calibrated from data collected at 209 reference sites, 179 of which also had been used to calibrate EMAP-West and WSA-West models (the other 30 sites were used as validation sites in EMAP-West and WSA). Spatial extent of the reference sites for each of the models was $\sim$150,000 km^2 (Fig. 3). The models used unique combinations of predictor variables (Table 1).

MMI development

WSA-West, EMAP-West, and CA MMIs were developed by a process similar to that used by Karr (1981) and extended by others (Kerans and Karr 1994,

TABLE 2. Benthic macroinvertebrate collection methods, target taxonomic levels, and organism counts used to build predictive models for observed/expected (O/E) indices and multimetric indices (MMI) for California (CA), the Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West), and the western portion of the Wadeable Stream Assessment (WSA-West). NCIBI = North Coast Index of Biotic Integrity, SCIBI = South Coast Index of Biotic Integrity, RWB = reach-wide benthic sampling, TRB = targeted-riffle benthic sampling.

Index	Model	Field method	Targeted taxonomic level	Organism count
O/E	EMAP-West	RWB	Some species, but mostly genus (including Chironomidae)	300 (after removal of ambiguous individuals)
	WSA-West	RWB	Some species, but mostly genus (including Chironomidae)	
	3 CA models	TRB	Some species, but mostly genus (including Chironomidae)	
MMI	EMAP-West	RWB	Some species, but mostly genus (including Chironomidae)	300
	WSA-West	RWB	Some species, but mostly genus (including Chironomidae)	300
	CA models (NCIBI/SCIBI)	TRB	Genus, Chironomidae to family	500

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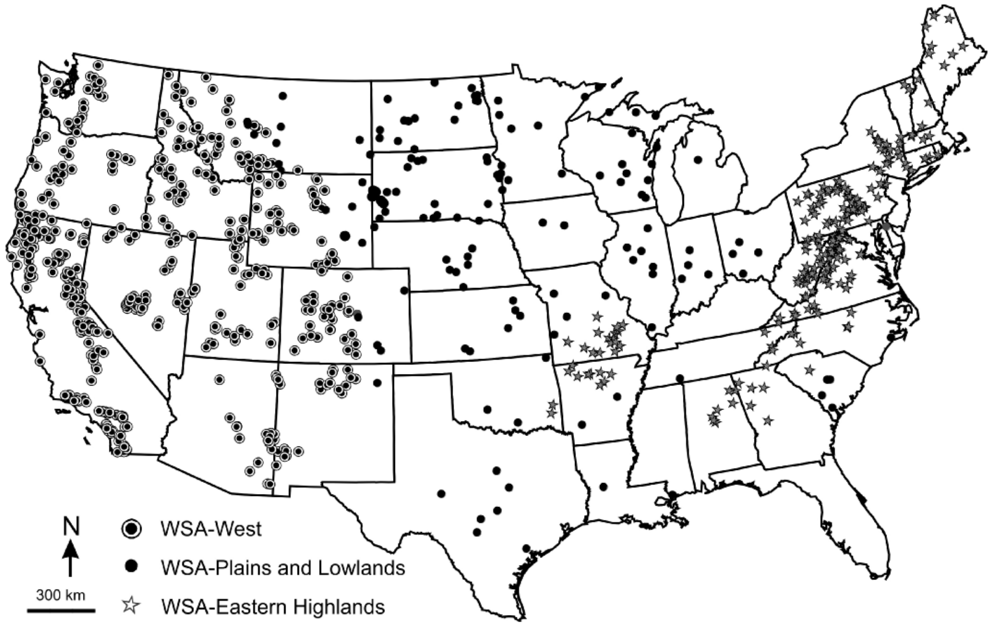

FIG. 1. Reference sites used to create the 3 Wadeable Streams Assessment (WSA) predictive models. Only the model (WSA-West) for sites in the Western Mountains and Xeric West aggregated ecoregions applies to California sites.

Hughes et al. 1998, McCormick et al. 2001, Klemm et al. 2003). The process is: 1) assign a large pool of sites to reference or test categories based on their degree of anthropogenic stress, 2) divide the site pool into calibration and validation sets, 3) use the calibration set to screen biological metrics for responsiveness to important stressor gradients, signal-to-noise ratios, and lack of redundancy with other metrics, 4) establish scoring ranges for selected metrics, 5) assemble a composite MMI from the component metrics, 6) establish impairment thresholds for the MMI, and 7) evaluate MMI performance against the validation data set (Herlihy et al. 2008, Stoddard et al. 2008).

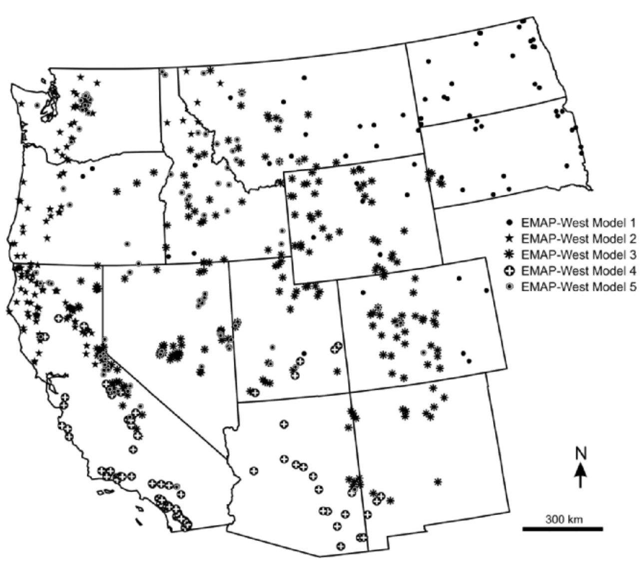

FIG. 2. Reference sites used to create the 5 Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West) predictive models.

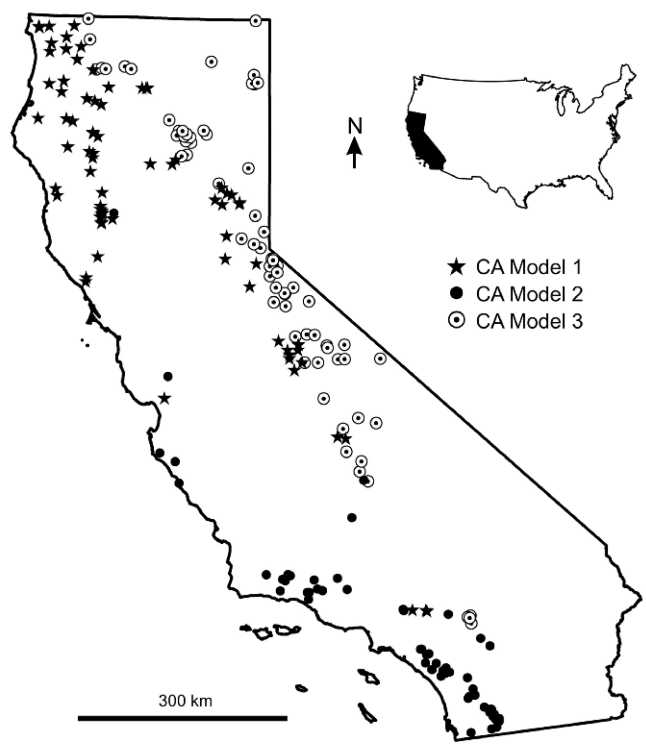

FIG. 3. Reference sites used to create the 3 California (CA) predictive models.

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TABLE 3. Benthic macroinvertebrate metrics used to build multimetric indices for California (CA), the Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West), and the western portion of the Wadeable Stream Assessment (WSA-West). NCIBI = North Coast Index of Biotic Integrity, SCIBI = South Coast Index of Biotic Integrity, EPT = Ephemeroptera, Plecoptera, and Trichoptera.

	CA		EMAP-West		WSA-West	
Metric	NCIBI	SCIBI	Mountain	Xeric	Western Mountain	Xeric West
EPT richness	X	X	X	X	X	X
% EPT taxa					X	
Diptera richness	X					
Coleoptera richness	X	X				
% noninsect taxa	X	X		X		
% noninsect individuals			X			X
% individuals in top 5 taxa			X		X	X
Shannon diversity				X		
Predator richness		X				
% predator individuals	X					
% omnivore taxa			X			
% collector individuals		X				
Scraper richness					X	X
% nongastropod scraper individuals	X					
Shredder richness				X		
% shredder taxa	X					
% burrower individuals			X			
% clinger taxa				X	X	X
% tolerant taxa		X	X		X	X
% intolerant taxa				X		
% intolerant individuals	X	X				

MMIs differed in a few important respects (Tables 2, 3). CA MMIs were based on subsamples of 500 organisms collected from targeted-riffle habitat and identified primarily to genus level, but the WSA-West and EMAP-West indices were based on subsamples of 300 organisms collected from multiple habitats with some individuals identified to species level (see *Test site field and laboratory methods* below for details).

WSA-West MMIs.—Two MMIs (Xeric West and Western Mountain) were developed to support WSA-West assessments. The MMIs were based on a calibration data set of 775 sites (235 Xeric West and 540 Western Mountain) (USEPA 2006, Stoddard et al. 2008). Each MMI used 6 metrics, 5 of which were used in both MMIs (Table 3). Scoring ranges for both MMIs were scaled from 0 to 100 (Van Sickle and Paulsen 2008).

EMAP-West MMIs.—Three MMIs (Xeric, Plains, and Mountain) were developed to support EMAP-West assessments (Stoddard et al. 2005, 2006). Two of these MMIs (Xeric and Mountain) applied to California sites. The calibration data set consisted of 809 sites, most of which (754) were used in WSA-West MMI development. Each MMI used 6 metrics, but only 1 metric (Ephemeroptera, Plecoptera, Trichoptera [EPT] richness) was used in both MMIs (Table 3). Scoring ranges for both MMIs were scaled from 0 to 100 (Stoddard et al. 2005).

CA MMIs.—Two MMIs were developed for use in coastal California: the Southern Coastal California Index of Biotic Integrity (SCIBI) (Ode et al. 2005) and the Northern Coastal California Index of Biotic Integrity (NCIBI) (Rehn et al. 2005). The 2 CA MMIs included parts of the Mountain (= WSA Western Mountain aggregated ecoregion) and Xeric (= WSA Xeric West aggregated ecoregion) climate regions used for the WSA and EMAP-West MMIs, and separate metric scoring ranges were established for the Omernik level III ecoregions within each CA MMI development area (Fig. 4A). One hundred nineteen of the 502 sites used to develop the CA MMIs were also used in EMAP-West and WSA-West MMI development. The NCIBI consisted of 8 metrics, whereas the SCIBI consisted of 7 metrics, and 4 metrics were used in both MMIs (Table 3). Scoring ranges for both MMIs were scaled from 0 to 100 (Ode et al. 2005, Rehn et al. 2005).

Test-site data

For our analyses, we used BMI data collected for 2 large-scale probability surveys of California streams. For clarity, we have restricted our use of the term *test sites* to refer only to these probabilistic samples of

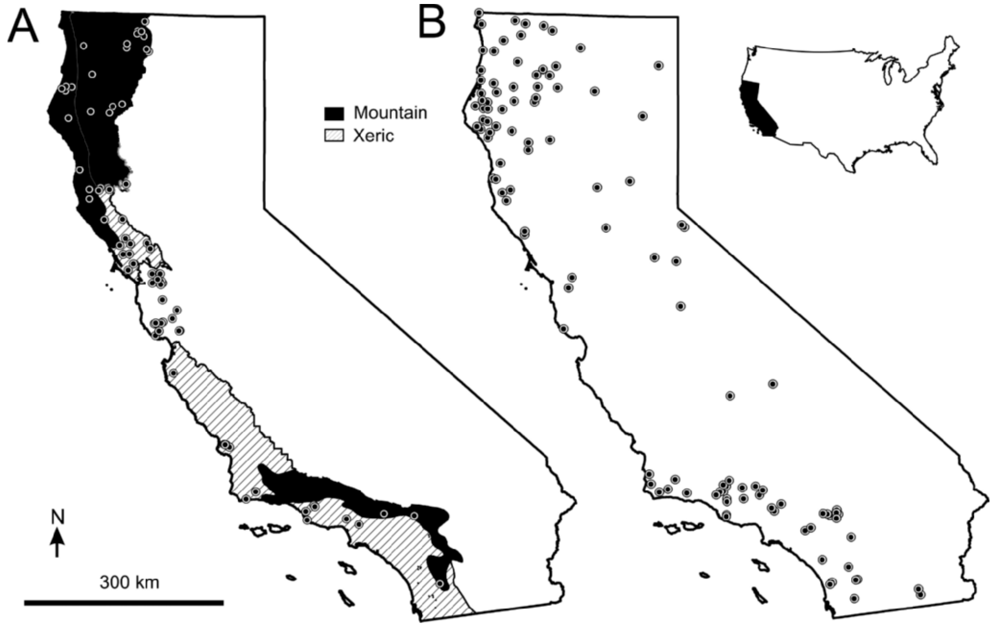

FIG. 4. Test sites used for the comparative analyses of multimetric indices ($n = 68$ sites) (A) and predictive models ($n = 127$ sites) (B).

evaluation sites and not to nonreference sites used to calibrate MMIs (which are sometimes referred to as test sites in MMI development). For the O/E comparisons, we used data collected from 127 sites during the EMAP-West survey (2000–2003). For the MMI comparisons, we used data from 68 sites sampled by the California State Monitoring and Assessment Program (CMAP) between 2004 and 2006. We used different sets of test sites for the O/E and MMI analyses for 2 reasons: 1) the restricted geographic boundaries of the CA MMIs limited the number of sites shared between O/E and MMI data sets, and 2) the MMI calibration data sets were partially composed of sites used in the set of O/E test sites. The 127 sites used to evaluate O/E indices were distributed throughout California (Fig. 4B), whereas the 68 sites used to evaluate MMIs were restricted to coastal watersheds (Fig. 4A). Most MMI test sites were concentrated in the northern ½ of the state (61 sites north of Monterey Bay), and most of these sites (40) were located within the region defined by the NCIBI calibration sites (Fig. 4A). The remaining 21 northern California sites were concentrated in the San Francisco Bay and Santa Cruz Mountains regions, which lie between the regions used to develop the CA MMIs (Fig. 4A). We used the NCIBI to score sites in the area between the NCIBI and SCIBI regions for the cross-index comparisons because this area is ecologically more similar to the North Coast than the South Coast and because reference conditions for this area were better represented in the NCIBI (Rehn et al. 2005, PRO, unpublished data). We used SCIBI scores for 14 sites that were within the region defined by the SCIBI calibration sites. The different geographic distributions of test sites might have affected comparisons between MMIs and O/Es, but they did not affect comparisons of MMIs and O/Es among the 3 geoclimatic scales (WSA-West, EMAP-West, CA).

Test-site field and laboratory methods.—We sampled all test sites with standard EMAP-West field methods (Peck et al. 2006). A sampling reach was defined as 40× the wetted stream width at the center of the reach, with a minimum reach length of 150 m. We collected 2 BMI samples from each reach with standard 500-μm D-frame nets: 1) a reach-wide composite sample consisting of one 0.09-m^2 sample taken from each of 11 equally spaced transects throughout the reach and 2) a targeted-riffle sample consisting of eight 0.09-m^2 samples taken from fast-water habitat units within the reach (Hawkins et al. 2003).

All BMI samples used for the test data sets were processed at the California Department of Fish and Game Aquatic Bioassessment Laboratory in Chico, California. At least 500 individuals were identified to the standard target taxonomic levels described in Richards and Rogers (2006), i.e., those levels of taxonomic resolution that can be consistently achieved. A true fixed 500-count random subsample was obtained by computer resampling the sample data. Samples with 450 to 500 individuals were retained in analyses. These raw data were used to produce the standardized taxon lists and metrics needed for the various indices (Table 3). All analyses

TABLE 4. Standard deviations (SDs) and impairment thresholds (ITs) for observed/expected (O/E) indices and coefficients of variation (CVs) and ITs for multimetric indices (MMI) for California (CA), the Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West), and the western portion of the Wadeable Stream Assessment (WSA-West). ITs for the O/E indices were established at 2 SD below the reference (calibration) mean. Only EMAP-West models 2 to 5 apply to California. NCIBI = North Coast Index of Biotic Integrity, SCIBI = South Coast Index of Biotic Integrity.

	O/E		MMI	
Index	SD	IT	CV	IT
CA				
Model 1	0.13	0.74		
Model 2	0.17	0.66		
Model 3	0.16	0.68		
NCIBI			14%	52
SCIBI			19%	39
EMAP-West				
Model 1	0.24	0.52		
Model 2	0.15	0.70		
Model 3	0.20	0.60		
Model 4	0.20	0.60		
Model 5	0.17	0.66		
Mountain			13%	55
Xeric			23%	36
WSA-West				
WSA-West	0.20	.59		
Western Mountain			26%	28
Xeric West			25%	34

were based on field methods, sample sizes, and taxonomic levels used to develop each index (Table 2).

Scoring sites: predictive models

BMI taxonomic data.—We further processed the raw subsample count data for use with the predictive models by: 1) converting the original identifications to the taxonomic levels used in the models (OTUs), 2) eliminating individuals that could not be assigned to an OTU (i.e., ambiguous individuals), and 3) resampling the remaining nonambiguous individuals to 300-count samples. Samples with <300 individuals were retained in analyses.

Predictor variables.—We obtained geographic coordinates (latitude and longitude) from global positioning system measurements taken during sample collection. We calculated watershed area after delineating upstream watershed boundaries for each site with automated geographical information system (GIS) scripts or manual delineation where necessary. We estimated long-term MMP, and mean and minimum monthly air temperature (MMT and MMA, respectively) values for each site from GIS grids for 1961 to 1990 obtained from the Oregon Climate Center (http://www.ocs.orst.edu/prism). We derived site elevations from 30-m digital elevation models (http://ned.usgs.gov). Channel (reach) slope was measured in the field (as it was in model development).

We used geographic and environmental attributes to assign each test site to the appropriate EMAP-West and CA models. We assigned test sites to the 5 EMAP-West models based on their latitude, longitude, elevation, MMP, MMT, watershed area, and channel slope. We made these assignments before model-building during the *k*-means analysis (MacQueen 1967). We assigned test sites to the appropriate CA model after model development. We used a simple classification and regression tree model based on long-term precipitation and air temperature to assign sites to the CA models.

We calculated O/E scores based on only those taxa with site probabilities of capture ≥0.5 because these values result in more precise O/E scores that usually are more sensitive to stress (Hawkins et al. 2000b, Ostermiller and Hawkins 2004, Van Sickle et al. 2007) than O/E scores based on all taxa in the reference-site calibration data set (i.e., $p > 0.0$). We set impairment thresholds at 2 standard deviations (SDs) below the mean score of reference sites for all O/E indices (Table 4).

Scoring sites: MMIs

BMI taxonomic data.—The MMIs differed with respect to organism count and taxonomic resolution. Therefore, we calculated MMI scores based on the sample counts and taxonomy used when developing each index (Table 2). We calculated scores for test samples that had been collected in a standard manner to avoid confounding comparisons with intermethod variability. We assigned all sites to either the Xeric West or Western Mountain aggregated ecoregion. The Western Mountain aggregated ecoregion was further divided into Southern California Mountains, Klamath Mountains, Coast Ranges, and Southern and Central California Chaparral and Oak Woodlands for the CA MMIs (Omernik 1987). We calculated MMI scores based on the specific scoring ranges developed for each individual metric and ecoregion and rescaled these scores to range from 0 to 100. As for O/E indices, we set impairment thresholds for all MMIs at 2 SDs below the mean score at reference sites (Table 4) when reporting impairment decisions.

Comparison of index scores

We used the CA indices as benchmarks for the performance of the WSA-West and EMAP-West indices. We based comparisons on index precision, bias, responsiveness, and sensitivity.

O/E comparisons.—We measured precision as the SD of reference-site O/E scores. We measured bias as the tendency for reference-site O/E scores to vary systematically with ≥ 1 of 4 natural gradients (% slope, elevation, watershed area, and % fast-water habitat). We also assessed whether one O/E score was a biased predictor of another at the same sites. We regressed the scores from one index against scores from the other index at the same sites and tested whether slopes were significantly different from 1 and y-intercepts were significantly different from 0. We illustrated the consequences of these types of biases by plotting the pairwise differences in index scores against the 4 natural gradients. We measured responsiveness as the mean difference between reference and test-site O/E scores. We measured sensitivity as the proportion of test sites assessed as impaired by the models. This measure of sensitivity is a joint function of precision, bias, and responsiveness. For these assessments, we defined the threshold values for inferring impairment as 2 SDs below the reference (calibration) means (Table 4). We used binomial tests (Zar 1999) on sites with disagreeing impairment decisions to determine if the indices were equally likely to detect impairment. This test was done within each of the 3 CA models and on all sites combined. In addition to our comparison of impairment determinations based on 2-SD thresholds, we evaluated 2 different threshold corrections for ecoregional differences. For the WSA-West indices, we established separate impairment thresholds for the Xeric West and Western Mountain aggregated ecoregions at the 5th percentile of the calibration reference population (estimated as 1.64 SDs below the reference mean; Herlihy et al. 2008). We also estimated separate thresholds for Western Mountain and Xeric West aggregated ecoregions at 2 SDs below the mean for each ecoregion, an approach consistent with our previous comparisons. For all relevant analyses, we applied Bonferroni adjustments for multiple comparisons when the correction was conservative. That is, we did not apply the correction when we were screening natural gradients as potential drivers of bias, but we did for hypothesis tests of index agreement (e.g., impairment decisions, responsiveness tests).

MMI comparisons.—MMI analyses paralleled the O/E comparisons. However, raw MMI scores were not directly comparable because the scores at calibration reference sites differed among the MMIs. Therefore, we rescaled the MMI scores by dividing the raw score by the reference mean for the index. We then used these adjusted scores as a common currency in all analyses in which we compared scores directly. Thus, the MMI scaling in these analyses was similar to the ~1.0 reference mean in O/E indices. We based only the comparisons of impairment decisions on raw MMI scores.

Results

O/E comparisons

Precision.—The predictions of the WSA-West and EMAP-West models were less precise (reference-site O/E SD = 0.17–0.20) than those of the CA models (SD = 0.13–0.17) (Table 4). Imprecision in model predictions contributed, in part, to weak relationships between the CA O/E scores and the WSA-West and EMAP-West O/E scores (CA vs WSA-West $r^2 = 0.32$, CA vs EMAP-West $r^2 = 0.35$) (Fig. 5A, B). However, the stronger agreement between the less-precise WSA-West and EMAP-West O/E scores (WSA-West vs EMAP-West $r^2 = 0.58$; Fig. 5C) indicates that factors other than precision (e.g., bias) must have affected differences in agreement.

Bias.—The WSA-West and EMAP-West O/E scores were biased predictors of the CA O/E scores and of each other; slopes and y-intercepts were significantly different ($p < 0.001$) from 1 and 0, respectively, for all comparisons (Fig. 5A–C). Differences were large, with slopes as low as 0.58 and y-intercepts as high as 0.36. These results showed that the nature of the bias was not constant across all sites. Instead, differences in O/E scores depended on the site-specific differences among models in how they either over- or underestimated E (the expected number of predicted taxa) relative to one another. O/E scores were biased predictors of one another, at least in part, because the WSA-West and EMAP-West models failed to adjust predictions of E for the effects of ≥ 1 natural gradients. This failure is illustrated by systematic variation in reference-site O/E scores produced by the WSA-West and EMAP-West models across % slope (WSA-West score = 0.025[% slope] + 0.80, $p = 0.001$; EMAP-West score = 0.023[% slope] + 0.67, $p = 0.002$) and % fast-water habitat gradients (WSA-West score = 0.0051[% fast-water habitat] + 0.747, $p < 0.001$; EMAP-West score = 0.0045[% fast-water habitat] + 0.63, $p < 0.001$). No such relationships were evident for CA O/E scores (CA score = 0.0086[% slope] + 0.78, $p = 0.259$; CA score = 0.0016[% fast-water habitat] + 0.77, $p = 0.205$). The reason the CA O/E scores were unrelated to reach slope is probably related to the fact that, within CA, % slope was associated with watershed area (Area), a predictor in all 3 CA models ($\sqrt{[\% \text{ slope}]} = 4.11 - 0.531[\log_{10}[\text{Area}] - 0.040[\text{latitude}]$ across all reference sites, $n = 209$, $R^2 = 0.14$, model $p < 0.001$). Therefore,

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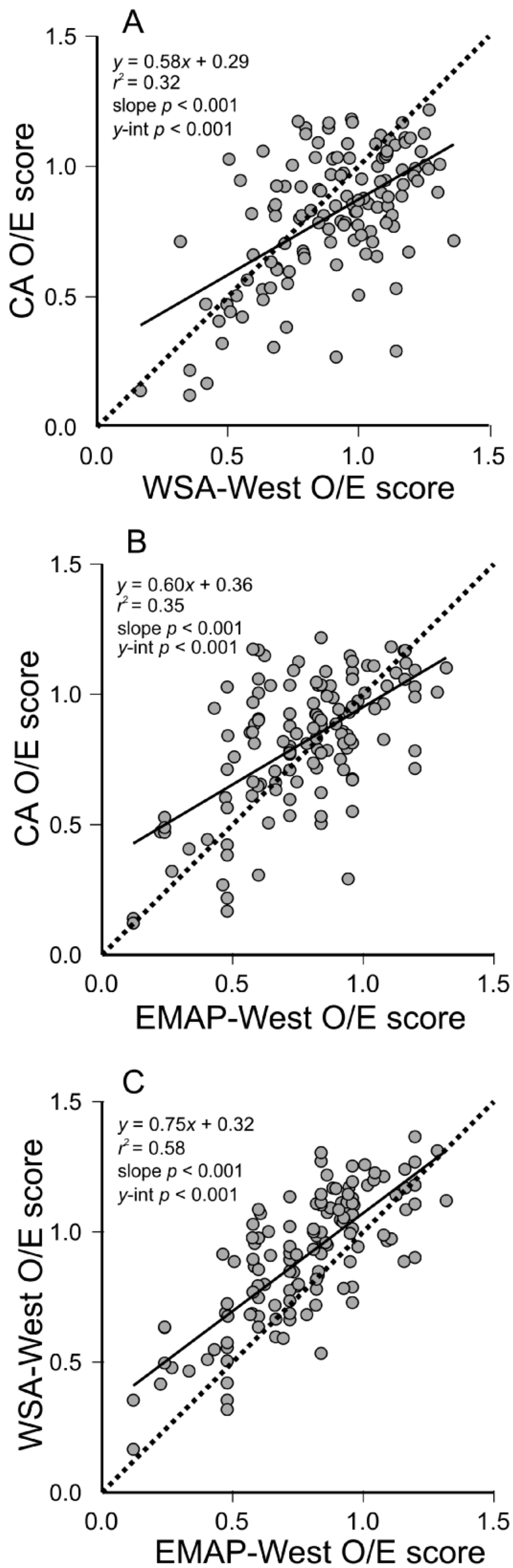

FIG. 5. Regressions between California (CA) predictive model observed/expected (O/E) scores and O/E scores from the western portion of the Wadeable Stream Assessment (WSA-West) (A) and the Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West) (B) and between WSA-West O/E scores and EMAP-West O/E scores (C). The dotted lines represent a perfect 1:1 relationship between the scores from the 2 models, and the solid lines indicate linear best-fit relationships. Significance tests are for y-intercept (y-int) = 0 and slope = 1.

watershed area might have been a surrogate predictor of % slope within CA. Percent fast-water habitat was measured at too few sites to determine its relationship with watershed area within CA. As a consequence of the bias between the WSA-West and EMAP-West model predictions, pairwise differences between O/E scores for both the WSA-West and EMAP-West models and the CA models were significantly related to % slope and % fast-water habitat (Fig. 6A, B). We did not observe similar biased predictions associated with either elevation or watershed area (Fig. 6A, B, Table 5), nor were any of these relationships observed for pairwise differences in O/E scores between WSA-West and EMAP-West (Fig. 6C, Table 5). Furthermore, correlation coefficients were low for all of these relationships (Table 5), indicating that very little variance in differences between the indices was explained by these natural gradients. The WSA-West model had a tendency to produce higher O/E scores than did the EMAP-West models, especially at lower O/E scores ($p < 0.005$, Table 5, Figs 5C, 6C), but this pattern was not related to the 4 natural gradients we examined.

Responsiveness.—The EMAP-West models tended to produce the lowest O/E scores, and the WSA-West models tended to produce the highest O/E scores at test sites (Table 6). O/E scores based on the CA models tended to be intermediate in magnitude. This pattern generally occurred for both Western Mountain and Xeric West aggregated ecoregions, but differences were not always statistically significant. However, the magnitude of difference in mean O/E scores between Western Mountain and Xeric West test sites varied with the models used. The CA models yielded lower mean O/E sores for Xeric West than for Western Mountain test sites (Table 6), whereas the EMAP-West and WSA-West models produced statistically similar mean O/E scores at Xeric West and Western Mountain test sites.

Index sensitivity and concordance among assessments.—The WSA-West O/E was much less likely to lead to inferences of impairment (16 of 127 sites; Table 7) than either the EMAP-West O/E (43 of 127 sites) or the CA O/E (35 of 127 sites) (binomial tests, $p < 0.001$). Application of a climate region correction based on 2 SDs (consistent with our main analyses) had no effect

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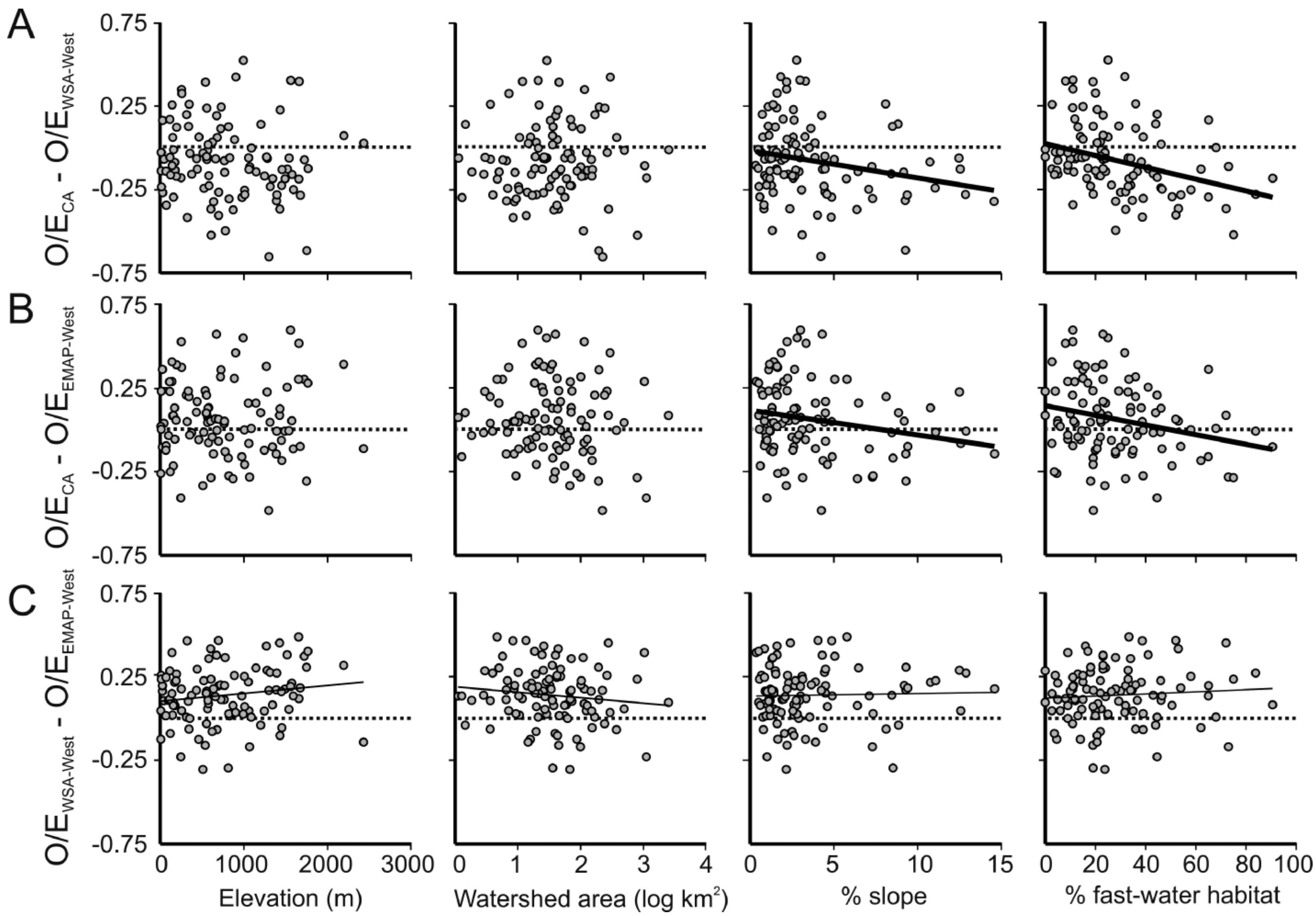

FIG. 6. Relationships between pairwise differences in observed/expected (O/E) scores and 4 natural environmental gradients at California test sites. Differences were obtained by subtracting the O/E score obtained with one predictive model from the O/E score obtained with the 2nd model at a test site. O/E scores were compared between predictive models for California (CA) vs the western portion of the Wadeable Stream Assessment (WSA-West) (A), CA vs the Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West) (B), and WSA-West vs EMAP-West. The dashed horizontal lines represent 0 difference between O/E scores from the 2 models. Thick solid lines show regressions with r^2 and slopes significantly different from 0; thin solid lines show regressions with y-intercepts significantly different from 0 but slopes that are not significantly different from 0.

on any impairment decision (16 of 127 sites impaired) because the separate Xeric West and Western Mountain thresholds were within 2 points on a 100-point scale of their combined threshold. However, when we applied the ecoregion correction based on the 5th-percentile threshold used for the national WSA (Herlihy et al. 2008), the number of test sites deemed impaired by the WSA-West O/E (27 of 127 sites) was not significantly different from the number of test sites deemed impaired by the CA O/E (35 of 127; binomial test, $p = 0.081$; Table 7).

MMI comparisons

Precision.—The NCIBI and SCIBI were more precise (reference-site coefficients of variation [CVs] = 0.14 and 0.19) than the WSA-West Western Mountain and Xeric West MMIs (CVs = 0.26, 0.25), but were comparable to the EMAP-West Mountain and Xeric MMIs (CVs = 0.13, 0.23) (Table 4). Associations among the rescaled MMI scores (CA vs WSA-West $r^2 = 0.70$, CA vs EMAP-West $r^2 = 0.76$, and WSA-West vs EMAP-West $r^2 = 0.75$; Fig. 7A–C) were much stronger than were associations among O/E scores (Fig. 5A–C).

Bias.—The rescaled WSA-West MMIs were biased predictors of both the CA and EMAP-West MMI scores, and slopes were significantly different from 1 ($p < 0.001$; Fig. 7A, C). In addition, the EMAP-West MMIs, on average, produced higher scores at test sites than did the CA MMIs (Fig. 7B, Table 6). The EMAP-West MMIs rated low-scoring sites higher than did the WSA-West MMIs and high-scoring sites lower than

TABLE 5. Regressions ($y = a + bx$) for pairwise differences between index scores (y) and 4 natural environmental gradients (x) at California test sites. Differences were obtained by subtracting the score obtained with one index from the score obtained with the 2nd index at a test site. Indices were observed/expected (O/E) indices or multimetric indices (MMIs) for benthic macroinvertebrates for California (CA), the Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West), and the western portion of the Wadeable Stream Assessment (WSA-West). MMI scores were rescaled to account for differences among calibration sites used to develop the different MMIs. See Figs 6 and 8 for scatter plots and regressions. * = $p < 0.05$ (significance threshold not adjusted for multiple comparisons). Area = watershed area.

Index	Natural gradient (x)	Difference tested (y)	b	p-value for b	a	p-value for a	r^2
O/E (n = 101)	Elevation	CA – WSA-West	–0.000043	0.283	–0.043	0.259	0.01
		CA – EMAP-West	0.0000042	0.918	0.059	0.132	0.00
		WSA-West – EMAP-West	0.000048	0.112	0.10	<0.001*	0.03
	Log_{10}(Area)	CA – WSA-West	0.0029	0.928	–0.081	0.125	0.00
		CA – EMAP-West	–0.025	0.424	0.10	0.060	0.01
		WSA-West – EMAP-West	–0.028	0.230	0.18	<0.001*	0.01
	% slope	CA – WSA-West	–0.016	0.019*	–0.017	0.606	0.05*
		CA – EMAP-West	–0.015	0.035*	0.12	<0.001*	0.04*
		WSA-West – EMAP-West	0.0015	0.770	0.13	<0.001*	0.00
	% fast-water habitat	CA – WSA-West	–0.0035	0.002*	0.023	0.543	0.09*
		CA – EMAP-West	–0.0029	0.012*	0.14	0.001*	0.06*
		WSA-West – EMAP-West	0.00064	0.458	0.12	<0.001*	0.01
MMI (n = 68)	Elevation	CA – WSA-West	0.000047	0.586	–0.24	<0.001*	0.00
		CA – EMAP-West	0.00012	0.041	–0.15	<0.001*	0.06
		WSA-West – EMAP-West	0.000073	0.415	0.086	0.028*	0.01
	Log_{10}(Area)	CA – WSA-West	–0.043	0.190	–0.13	0.105	0.03
		CA – EMAP-West	–0.057	0.010	0.011	0.832	0.10
		WSA-West – EMAP-West	–0.014	0.674	0.14	0.095	0.00
	% slope	CA – WSA-West	0.0024	0.832	–0.23	<0.001*	0.00
		CA – EMAP-West	0.011	0.151	–0.14	<0.001*	0.03
		WSA-West – EMAP-West	0.0085	0.460	0.090	0.020*	0.01
	% fast-water habitat	CA – WSA-West	0.0021	0.182	–0.28	<0.001*	0.03
		CA – EMAP-West	–0.00071	0.518	–0.10	0.004*	0.01
		WSA-West – EMAP-West	–0.0028	0.086	0.18	<0.001*	0.04

did the WSA-West MMIs (Fig. 7C). However, most of these differences in MMI scores were not associated with the natural gradients we considered, except for the significant relationships of CA and EMAP-West pairwise differences with elevation and watershed area (Fig. 8B).

Responsiveness.—On average, the rescaled CA MMIs scored test sites lower than did the rescaled EMAP-West MMIs, which in turn scored test sites lower than did rescaled WSA-West MMIs (Table 6). This trend generally held for both mountainous and xeric regions, but the WSA-West Western Mountain vs EMAP-West Mountain contrast was not statistically significant. All MMIs tended to score test sites in the xeric region lower than test sites in the mountainous region, but the difference in mean scores based on the WSA-West MMI was not significant (Table 6).

Index sensitivity and concordance among assessments.—As with the O/E indices, impairment decisions differed considerably among the rescaled MMI scores (Table 8). The number of sites assessed as impaired was far fewer for the WSA-West and EMAP-West MMIs (21 and 17 sites of 68 test sites, respectively) than the CA MMI (39 of 68 test sites; binomial tests, $p < 0.001$). This pattern occurred in both xeric and mountainous regions but was significant only in the xeric region (binomial tests, mountainous $p = 0.219$, xeric $p < 0.001$).

Summary of performance of EMAP-West and WSA-West indices relative to CA indices.—Differences in index precision, bias, and responsiveness each contribute to differences in index performance as measured by index sensitivity, the likelihood that an assessment will identify impairment. In our study, assessment differences between EMAP-West or WSA-West indices and CA indices depended on the type of index examined and specific differences in index precision, bias, and responsiveness (Table 9). The large-scale indices tended to lead to different inferences regarding biological condition than did the CA indices, but the specific differences among indices were variable. These differences caused the EMAP-West O/E indices to have sensitivity similar to that of the CA O/E indices, whereas the WSA-West O/E index was less sensitive. The difference between these 2 large-scale indices appeared to be associated with differences in their

Table 6. Results of 2-tailed t-tests for differences in index responsiveness between sets of Mountain (MTN) and Xeric (XER) test sites (ecoregion comparison) or between pairs of indices (index comparison) for California (CA), the Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West), and the western portion of the Wadeable Stream Assessment (WSA-West) surveys. Indices were observed/expected (O/E) indices or multimetric indices (MMIs) for benthic macroinvertebrates. MMI scores were rescaled to account for differences among calibration sites used to develop the different MMIs. Mean 1 and Mean 2 indicate the mean scores of the 1st and 2nd members of each tested pair; note that Mean 1 – Mean 2 might not equal the value in the Difference column because of rounding errors. * = statistically significant ($\alpha = 0.0167$).

Index	Comparison	Ecoregion	Survey	Mean 1	Mean 2	Difference	p	Test
O/E	Index	Both (n = 127)	CA vs WSA-West	0.82	0.90	0.09	<0.001*	Paired t-test
			CA vs EMAP-West	0.82	0.77	0.04	0.032	
			WSA-West vs EMAP-West	0.90	0.77	0.13	<0.001*	
		MTN (n = 74)	CA vs WSA-West	0.87	0.93	0.06	0.023	Paired t-test
			CA vs EMAP-West	0.87	0.80	0.07	0.002*	
			WSA-West vs EMAP-West	0.93	0.80	0.13	<0.001*	
		XER (n = 53)	CA vs WSA-West	0.75	0.87	0.12	0.005*	Paired t-test
			CA vs EMAP-West	0.75	0.74	0.00	0.938	
			WSA-West vs EMAP-West	0.87	0.74	0.12	<0.001*	
	Ecoregion	MTN vs XER	CA	0.87	0.75	0.12	0.006*	2-sample t-test
			WSA-West	0.93	0.87	0.06	0.156	
			EMAP-West	0.80	0.74	0.05	0.248	
MMI	Index	Both (n = 68)	CA vs WSA-West	0.65	0.88	0.23	<0.001*	Paired t-test
			CA vs EMAP-West	0.65	0.77	0.12	<0.001*	
			WSA-West vs EMAP-West	0.88	0.77	0.11	<0.001*	
		MTN (n = 30)	CA vs WSA-West	0.80	1.00	0.20	<0.001*	Paired t-test
			CA vs EMAP-West	0.80	0.88	0.07	0.009*	
			WSA vs EMAP-West	1.00	0.88	0.13	0.018	
		XER (n = 38)	CA vs WSA-West	0.53	0.78	0.24	<0.001*	Paired t-test
			CA vs EMAP-West	0.53	0.69	0.15	<0.001*	
			WSA vs EMAP-West	0.78	0.69	0.09	0.006*	
	Ecoregion	MTN vs XER	CA	0.80	0.53	0.27	<0.001*	2-sample t-test
			WSA-West	1.00	0.78	0.23	0.0219	
			EMAP-West	0.88	0.69	0.19	0.001*	

responsiveness. The MMIs showed the opposite response, in that the EMAP-West MMIs were slightly more sensitive than the CA MMI in the Mountain climate region, whereas the WSA-West MMIs was less sensitive than the CA MMI in the Xeric West aggregated ecoregion. As for the O/E comparisons, the differences between the EMAP-West and WSA-West MMI sensitivities were associated with differences in their responsiveness.

Discussion

The multiple spatial scales over which environmental gradients influence the taxonomic and functional

Table 7. Comparison of counts of California test sites declared impaired (I) or not impaired (NI) by observed/expected (O/E) indices developed for California (CA), the Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West), and the western portion of the Wadeable Stream Assessment (WSA-West).

		CA model 1 (n = 58)		CA model 2 (n = 44)		CA model 3 (n = 25)		Total (n = 127)		
Predictive model	Status	I	NI	I	NI	I	NI	I	NI	All sites
CA	I	13		16		6		35		35
	NI		45		28		19		92	92
EMAP-West	I	10	7	11	8	4	3	25	18	43
	NI	3	38	5	20	2	16	10	74	84
WSA-West	I	5	1	7	2	0	1	12	4	16
	NI	8	44	9	26	6	18	23	88	111
WSA-West (5th-percentile	I	9	4	9	4	0	1	18	9	27
ecoregion-adjusted threshold)	NI	4	41	7	24	6	18	17	83	100

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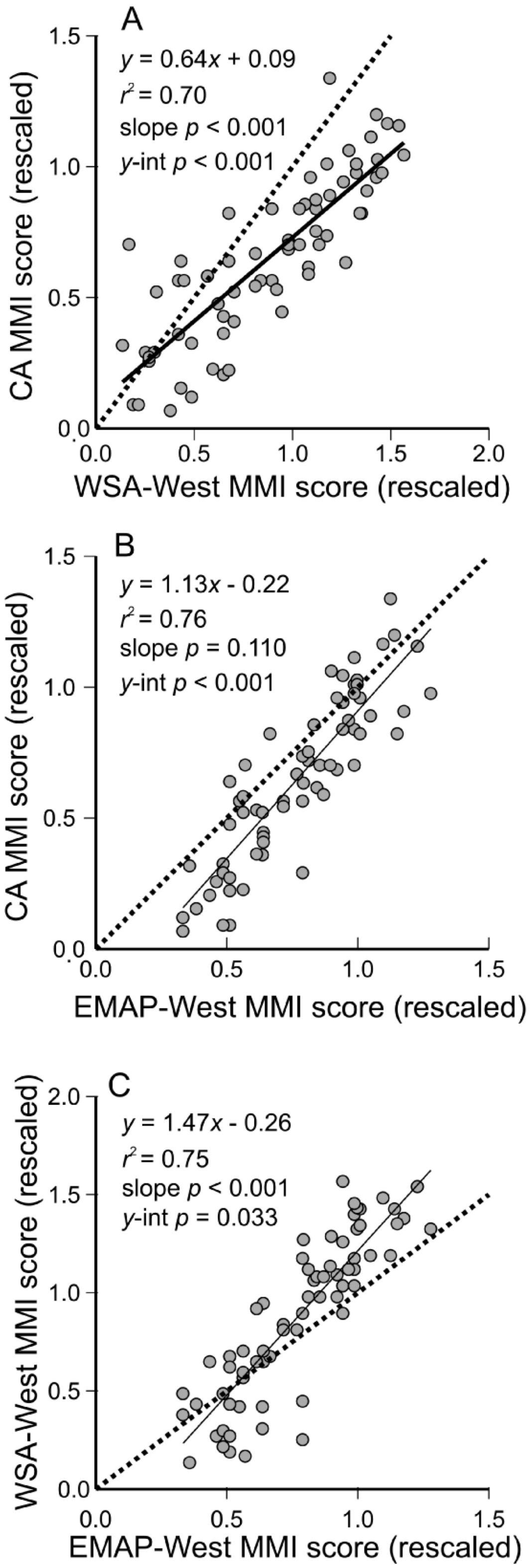

FIG. 7. Regressions between rescaled California (CA) multimetric index (MMI) scores and MMI scores from the western portion of the Wadeable Stream Assessment (WSA-West) (A) and the Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West) (B) and between WSA-West MMIs and EMAP-West MMIs (C). MMI scores were rescaled to account for differences among calibration sites used to develop the different MMIs. The dotted lines represent a perfect 1:1 relationship between the models, and the solid lines indicate linear best-fit relationships. Significance tests are for y-intercept (y-int) $= 0$ and slope $= 1$.

composition of freshwater assemblages has been the focus of considerable interest in recent years (Poff 1997, Johnson et al. 2004, 2007, Heino et al. 2007, Hoeinghaus et al. 2007, Mykrä et al. 2007, 2008). At the heart of these studies is a desire to clarify our understanding of the factors that determine the limits of species distributions, one of the central goals of ecological theory (Levins 1966, Wiens 1989, Peters 1991, Brown et al. 1996, Guisan and Zimmermann 2000). This issue has significant implications for the utility of biotic indices because their effectiveness depends on how well we understand how distribution patterns of individual taxa are influenced by landscape and waterway environmental heterogeneity and how those effects are expressed at different scales of observation.

Index comparability

O/E indices.—Matching test sites with their appropriate reference condition is a critical element of all bioassessments (Moss et al. 1987, Hughes et al. 1995, Stoddard et al. 2008). Errors in specifying the correct reference condition can lead to either under- or overestimates of the true biological condition at individual sites. Our results show that the failure of the large-scale predictive models to account for the effects of some naturally occurring environmental factors caused substantial systematic differences among the O/E scores derived from these models relative to scores derived from the CA models. The fact that the most spatially extensive models (EMAP-West and WSA-West) did not adjust for the effects of local environmental heterogeneity (i.e., % slope, % fast-water habitat) on E, and hence O/E, shows that such spatially extensive models might have limited applicability for site-specific assessments and use of these assessments to generate regional assessments. There are several reasons why the more spatially extensive models might have failed to account for the effects of % slope and % fast-water habitat on assemblage composition. First, available map-derived variables might not have been good surrogates for these variables when used at large scales. For example, watershed area probably is related to ≥1 factors, including % slope and % fast-water habitat, that influence taxon presence at a site (Hynes 1970, Allan

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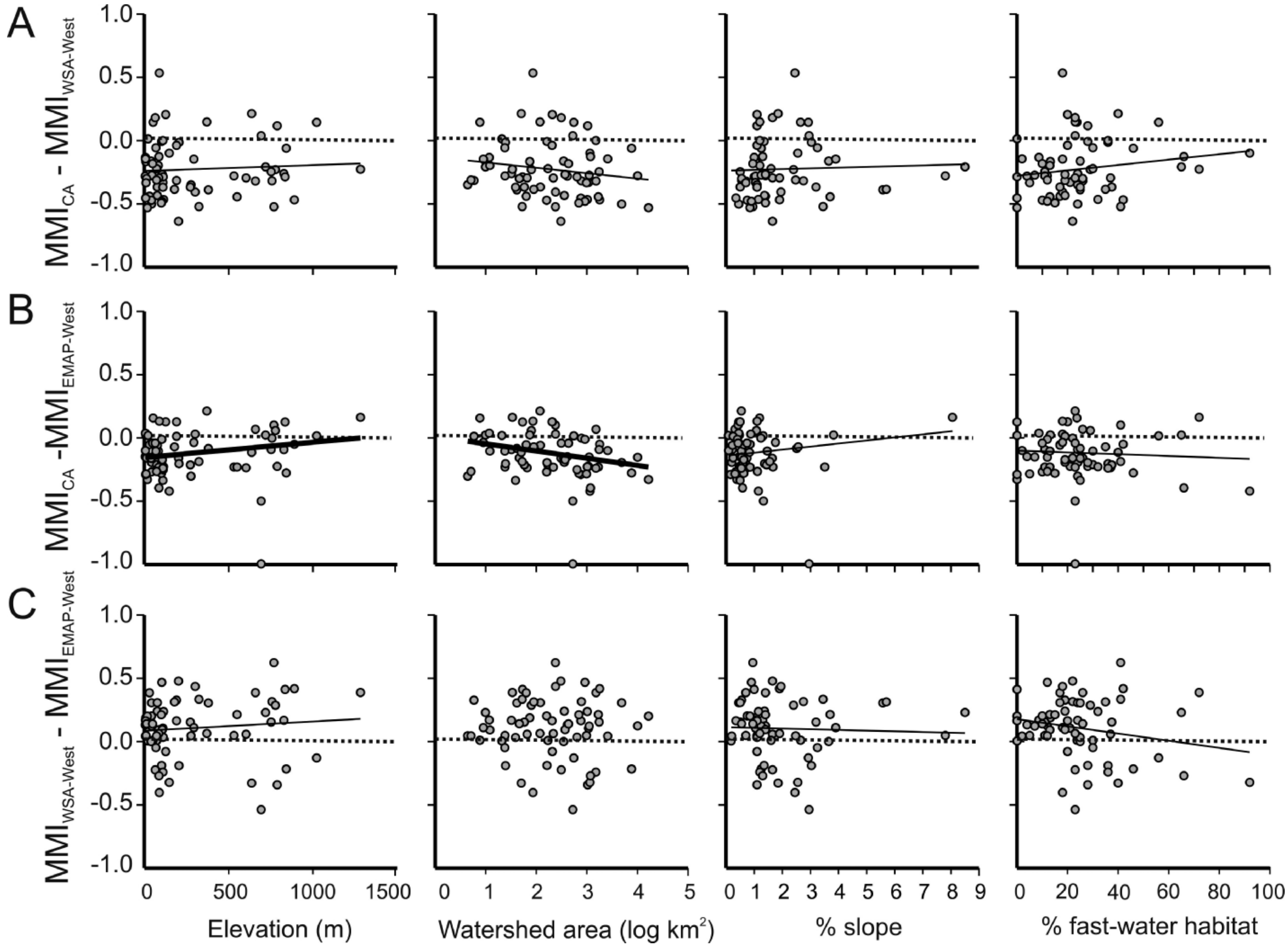

Fig. 8. Relationships between pairwise differences in rescaled multimetric index (MMI) scores and 4 natural environmental gradients at California test sites. MMI scores were rescaled to account for differences among calibration sites used to develop the different MMIs. Differences were obtained by subtracting the score obtained with one MMI from the score obtained with the 2nd MMI at a test site. MMI scores were compared between predictive models for California (CA) vs the western portion of the Wadeable Stream Assessment (WSA-West) (A), CA vs the Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West) (B), and WSA-West vs EMAP-West. The dashed horizontal lines represent 0 difference between MMI scores from the 2 models. Thick solid lines show regressions with r^2 and slopes significantly different from 0; thin solid lines show regressions with y-intercepts significantly different from 0 but slopes that are not significantly different from 0.

Table 8. Comparison of counts of California test sites declared impaired (I) or not impaired (NI) by multimetric indices (MMIs) developed for California (CA), the Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West), and the western portion of the Wadeable Stream Assessment (WSA-West).

		CA mountainous (n = 30)		CA xeric (n = 38)		Total (n = 68)		
MMI		I	NI	I	NI	I	NI	All sites
CA	I	10		29		39		39
	NI		20		9		29	29
EMAP-West	I	5	1	15	0	20	1	21
	NI	5	19	14	9	19	28	47
WSA-West	I	5	1	11	0	16	1	17
	NI	5	19	18	9	23	28	51

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TABLE 9. Summary of differences in precision, bias, responsiveness, and sensitivity of the observed/expected (O/E) indices or multimetric indices (MMIs) for benthic macroinvertebrates developed for the Environmental Monitoring and Assessment Program Western Pilot Study (EMAP-West) and the western portion of the Wadeable Stream Assessment (WSA-West) relative to indices developed for California (CA). Similar = no statistical difference, lower and higher indicate the direction of statistically significant ($p < 0.05$) differences.

	O/E		MMI	
Performance measure	EMAP-West	WSA-West	EMAP-West	WSA-West
Precision	Lower	Lower	Similar	Lower
Bias	Yes	Yes	Yes	Yes
Responsiveness	Lower	Lower	Lower	Lower
Sensitivity	Similar	Lower	Lower	Lower

and Castillo 2007). However, watershed area might not be consistently associated with % slope across a region the size of the western US. In the 3 sets of models we examined, watershed area appeared to account for differences among sites in % slope for only the spatially less-extensive CA models. Even in those models that used direct measures of % slope as a predictor variable (e.g., the WSA-West model), the relationship between invertebrate taxa and % slope might have been obscured by strong relationships between invertebrate composition and predictors, such as temperature and precipitation, that vary markedly across regions. Furthermore, a predictive model based on linear relationships between biotic composition and predictor variables will fail to represent accurately any nonlinear relationships and, hence, will predict inaccurately the taxa that should occur under specific states of that variable. In contrast, over a smaller range of environmental conditions, surrogate predictors, such as watershed area, temperature, or precipitation, might adequately capture differences between sites in local habitat features such as % slope and type of habitat. In general, these problems of prediction bias might be reduced in the future by improving how well reference-site networks represent all streams of interest (in terms of sample size and type of streams) and by using robust predictors, such as Random Forests (Cutler et al. 2007), that do not assume linear relationships.

The fact that the WSA-West and EMAP-West models strongly underestimated impairment relative to the CA model has at least 2 potential explanations: 1) poorer precision in the WSA-West model resulted in lower impairment thresholds and thus fewer impairment decisions, 2) WSA underestimated the probabilities of capture of some of the taxa that contribute to the O/E calculations. The 2nd result could have arisen if the reference sites used to predict the fauna in California streams were less rich, on average, than the otherwise-similar California sites assessed. Vinson and Hawkins (1996) reported that invertebrate taxonomic richness in streams draining mountainous regions of California (Sierra Nevada) was higher than richness in streams draining other mountainous regions in the western US. Therefore, models based on a mix of reference sites from across the western US might be expected to underpredict richness at CA mountainous sites. This explanation seems plausible for the WSA-West model because average WSA-West O/E scores for CA mountainous reference sites were >1, on average (Sierra Nevada = 1.04, Southern Coastal Mountains = 1.11, and Klamath Mountains = 1.04). However, EMAP-West reference-site O/E scores did not show this trend. It seems prudent to refine models to account explicitly for the effects of biogeographical history on taxonomic richness. Such modeling might be accomplished through the use of categorical predictive variables that classify sites by their relevant zoogeographic region rather than general-purpose ecoregions (Hawkins and Vinson 2000, Hawkins et al. 2000a). The contrasting result for the EMAP-West model (i.e., that EMAP-West model did not underestimate impairment relative to the CA model despite precision values intermediate between the CA and WSA models) is probably the consequence of the tendency of the EMAP-West model to score sites lower than the WSA-West model.

MMIs.—Agreement among the MMI scores was considerably stronger than for the O/E indices, but the relationships between scores were not consistent across the scoring range, indicating differences in responsiveness of the indices at low vs high biotic condition sites. Also, although the EMAP-West and WSA-West MMIs were derived from nearly identical data sets, numerous differences in the performance of the 2 larger MMIs, including precision, responsiveness and sensitivity, reflected the different approaches used to develop the MMIs (Ode et al. 2005, Rehn et al. 2005, Stoddard et al. 2005, 2008).

Differences in MMI responsiveness probably were caused by ≥ 1 of the following differences in: 1) how metrics were scaled in the separate indices, 2) the quality of sites used to calibrate the indices, or 3) how individual metrics in each MMI respond to stress. Metrics overlapped considerably among indices; thus, much of the difference among the MMIs in their assessments probably lies in differences in the scoring ranges of specific metrics. For example, the number of EPT taxa is a nearly ubiquitous metric in MMIs (Karr and Chu 1999), but the scoring range for this metric varies among regions. An EPT scoring range established from reference-site data combined across a large spatial extent will not necessarily reflect local reference conditions. In some regions, test sites will be underscored; in others they will be overscored. We found evidence of this effect in the number of disagreements in impairment decisions made under the different MMIs. Furthermore, the WSA-West MMIs did not indicate a difference in biotic condition between mountainous and xeric test sites, whereas the CA and EMAP-West MMIs did. This finding was echoed in the way impairment decisions differed between EMAP-West and WSA-West indices in xeric and mountainous regions. Both EMAP-West and WSA-West MMIs tended to overestimate impairment at mountainous sites relative to the CA MMIs, whereas the WSA-West MMI underestimated impairment at xeric sites relative to the CA MMIs.

A final potential explanation is that differences in MMI performance were related to differences in the calibration sets used to derive the metric scoring ranges. MMIs are calibrated with both reference and test data, so any difference in the biological quality of either set of calibration sites can affect how a site is scored, just as they can in O/E indices (Hawkins 2006). We cannot address how seriously such differences affected index performance at this time because we had incomplete information regarding the quality of reference and test sites used to calibrate the different indices.

Effects of spatial scale on index performance.—Ecologists have long known that taxonomic composition is influenced by natural environmental gradients. How these relationships are expressed at different spatial scales, and hence, affect biological indices, is much less clear, but is of increasing interest (Finn and Poff 2005, Cao et al. 2007, Heino et al. 2007, Mykrä et al. 2008). MMIs and predictive models use different methods for accounting or adjusting for natural gradients. Predictive models are designed explicitly to describe how natural environmental gradients affect the distribution of individual taxa (Wright et al. 1989, 2000). However, some natural gradients might be important at certain geographic scales, but cease to matter at other scales, as shown in our study and elsewhere (Mykrä et al. 2008).

In contrast to O/E indices, MMIs attempt to minimize the effects of natural gradients by a priori classification of reference sites into environmentally homogeneous sets of sites. In addition, metrics are selected to be insensitive to natural gradients, or are modified by adding correction factors that adjust for scoring differences along gradients (Karr and Chu 1999). For example, in our study, scoring ranges for the EPT richness metric varied little across spatial scales within ecoregions (Ode et al. 2005, Rehn et al. 2005, Stoddard et al. 2005, 2008), and the NCIBI explicitly corrects for watershed area in affected metrics (Rehn et al. 2005). In our study, the large-scale predictive models were not completely successful in adjusting for 2 of the gradients (% slope and % fast-water habitat) we examined. Likewise, the CA and WSA-West MMIs were not completely effective at controlling for an elevation gradient.

Index performance and model traits.—All of the biological indices in our evaluations produce scores by comparing biological expectations to observed biology. E is explicitly modeled in O/E (i.e., predicted), and MMI expectations are derived from a set of reference sites that are grouped (by ecoregion, stream size, etc.) to maximize similarity of the biological assemblages at reference sites. Thus, both O/E and MMI are indices based on modeled expectations. Levins (1966) postulated that an inherent tradeoff exists among 3 desirable model traits: reality (i.e., accuracy, or lack of bias), precision, and generality (see also Guisan and Zimmermann 2000). These model traits are not necessarily mutually exclusive, but we cannot expect the models used to predict biotic conditions to optimize each trait. Generality was improved at the expense of both reality and precision when standardized indices applicable across a large range of geoclimatic conditions were created. This tradeoff points to the need to develop more localized models for bioassessment programs, especially those that use biocriteria to infer whether streams are supporting their designated aquatic life uses. However, the fact that impairment decisions can be very sensitive to the thresholds used to define impaired conditions (as we saw when we applied an ecoregion-based correction to the WSA-West model for our O/E comparisons), suggests that it might be possible to adjust for some of the systematic differences among the models. Larger models could be rendered more suitable for local application by calibrating impairment thresholds to local reference conditions. In practice, a local regulatory entity could recalculate the SDs for O/E or MMI scores based only on local reference sites and use these local SDs to set locally relevant thresholds.

Concluding remarks

We asked whether indices developed from geoclimatically extensive data can substitute for more locally produced indices. The answer depends on their intended use and the type of indicator. In regional condition assessments, accuracy (lack of bias) is more important than precision. That is, we can make up for low precision by using large numbers of samples with the expectation that the estimated average condition will be accurate. For the purpose of regional assessments, EMAP-West O/E results were generally comparable to those of CA O/Es. In contrast, the WSA-West O/E results probably would be underestimates of regional impairment because of its strong bias. Lower precision and differences in responsiveness across the scoring range make the WSA-West MMIs less desirable for regional condition assessments.

For site-specific assessments, where both accuracy and precision are important, locally derived indices should outperform large-scale indices for both types of index (Mykrä et al. 2008). Most applications of bioassessment tools are site-specific, so there is a clear need to continue to develop regional models that explicitly take locally important gradients into account (Heino et al. 2007). However, the EMAP-West MMI had similar precision to that of CA MMIs and EMAP-West MMI scores were highly correlated with CA MMI scores. Thus, the EMAP-West MMI might provide an acceptable substitute in California (and potentially other regions in the western US) until local MMIs are developed, if care is taken to adjust impairment thresholds to reflect local reference conditions.

Last, our results suggest 3 related applied research needs: 1) identify the geographic or geoclimatic scales that optimize index performance, 2) determine the factors that most strongly influence index performance and identify the geographic scales at which they vary, and 3) identify ways to specify more accurately the reference condition from geoclimatically extensive sets of reference-site data. We know little about which factors influence the optimal geographic scale for producing predictive models or MMIs, but the rapidly expanding field of bioassessment would benefit greatly from the ability to predict these factors.

Acknowledgements

We thank the staff of the California Department of Fish and Game Aquatic Bioassessment Laboratory who collected the field data and identified the benthic invertebrates used in the test data sets and Alan Herlihy who provided helpful information about EMAP-West and WSA-West model development. Funding for EMAP and the California Monitoring and Assessment Program was provided by the EPA (Assistance Agreement No. CR82823801) and the California State Water Resources Control Board's (SWRCB) Non Point Source Program (Agreement Number 03-273-250–2). Our study was supported by the SWRCB Surface Water Ambient Monitoring Program. CPH was supported, in part, by US EPA Science To Achieve Results (STAR) grants R-82863701 and R-83059401 and a contract with Region 5 of the US Department of Agriculture Forest Service. This manuscript was greatly improved by comments from John Van Sickle and 2 anonymous referees.

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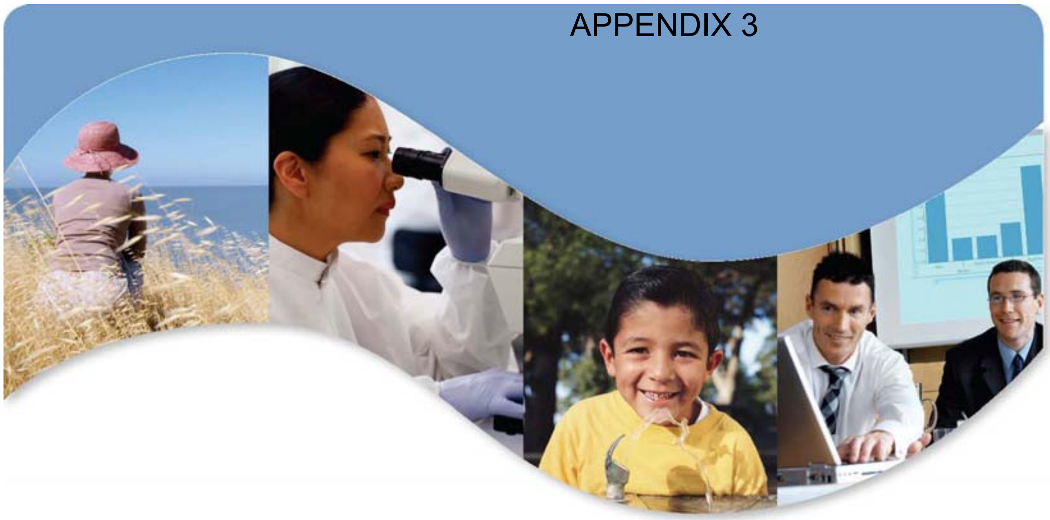
Received: 21 March 2008
Accepted: 18 August 2008

ATTACHMENT B

APPENDIX 3



SWAMP Surface Water Ambient Monitoring Program

Final Technical Report | 2009

Recommendations for the Development and Maintenance of a Reference Condition Management Program (RCMP) to Support Biological Assessment of California's Wadeable Streams

March 2009

California Water Boards

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DOC#1335288

ATTACHMENT B
APPENDIX 3

Recommendations for the development and maintenance of a reference condition management program (RCMP) to support biological assessment of California's wadeable streams

Report to the State Water Resources Control Board's Surface Water Ambient Monitoring Program (SWAMP)

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March 2009

Technical Report 581

DOC#1335288

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EXECUTIVE SUMMARY

Direct measures of the ecological condition of waterbodies have received a recent surge in interest within California's water quality management and regulatory programs because biology-based assessments have several advantages over chemistry- or toxicity-based assessments. Biological assessments are more closely linked to the beneficial uses to be protected and chemistry- or toxicity-based criteria usually lack the predictive ability to infer biological condition. Ultimately, California needs to develop biology-based standards, or biocriteria, as a regulatory tool for monitoring and protecting aquatic life use.

Biological assessment tools, including biocriteria, attempt to objectively "score" the biological integrity at a given site. A crucial component to the development of assessment tools is understanding biological expectations at reference sites that consist of natural, undisturbed systems. These reference systems set the biological condition benchmarks for comparisons to the site(s) being evaluated. Two recent external reviews of the State Water Board's Surface Water Ambient Monitoring Program (SWAMP) affirmed the importance of a sound statewide reference condition program (i.e., TetraTech 2002, SPARC 2006).

In October 2007, the SWAMP bioassessment committee assembled a technical panel of statewide and national experts in bioassessment. The panel met for three days to develop a set of recommendations that the SWAMP program could use to establish and maintain a comprehensive reference condition management program (RCMP). The program accounts for biological variation caused by natural environmental gradients and balances statewide consistency with the flexibility needed to adapt to California's diverse regional settings. Furthermore, the plan allows for adaptive refinement over time.

The panel defined a general strategy for establishing the RCMP that has four components:

1. California will be divided into different geographic regions based on coarse biogeographic similarities in order to partition some of the natural variability among regions (these boundaries should be consistent with those used for the SWAMP Perennial Streams Assessment)
2. A pool of reference sites will be assembled within each region through a sequential process of identification and screening of candidate sites
3. The sites within each reference pool will be managed through iterative review of data to refine regional boundaries, ensure continued suitability of sites and ensure adequate representation of natural gradients
4. A monitoring design will be created for sampling this pool of reference sites to document the range of biological and physical condition at reference sites, and monitor for changes to this condition over time

The panel recommended identifying and screening candidate locations to create a pool of verified reference sites using either a "standard model" or an "alternative model". The standard model will cover the vast majority of the state where high quality sites are available. The alternate model will apply in those regions where an insufficient quantity of high quality sites exist and another strategy is required for selecting candidates for the reference pool. This may include regions such as the agriculturally dominated Central Valley or the intensely urbanized southern California coastal plain.

The standard model is a synthesis of widely used techniques for selection and screening candidate sites using a toolbox consisting of existing site data, GIS techniques, expert knowledge and site visits. The alternative approach consists of two general strategies: 1) modification of standard tools (e.g., lowering the GIS screening thresholds, collecting more intensive site data) and 2) use of non-standard approaches. The non-standard approaches include:

- Select best sites using existing biological indices
- Species pool approach
- Factor-ceiling approach
- Model taxon preferences for limiting environmental gradients

These different approaches are not mutually exclusive and several panel members recommended they be used in combination to provide weight-of-evidence that candidate sites are acceptable for the reference pool in these difficult locations.

The panel outlined a monitoring strategy for the RCMP, which included recommendations for sampling methods, sampling density and frequency, and the set of biological, chemical and physical attributes that should be collected at each reference site. The panel strongly recommended that the RCMP should be compatible with ongoing statewide monitoring programs such as the newly developed SWAMP Perennial Streams Assessment. For the monitoring design, the panel recommended both random and targeted sites. A probabilistic rotating panel was suggested for the random design because it provides an unbiased method for defining natural variability while still optimizing large-scale trend detection. Targeted repeated sampling designs are useful for detecting trends at specific locations; some of these sites have been sampled for years and provide a rich history that should not be lost.

To guide the SWAMP program as it implements the RCMP, the panel made a series of recommendations for prioritizing the elements of the plan. The panel recommended that the implementation begin by screening existing datasets for reference sites, followed by a combination of GIS screens and site visits to fill in gaps in regions with few reference sites.

FOREWORD

The recommendations in this document were developed by a technical panel composed of experts in bioassessment. The panel reflected a broad range of local, statewide, and national experiences with freshwater bioassessment, specifically with defining reference conditions for bioassessment and biocriteria. The panel met for three days on October 17-19, 2007 to outline the content of this document. The meeting followed a four-step process:

1) Defining the background of the problem
2) Establishing a set of guiding philosophies for the development of a reference site management plan
3) Providing general guidance by outlining an overall approach
4) Providing detailed guidance for specific technical issues

This document follows a similar format. This document captures all of the items agreed to by consensus of the group and attempts to point out diverging opinions or unresolved issues. On occasion, we expand on key concepts that were implicit to our discussions, but may not have been discussed directly. Where appropriate, we use sidebars, tables, and figures to illustrate key concepts or provide additional information. Thank you to Dr. Robert Hughes (Oregon State University) for additional document review.

Panel Members (from left to right): David Herbst (University of California at Santa Barbara, Sierra Nevada Aquatic Research Laboratory), Peter Ode (California Department of Fish and Game, Aquatic Bioassessment Laboratory), Raphael Mazor (Southern California Coastal Water Research Project), D. Phil Larsen (US EPA retired, Western Ecology Division), Andrew Rehn (California Department of Fish and Game, Aquatic Bioassessment Laboratory), Lenwood Hall (University of Maryland, Wye Research and Education Center), Terrence Fleming (US EPA Region IX, Office of Water), Charles Hawkins (Utah State University, Western Center for Monitoring and Assessment of Freshwater Ecosystems), Alan Herlihy (Oregon State University, Department of Fisheries and Wildlife), Kenneth Schiff (facilitator, Southern Coastal California Water Research Project).

CONTEXT: LINKING BIOASSESSMENT TO BIOCRITERIA[1]

Aquatic bioassessment is the applied science of interpreting the ecological condition of waterbodies directly from the organisms that inhabit them. Biocriteria are narrative or numeric standards that define whether the integrity of biological communities is impaired at a specific site. Water quality regulatory programs can receive many benefits from adopting biology-based standards as targets of their policies and management actions. The key to using biology-based methods effectively is the establishment of benchmarks that objectively define the biological expectations (or potential) of a given site. Reference conditions provide these objective benchmarks.

Why bioassessment?

The Clean Water Act (Section 101a) requires states to "restore and maintain the chemical, physical and biological integrity" of their waterbodies. For decades, most state water quality monitoring programs have focused on the chemical integrity (and to a lesser extent physical integrity) of waterbodies largely because these parameters are relatively simple to sample, relatively straightforward to measure and evaluate, and methods for developing chemical criteria are relatively standardized. While chemical/ toxicological and physical condition monitoring may provide indirect measures of ecological condition, exclusive focus on these measures is inadequate for protection of aquatic life uses, one of the primary beneficial uses of concern in water quality management. Because many chemical/ physical water quality thresholds are based on toxicity to aquatic organisms (USEPA WQS handbook, 2nd Edition 1994), these indirect measures are often surrogates for the beneficial use that is the target of protection efforts. Furthermore, biological integrity is frequently impaired by factors other than chemical contamination (e.g., hydrologic alteration, instream and riparian habitat alteration). Ultimately, ecological condition assessments provide the most appropriate assessment endpoint for protecting beneficial uses associated with aquatic life.

Why biocriteria?

Adoption of biology-based regulatory standards has the potential to provide significant enhancements to the protection of water resource integrity because biocriteria provide a regulatory mechanism for applying bioassessment's benefits to numerous water resource objectives.

The State Water Resources Control Board's Surface Water Ambient Monitoring Program (SWAMP) is supporting the biocriteria goal by developing tools for using benthic macroinvertebrates as indicators of the health of aquatic life in perennial streams. SWAMP's objective is to develop the bioassessment infrastructure (i.e., standardized methods, analytical tools, objective reference conditions, interpretive framework) that will enable water quality programs to employ biocriteria in a variety of regulatory applications.

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[1] Much of the information summarized in this section was synthesized from several key sources: Barbour *et al*. 1996a, Karr 1995, 1997, Stoddard *et al*. 2006.

Importance of reference conditions to bioassessment and biocriteria

The development of chemical criteria for aquatic life follows a relatively straightforward process in which numerical standards are based on results from lab-based toxicity testing. For most chemical contaminants, management objectives are focused on keeping concentrations below these toxicity-derived numerical thresholds. In contrast, biological objectives are based on maintaining the integrity of an assemblage (or multiple assemblages) of organisms. The challenge in developing biocriteria is translating what is currently a narrative standard into an ecologically relevant numerical standard. Development of biological criteria, however, is complicated by the fact that the composition of stream communities varies naturally even in the absence of anthropogenic stress. Thus, biocriteria will require a fundamentally different approach to establishing the expectations for unimpaired waterbodies.

Reference conditions (based on reference sites) provide a widely accepted mechanism for defining appropriate expectations and accounting for this natural variability (Hughes *et al*. 1986, Barbour *et al*. 1996, Karr and Chu 1999, Bailey *et al*. 2004). Reference sites are sections of streams that represent the desired state of stream condition (*sensu* Meyer 1997) for a region of interest. Once suitable reference reaches have been identified, these are used to characterize the range of biotic conditions expected for minimally disturbed sites. Deviation from this range is then used as evidence that test sites are impaired. [2]

A standardized lexicon of terms used to define biological expectations (adapted from Stoddard *et al.* 2006):

Reference Condition (RC(BI)) ~ Because this term has been used for a wide range of meanings, Stoddard *et al.* (2006) argue that the term should be restricted to meaning "reference condition for biological integrity … in the absence of significant human disturbance or alteration"

Minimally Disturbed Condition (MDC) ~ stream condition in the absence of "significant" human disturbance. Assumes all streams have some anthropogenic stresses, but in most cases will approach true RC(BI)

Historical Condition (HC) ~ stream condition at a specific point in time (e.g., pre-Columbian, pre-industrial, pre-intensive agriculture, etc.)

Least Disturbed Condition (LDC) ~ the best physical, chemical and biological conditions currently available ("the best of what's left"). This definition is sufficiently flexible to establish biological expectations even in highly altered systems

Best Attainable Condition (BAC) ~ the expected ecological condition of least disturbed sites given use of best management practices for an extended period of time. This definition is helpful for communicating the potential for improving ecological condition above the currently best available conditions

Tiered aquatic life use (TALU) framework

The potential for biocriteria to improve aquatic life beneficial use protection can be greatly enhanced by a flexible framework for interpreting beneficial use attainment in a variety of settings. The current system of aquatic life use designations in California is outdated and does not adequately take advantage of advances in our ability to assess aquatic life use attainment. The USEPA and other states (notably, Maine and Ohio) have recognized this problem and have

[2] Approaches to the selection of reference sites have been discussed extensively (Hughes and Larsen 1988, Hughes 1995, Rosenberg *et al.* 1999, Stoddard *et al*. 2006). Although there has been much debate about terminology used to describe expected biological conditions, the concept is flexible and can be applied either very narrowly (e.g., the condition of waterbodies before European invasions) or more broadly (e.g., the "least disturbed" or "best available" conditions currently found in a region of interest). The strategy in this document follows terminology usage recommended by Stoddard *et al*. 2006 (see text box).

developed a "tiered" system of aquatic life use designations, which utilize the power of biological information to develop graduated levels of protection.

"Tiered aquatic life uses" (TALU), supported by numeric biocriteria, can be thought of as defining different management levels for biological condition across a quality continuum that ranges between "natural" conditions to complete loss of the natural biological community (Figure 1). In the TALU system, "tiers" represent classes of waterbodies that are grouped based on similarities in anthropogenic disturbance levels, resulting biological condition, and recovery potential (USEPA 2005). Under this flexible system, designated uses to support aquatic life can cover a broad continuum of biological conditions, with some waters being closer to the ideal of "natural" or "minimal human impact" than others. Biocriteria applied in a framework of TALU designations can help shift the regulatory focus from performance-based standards (e.g., limiting the number of chemical criteria exceedences) to impact-based standards (e.g., attainment of ecological condition targets).

Reference conditions play two distinct roles in the TALU framework

The y-axis in the TALU framework (see Figure 1) is biological condition, a scale that measures ecological integrity of a site. The upper limit of the biological condition axis is anchored by an idealized target that represents the natural state of ecological conditions, or RC(BI) in the strict sense of Stoddard *et al.* (2006).

In addition, within each tier, there is some best attainable condition (BAC, *sensu* Stoddard *et al.* 2006) for waterbody classes in these tiers.

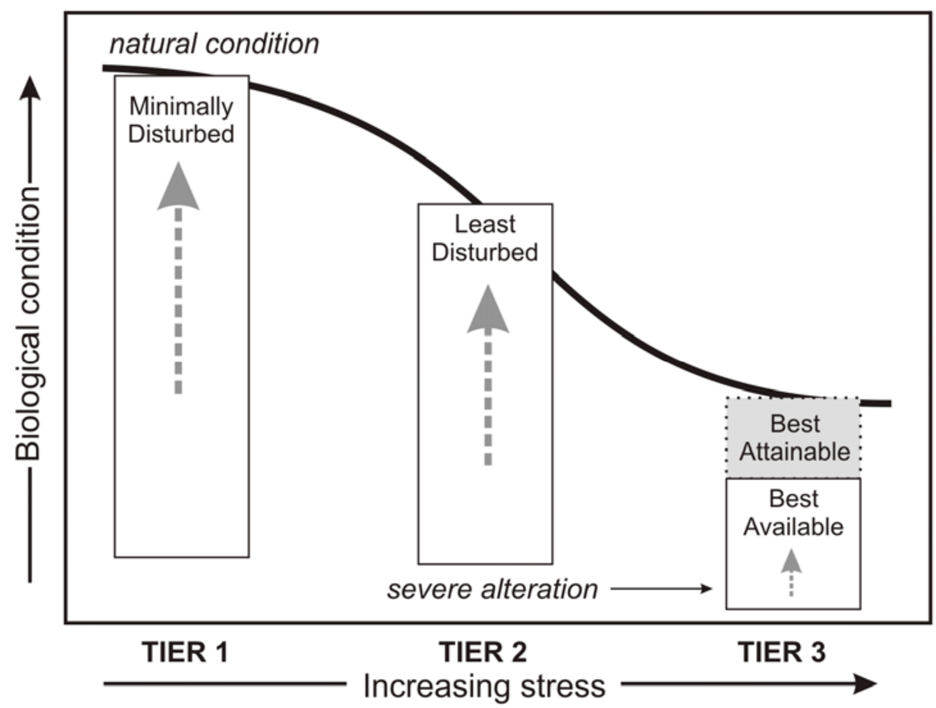

Figure 1. The biological condition gradient (BCG) used to define stream condition tiers in the TALU framework. Boxes indicate the expected range of biological condition scores at sites within each tier. Figure modified from Stoddard *et al*. 2006.

INTRODUCTION

General background

As the use of biological information in states' water quality regulatory programs has expanded across the US, these programs have followed a typical progression in which biosurveys (collection of biological samples, often as supplements to existing chemical monitoring) are followed by bioassessments (assessing ecological condition from biological data), finally progressing to full biocriteria (use of biological data to make regulatory decisions about aquatic life use condition).

As other programs proceeded along the path toward standardized interpretation of bioassessment data, they all recognized the need for grounding their programs with explicitly defined expectations for biological condition. Although criteria and procedures used to identify reference sites vary from program to program, the basic approaches used by most programs are quite similar. A partial review of water quality assessment programs in the North America (both state and federal programs), European Union (Water Framework Directive) and Australia (Water Reform Framework) revealed that many programs employed a similar GIS-based landscape-scale analysis to identify candidate watersheds, followed by site reconnaissance to evaluate reach-scale impacts (Barbour *et al*. 1996a, Whittier *et al*. 1987, Rosenberg *et al*. 1999, ANZECC and ARMCANZ 2000, Drake 2003, REFCOND 2003, Grafe 2004).

Reference sites manage natural variation

The composition of organisms at a site is a function of both natural and anthropogenic factors. These factors can be viewed as a series of "filters" that determine which taxa occur at a site (Poff and Ward 1990, Poff 1997, Statzner *et al*. 2001). For example, the pool of benthic macroinvertebrate taxa occurring within a large region like California's Sierra Nevada is a function of large scale processes (e.g., parent geology, climate and evolutionary history); the subset of taxa that occur at a given site at a given point in time is determined by a series of biotic and abiotic filters (e.g., life history traits, competition and predation, substrate composition, pH, thermal and hydrologic regimes, pollution tolerance) that further limit the occurrence of each taxon. The central challenge in bioassessment is to develop techniques that maximize the detection of signals of anthropogenic stress filters while minimizing the noise from natural filters. The identification of reference sites (that captures sources of natural variation) is a key component of most strategies for meeting this challenge (Hughes 1995, Wright and Li 2002, Bailey *et al*. 2004).

California's progress toward biocriteria implementation has followed a similar path. Since the early 1990s, bioassessment samples have been collected from more than 4000 sites by state and federal agencies alone (Figure 2). Some of these programs have been spatially extensive probability assessments of environmental condition such as the US EPA's Environmental Monitoring and Assessment Program (EMAP) and the California's Monitoring and Assessment Program (CMAP). Others are more directed studies to assess watershed-specific conditions or trends at locations of interest such as regional SWAMP monitoring, US Forest Service monitoring, and the US Geological Survey's National Water Quality Assessment Program (NAWQA). In addition, an abundance of additional sites have been sampled for National Pollutant Discharge Elimination System (NPDES) permit monitoring, and by citizen monitoring groups.

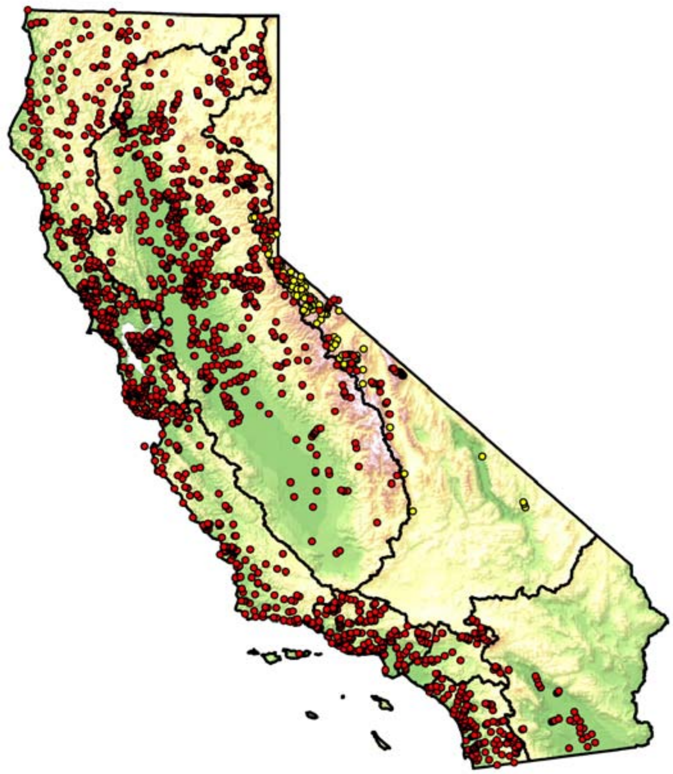

Figure 2. Approximately 3000 bioassessment sampling locations in California sampled between 1994 and 2007. Red circles represent sites processed by Aquatic Bioassessment Laboratory, yellow circles represent those processed by Sierra Nevada Aquatic Research Laboratory. More than 1000 other sites have been sampled by other state and federal agencies, permitted dischargers and citizen monitoring groups.

Because the early applications of bioassessment techniques in California were fragmented, the procedures for defining reference condition were largely *ad hoc* or project specific, with little or no attempt to apply consistent methods from project to project. Most of the reference or "control" sites used in early California bioassessment studies (e.g., point source enforcement cases, watershed specific bioassessments) were selected to define local expectations and were not selected using common criteria that would enable comparisons among projects.

Several large scale efforts to screen reference sites were undertaken in the early 2000's to support biological index development or as part of large state probability surveys: Western EMAP (2000-2003) and CMAP (2004-2007). In a concurrent effort, the USFS collaborated with scientists at Utah State University to identify over 200 reference sites on forest service lands in California between 1998 and 2000. Sites from these sampling programs were combined with other regional datasets to produce several of the main biotic indices used in California (statewide O/E models, North Coast IBI, South Coast IBI). Separate reference sites were used to develop the Eastern Sierra IBI (Herbst and Silldorf 2006).

In all of the large-scale studies between 1998 and 2007, both landscape scale and local scale factors were used for screening reference sites. Although common approaches were used to screen sites for most of these projects, little or no attempt was made to ensure consistency in screening among projects. This limits the utility of existing reference sites for statewide applications for several reasons. First, each project may use very different factors for selecting reference sites (e.g., one program may rely more on landscape scale factors while another may rely more on local scale factors). Second, some projects may use similar factors to select reference sites, but use different thresholds to screen sites (e.g., road density cutoffs or % upstream development cutoffs). Third, even when similar screening criteria are used for the same landscape or local scale factors, temporal variation in the reference site data has rarely been accounted for.

Why SWAMP needs an RCMP

The recent commitment by the SWAMP program to develop bioassessment/ biocriteria infrastructure provides us with an opportunity and impetus to standardize the reference site selection process statewide. The SWAMP program has long recognized this need, recently devoting a significant portion of its funding to developing reference condition datasets. Three recent peer reviews of SWAMP affirmed the importance of this effort:

1. In 2002, the SWAMP program funded an external review of bioassessment programs throughout California. That review was conducted by the lead author of the USEPA's bioassessment guidance document for streams and rivers.[3]

2. In 2005-06, the entire SWAMP program was peer-reviewed by an external "Scientific Planning and Review Committee" (SPARC), comprised of water quality experts from around the country.[4] The SPARC strongly recommended that SWAMP continue to develop its bioassessment program as a very high priority, specifically commenting that: a) the state board should consider revamping its entire standards program to make better use of biological endpoints (i.e., bioassessments) and b) the bioassessment program should focus particular attention on fostering consistency in its scoring indices.

3. In 2008, the USEPA (2009) conducted a Critical Elements Review of SWAMP's progress toward developing the technical elements to support biocriteria. The review stressed the fundamental importance of defining reference conditions and supported CA's reference condition strategy.

Establishing consistency in SWAMP's reference site selection process is clearly a key to effective implementation of biocriteria. However, identifying reference sites for California's perennial streams is complicated by its size (i.e., there are more than 300,000

[3] The external review, conducted by Dr. Michael T. Barbour and Colin Hill of Tetra Tech, Inc., produced a final report in January 2003 titled *The Status and Future of Biological Assessment for California Streams*, which may be viewed on the Internet at http://www.swrcb.ca.gov/swamp/reports.html

[4] The SPARC's final report is posted at: http://www.waterboards.ca.gov/swamp/docs/reports/sparc486_swampreview.pdf

stream kilometers), diverse ecological settings (12 Level III Omernik ecoregions are present in California, Figure 3), and anthropogenic settings (vast regions of the state are entirely converted to either agricultural or urban land uses). There are many natural gradients within each ecoregion. For example, the elevation in the Southern California Coastal Ecoregion extends from sea level to 8,000 feet encompassing cold water, high gradient mountain streams, but also includes warm water, low gradient streams in the flood plain. To complicate matters further, there are extreme natural temporal cycles of dry and wet years, which may not occur in all regions of the state during the same year. This is compounded by the episodic natural disturbance of flooding and fires. Finally, human-dominated landscapes can be so pervasive in locations such as urban southern California and the agriculturally dominated Central Valley that no undisturbed reference sites may currently exist in these regions. A statewide framework for consistent selection of reference sites must account for this complexity.

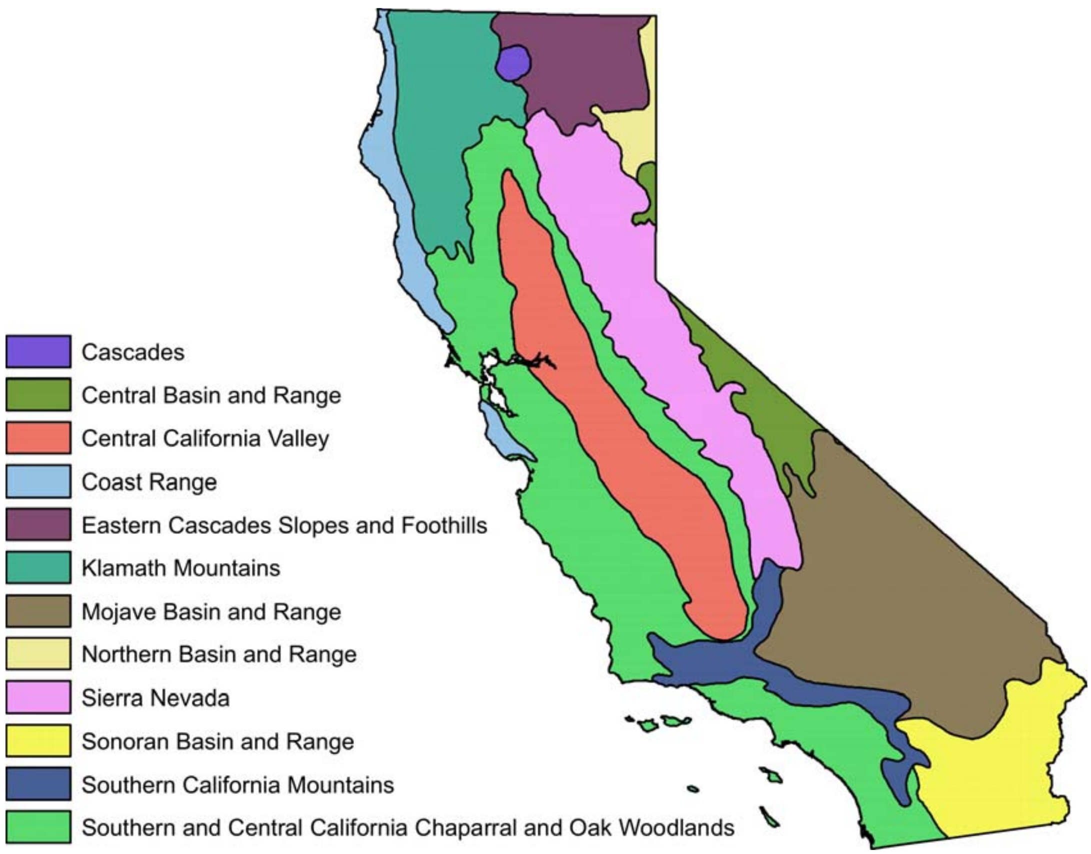

Figure 3. Boundaries of 12 Level III Omernik ecoregions present in California.

GOALS AND OBJECTIVES

This document summarizes recommendations to SWAMP for the development and maintenance of a Reference Condition Management Program (RCMP) that will support its regulatory biological assessment programs. The goal of the SWAMP RCMP is to provide an objective system for defining the expected biological and physical condition for wadeable streams and rivers in California. This system will identify pools (populations) of verified reference sites and outline procedures for sampling them to determine the range of biological expectations in these pools.

The monitoring objective

Data collected from reference sites will be used to answer a primary question: "what is the expected natural composition of lotic freshwater organisms in each of the major biogeographical regions of California"? The answer needs to be determined with sufficient rigor to serve as the basis for setting defensible numeric biocriteria. Our primary focus is on establishing expectations for benthic macroinvertebrate assemblages in perennial wadeable streams, but we expect that the approach will allow similar assessments of algal and fish assemblages as well as instream habitat condition and riparian condition.

Accounting for natural variability

An extension of the central monitoring question is: "what is the range of biotic measures (e.g., taxonomic composition, individual metrics and biological indices) in high quality sites and which natural environmental gradients (both spatial and temporal) are most strongly related to this variation." Ultimately, the goal is to identify the major sources of natural variability for all biological response measures (Figure 4). To account for these gradients, reference sites should be distributed to represent the full gradient range.

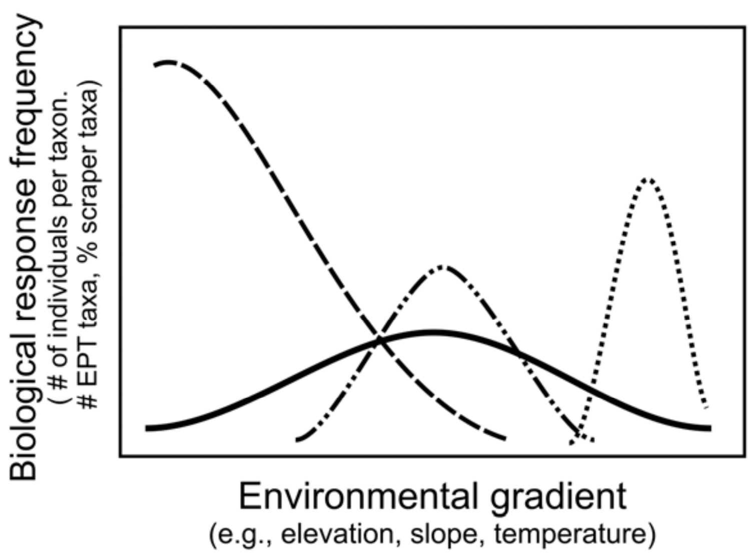

Figure 4. Hypothetical frequency distribution relationships between biological responses and environmental gradients.

GUIDING PHILOSOPHIES

In order to guide the development of the RCMP, the panel agreed upon a set of basic philosophies. These philosophical principals were used to guide their decision-making:

- **Use natural condition as the desired state whenever possible -** The panel's goal was to identify sites in natural or near-natural conditions whenever possible. However, the panel recognized that there are regions in the state where an insufficient number of sites in near-natural condition were likely to be found. The panel agreed that setting biological expectations were no less important in these regions. Therefore, the panel endeavored to identify the best attainable condition in these suboptimal regions of the state.

- **Balancing statewide consistency with regional flexibility** - The panel agreed that the reference strategy should balance a set of desirable, but sometimes naturally conflicting, traits: objectivity, consistency and flexibility. For example, a reference program that works for all of California can't be both perfectly consistent and perfectly flexible. This strategy aims to balance the competing demands of statewide consistency with the flexibility needed to adapt to unique regional conditions.

- **Reference site management is an iterative process -** The management of a reference site network is an ongoing and iterative process. The monitoring program should be responsive to new information and perspectives gained from selecting and monitoring reference sites. The general strategy should build in analysis of data to optimize selection strategies (process of selecting sites) and management design (e.g., how many sites, regional boundaries, which natural gradients to account for).

- **The RCMP should be transparent -** The technical process of determining reference conditions should be transparent to external review. As the state moves toward implementation of biocriteria, transparency and comprehension of the RCMP process will improve stakeholder confidence and provide structure for discussions about setting objective standards.

- **These recommendations are a starting point -** The panel understood that their recommendations provide a starting point for evaluating reference condition rather than an exhaustive set of operating procedures for selecting reference sites. This document is written assuming that SWAMP will develop a technical workplan that details a more refined program as the RCMP is implemented.

GENERAL GUIDANCE

The general approach for establishing the SWAMP reference site network has four components:

1. California should be divided into different geographic regions based on coarse biogeographic similarities in order to partition some of the natural variability among regions
2. A pool of reference sites should be assembled within each region through a sequential process of identification and screening of candidate sites
3. The reference pools should be managed through iterative review of data to refine regional boundaries, ensure continued suitability of sites and ensure adequate representation of natural gradients
4. A monitoring design should be created for sampling this pool of reference sites to document the range of biological and physical condition at reference sites, and monitor for changes to the condition of reference sites over time

All but the second component, site selection, apply equally to all regions of the state. The site selection process has two versions depending on the availability of high quality reference sites. We refer to the two versions in this document as: 1) the “standard model”, which applies to regions with a sufficient number of reaches with relatively low levels of anthropogenic stress; and 2) the “alternate model”, which applies to regions that do not have a sufficient number of high quality reaches. The vast majority of California should be able to apply the standard model.

Component I: Partitioning CA into biogeographic regions

Two general schemes are available for delineating California’s ecoregions (Omernik 1995 and Bailey *et al.* 1994). We follow Omernik’s divisions here because the boundary delineation decisions were generally based on a broader range of geology, climate and zoogeography than Bailey’s. Omernik Level III ecoregions have been delineated for all of North America (Omernik 1995), with 12 Level III ecoregions falling in California (Figure 3).

Partitioning the state into different regions based on habitat similarities has some precedence in California bioassessment. The SWAMP Perennial Streams Assessment (PSA) has relied on a combination of Omernik ecoregions and regional board boundaries to partition the state for assessment purposes (Figure 5). Because these definitions include significant ecological gradients that contribute to natural variability in biological assemblages, and because they comprised existing assessment units, the panel agreed that these delineations were appropriate to use as initial boundaries for the reference network. However, the panel also stressed that ecoregions do not always adequately capture natural gradients that are key drivers of aquatic assemblages (insert references here, Hawkins and Norris 2000). Thus, data analyses must address the suitability of these boundaries as the program collects more data.

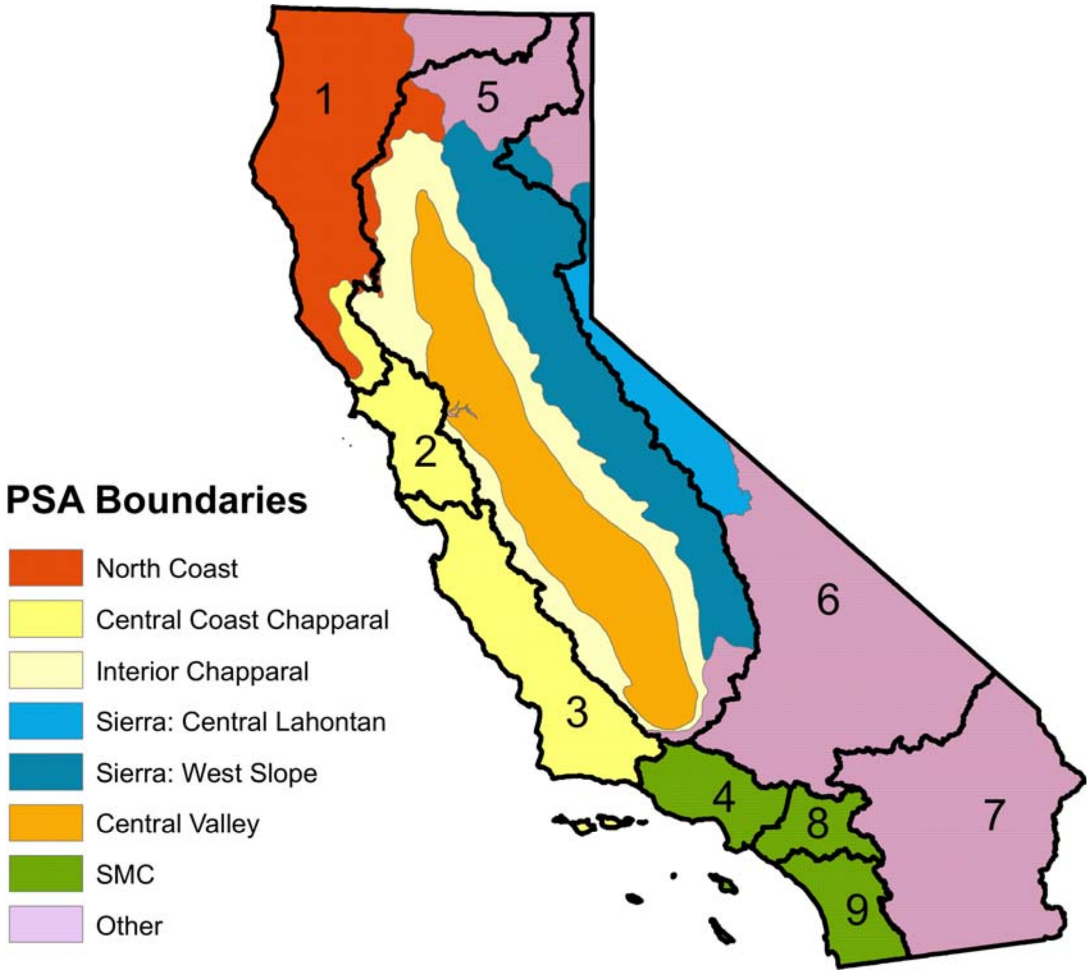

Figure 5. Boundaries used for defining the regional subunits of the SWAMP Perennial Stream Assessment (PSA) survey. SWAMP regional board boundaries one through nine are indicated by thick lines. SMC=Southern Coastal California Stormwater Monitoring Council.

Component II (a): Selecting sites: the "standard model"

The second step in the general approach is the most resource intensive and technically challenging: to develop a large pool of reference sites within each ecoregion. The ability to precisely establish biological expectations within each region is a function of the number of sites that are sampled and natural variability within each region. Therefore, the pool of reference sites should be large enough to provide a robust characterization of natural variability. Furthermore, reliance on a small number of reference sites is risky because it increases the consequences of catastrophic failure of individual sites. The size of the site pool in each region will depend on the number of major environmental gradients in each region (e.g., elevation, temperature, etc.) and the strength of influence of these gradients on biotic assemblages.

The panel recommended a sequential approach for assembling a set of candidate reference sites and screening suitable sites for the final reference pools within each region. The process includes: 1) screening data from previous site visits to identify candidate sites, 2) application of remote sensing and point-source GIS data screens of all potential stream reaches (combining landscape and local scale) to identify candidate sites, 3) use of best professional judgment/ local knowledge to add sites to the candidate pool.

Once a set of candidate sites is assembled, each candidate site should receive an on-site visit to evaluate its suitability. The exact type of data collected for evaluations during this stage will vary by region, but at a minimum should include: observations of local landuse activities, instream and channel habitat condition, riparian condition, evidence of recent natural disturbance. Some regions may require additional chemical data (water column or sediment) or toxicological data to confirm site suitability.

Sites that pass both the remote sensing and field reconnaissance screens become part of the reference pool for that region.

Component II (b): Selecting sites: the "alternate model"

The panel recognized that the standard model is not likely to work in all regions of California. The conversion of natural landscapes to agricultural and urban land uses is so extensive in some parts of the state that the entire region is devoid of waterbodies that could be used to define reference condition. Most regions of California should be able to use the standard model; the alternate model should only be used when the standard model is not feasible.

The panel defined the following criteria as triggers for acceptable use of alternate site selection strategies (both criteria must apply):

1) Insufficient high quality sites are available within one of the main regions (or a large section of one of the main regions) to adequately characterize ecological potential. Suitable stream reaches are unavailable for one or more of the following reasons:
    a) Anthropogenic landuse is a dominant factor in all watersheds within the region (or subregion)
    b) Normal flow is modified (e.g., flow diversions, dams, withdrawal or augmentation)
    c) Natural channels are altered (e.g., all or most channels converted to conveyances, irrigation supply/drains)
    d) Riparian corridors are impacted throughout the region (e.g., concretized riparian or surrounding landscape modified)

2) No comparable region exists from which to draw inference about biological expectations. That is, the areas are unique in their biological expectation so regions with few reference sites are not able to incorporate sites from another region.

This situation is not unique to California streams and many large programs have recognized the need to deal with regions with insufficient reference sites (REFCOND 2003, Stoddard *et al*. 2005, Paulsen *et al*. 2006). National guidance for developing state biocriteria programs highlighted the need for special treatment of these conditions (Barbour *et al*. 1996a,b). While the unique needs of these regions are widely recognized, the approaches for establishing ecological potential for reference-poor regions are far from standardized.

The RCMP panel outlined a general strategy for approaches to explore in reference-poor regions. The RCMP panel did not take any strong position on the relative strengths of these alternatives nor how different approaches should be combined to define expected conditions in reference-poor regions. Some of the alternative strategies included:

1. Use a modified version of the standard approach (e.g., use lower thresholds, emphasize local condition measures)
2. Alternate approaches
    a. Use existing tools to screen sites
    b. Species pool approach
    c. Factor-ceiling approach
    d. Model taxon preferences for key environmental gradients

These alternative strategies are not mutually exclusive and, when appropriate, should be used as multiple lines of evidence to reinforce an objective definition of biological expectation in regions without reference sites. In the "specific guidance" sections of this document (see Alternate Strategies for Selecting Sites) we describe these approaches and discuss strategies for applying them to California's challenging landscapes.

Component III: Managing the regional site pools

After the site pools have been assembled for each region, the RCMP requires an ongoing evaluation of data from these sites to address several key management questions. There are two major components to managing the reference pools: 1) evaluation of the regional representation of natural gradients and 2) periodic review of sites to evaluate changes to their suitability.

The ability to effectively understand natural sources of biological variation is fundamental to establishing sound biocriteria[5]. Therefore, the RCMP must directly assess the reference pools to ensure representation of regionally important natural gradients. This review should include a periodic review of the suitability of the initial regional boundaries proposed here.

The second aspect to site management is periodic review of sites in the reference pools to assess their continued suitability as reference sites. Conditions within stream reaches and in their upstream drainages can change over time (e.g., timber harvest, conversion of natural landscapes to agricultural or urban/suburban/exurban uses). Furthermore, we may discover sources of stress that were unknown when sites were initially added to the reference pools (e.g., discovery of nonpoint source discharges, mines, flow withdrawals/diversions, small-scale placer mining, etc.). Sites that fall into this category may be monitored to measure the impacts of these stressors, but they should be removed

[5] See discussion on p. 5.

from the reference site pools. In contrast, natural disturbances (e.g., forest fires, catastrophic flooding or landslides) can also alter the biological condition at sites and they should be excluded for sampling temporarily, but should remain in the reference site pool[6].

Component IV: The monitoring strategy

The panel recommended an integrated probabilistic and targeted sampling design for the RCMP. The probabilistic approach will sample a rotating subset of randomly-selected (rotating panel design) sites from within the reference pool each year to estimate average biological condition. A subset of the randomly-selected sites should be sampled annually to measure year-to-year variability at sites and improve SWAMP's ability to detect drift in reference condition within each region over time. This design provides an unbiased assessment of natural variability with enhanced trend detection.

Targeted sampling is comprised of fixed sites near locations of special interest, but this should be supplemental to the probabilistic sampling effort. Fixed sites provide additional power to detect trends, but suffer from its inability to extrapolate to other locations. However, many agencies already monitor reference sites and, provided they meet the RCMP selection criteria, these sites have the added benefit of years of historical data. As SWAMP extends its reference monitoring program through collaboration with other state and federal programs, it should retain the ability to incorporate these sites.

The panel emphasized sampling more probabilistically selected sites over targeted sites, but did not make any recommendations about relative proportion of each type. This decision should reflect the relative importance to the SWAMP program of estimating current biological expectation versus detecting changes in the reference state. Changes in the reference state may become increasingly important due to factors such as climate change.

[6] A special study of natural disturbance recovery could be especially enlightening with regard to understanding natural variation.

SPECIFIC GUIDANCE

1.0 Site Selection: Assembling the reference candidate pool

The panel recommended a sequential approach for assembling a pool of potential reference sites using a series of tools to identify candidate sites (Figure 6). The toolbox components included: 1) use of existing data from previous site visits, 2) GIS data screens of all potential stream reaches using databases of stressor data (combining landscape and local scale), 3) expert selection of site locations based on regional experience.

1.1 Use of existing sites

Previously sampled sites are an excellent source of candidate reference sites and where available in sufficient numbers, can constitute a ready-made pool of reference sites. However, previously sampled sites vary widely in the amount of information associated with them, and they fall into two categories: 1) sites with a large amount of associated environmental data that is sufficient to evaluate without additional data collection, 2) sites that require additional data collection to produce adequate evaluations. Several programs in the state have collected sufficient data to meet the first condition (e.g., EMAP, Central Valley WEMAP, CMAP, SNARL, some regional board programs), but most sampled sites fall into the second class.

The current distribution of existing candidate sites in California is illustrated in Figure 7. Sites were pre-screened from ABL and SNARL databases and sorted into one of three tiers based on the availability of different types of screening data. Under the RCMP, Tier 1 sites would pass to the pool of verified reference sites if they passed a BPJ screen (see following section), sites in other tiers would be placed in the candidate pool and be subjected to the full site screening process (Figure 6).

1.2. GIS data screens of all potential stream reaches using databases of stressor data [7]

If regions do not have sufficient existing sites to fill the final pool of fully screened reference sites (steps 1 - 3 of the general guidance), then new candidate sites should be identified through use of geographic information systems (GIS) techniques for screening remote sensing data and GIS databases of point source stressors. GIS-based searches for candidate reaches are expected to contribute the majority of sites in many regions.

Ode (2002) described a GIS based method for identifying candidate stream reaches using a series of remote sensing data filters. Under this approach, candidate watersheds are identified for a region with GIS techniques and then stream reaches within these watersheds are targeted for reconnaissance to verify reference quality characteristics. The RCMP generally follows this approach, which consists of the following steps:

[7] GIS techniques are used at two different stages of the RCMP process: 1) searching for potential new reference streams (described in this section) and 2) quantifying impacts to existing sites (described in the following section). The techniques are very similar, but differ somewhat in their application. The search phase is a relatively coarse screen of candidate watersheds while the verification phase is site specific and allows for multiple spatial scales of GIS analysis (see Figure 8).

1.2.1 Assemble GIS layers of important landuse disturbances
The list of potential impacts to stream condition is very long and includes multiple point and non-point sources of disturbance. Quantitative measures of many human or human-influenced activities are available in digital spatial (GIS) formats from various state and federal agencies (see Tables 1 and 2), but there is a very large amount of variation in the degree to which datasets are accurate, current, and consistent across wide geographical ranges.

1.2.2 Determine appropriate reporting units (areas of analysis) and create necessary GIS layers~ Current GIS applications for locating least disturbed waterbodies in a region (see ATtILA text box) calculate summary stressor metrics (e.g., % urban landuse, road density) for each reporting unit (typically watersheds) in the region of interest. Candidate stream sites are then selected from within these watershed areas. It is recommended that the RCMP use a modified version of watershed polygons developed by the national NHD+ program.[8]

1.2.3 Use ATtILA extension to calculate stressor metrics using remote sensing and point source datasets (see ATtILA text box)~ ATtILA produces summary output in a spreadsheet containing multiple stressor metrics for each candidate watershed (i.e., % agricultural landuse, % impervious surface, # of mines, # road crossings/stream km).

1.2.4 Analyze distribution of stressor metrics and select appropriate thresholds
Screening thresholds for GIS stressor metrics can be set using a variety of approaches: 1) visual inspection of frequency histograms for natural breaks in distributions, 2) statistical criteria[9] (e.g., eliminate watersheds with road densities greater than 1.5 standard deviations above the mean for all watersheds in the region, or eliminate all but the lowest 25th percentile of all road densities), 3) established (i.e., literature based) impact thresholds. At this stage in the screening process, the RCMP panel recommended the use of fairly liberal screening thresholds since GIS data are often inexact and impacted sites can be screened during later stages of the site verification process.

1.2.5 Eliminate watersheds that fail GIS screens
Because of the large number of stressor variables that are quantified in this step, there will be a large number of metrics to evaluate. The panel discussed two options for how to combine the information from these different screens:

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[8] With funding from the SWAMP program, CSU Chico's Geographic Information Center (GIC) has developed a method for creating nested watersheds from the native polygons available from the NHD+ program. The NHD+ polygons are limited in their utility as reporting units because they are non-overlapping. Thus, 2nd order watershed boundaries in NHD+ do not include their tributary 1st order basins. The GIC's modification creates new watershed polygons that are aggregates of all upstream polygons (e.g., 4th order watersheds contain all upstream 3rd, 2nd and 1st order polygons).

[9] Effective of statistical properties of distributions to define thresholds depends on a normal distribution of scores. Some distributions (e.g. highly skewed or bimodal) may be better interpreted by looking for natural breaks or using literature based criteria.

a) Screens could be applied as a series of filters, with failure in any metric resulting in elimination of the watershed from the candidate pool.

b) Alternately, a multi-metric index of stressors could be used to create a composite score for each candidate site and low scoring watersheds would be removed from the candidate pool.

The panel recommended the use of a hybrid approach, in which the multi-metric scoring would be used to screen watersheds, but "kill-switches" would be employed to eliminate watersheds that exceeded high impact thresholds for particular stressors (e.g., eliminate watersheds with > 10% urban landuse).

As an additional consideration, the panel recommended that the RCMP explore quantitative methods for deciding which impacts to use for selection. For example, some stressors may have a greater effect than others and, thus, should be weighted more heavily than relatively benign influences. A corollary would apply to data sets with different levels of confidence. For example, information about mine locations may be available, but not about which are actively contributing contaminants to streams.

ATtILA extension for GIS Landscape Analysis

http://www.epa.gov/esd/land-sci/attila/intro.htm

To quantify landuse activities occurring upstream of sites, the Ebert and Wade (2004) developed a user friendly interface that accepts a range of GIS data layers and produces summary statistics for areas defined by the user. The extension, Analytical Tools Interface for Landscape Analysis (ATtILA), is a plugin to ESRI's ArcView® (version 3.x) GIS software (ESRI Products) and takes advantage of ESRI's Spatial Analyst extension to run the spatial calculations.

- The ATtILA extension calculates the percentages of various landuse activities occurring in specified areas (urban; forested; agricultural-row crops; agricultural- orchards/vineyards; agricultural-total), other correlated measures of human activity (population density; road length; road density; road crossings/stream mile; percent impervious surface), and estimated nitrogen and phosphorus loadings.
- ATtILA can use polygons of any spatial extent as reporting units (e.g., entire upstream basin, local buffers)
- In 2007, the SWAMP program provided funds for a project to adapt the ATtILA extension to meet the GIS needs the RCMP process. Specific enhancements being developed include the ability to add custom stressor coverages, summarize point source data, and facilitate rapid adjustment of stressor thresholds for screening candidate sites. The project will be coordinated with the implementation of the RCMP
- It is expected that the capabilities of the modified ATtILA extension will expand as the RCMP process develops over time.

1.2.6 Identify candidate stream reaches within candidate watersheds[10]

After eliminating watersheds using GIS screens, the remaining watersheds represent potential candidates for the reference pool. These areas may be able to be further refined to further isolate candidate stream reaches (see Figure 8).

[10] An alternative strategy is to select candidate stream segments directly using analytical tools designed to work with the NHD+ datasets. Under this approach, confluence points would be the the reporting unit and NHD+ tools would summarize all upstream landuses. Errors in the current version of NHD+ (primarily problems with flowline connectivity) currently limit the effectiveness of this approach, but it may become more useful as NHD+ improves. The RCMP should remain open to both approaches and revisit this issue as new versions of NHD are released.

1.3 Use of local knowledge to add sites to the candidate pool

Although existing data and GIS searches will contribute the majority of sites to the candidate pool, a few sites may be added to the candidate pool on the basis of local knowledge. Local knowledge can sometimes help in identifying candidate sites because GIS datasets are imperfect and GIS screens may pass over good sites because of inaccurate or outdated disturbance information. These sites, however, should be critically evaluated because subpar sites based on local knowledge will dilute the quality of the reference pool. More rigorous evaluation of these sites should include examination of existing data.

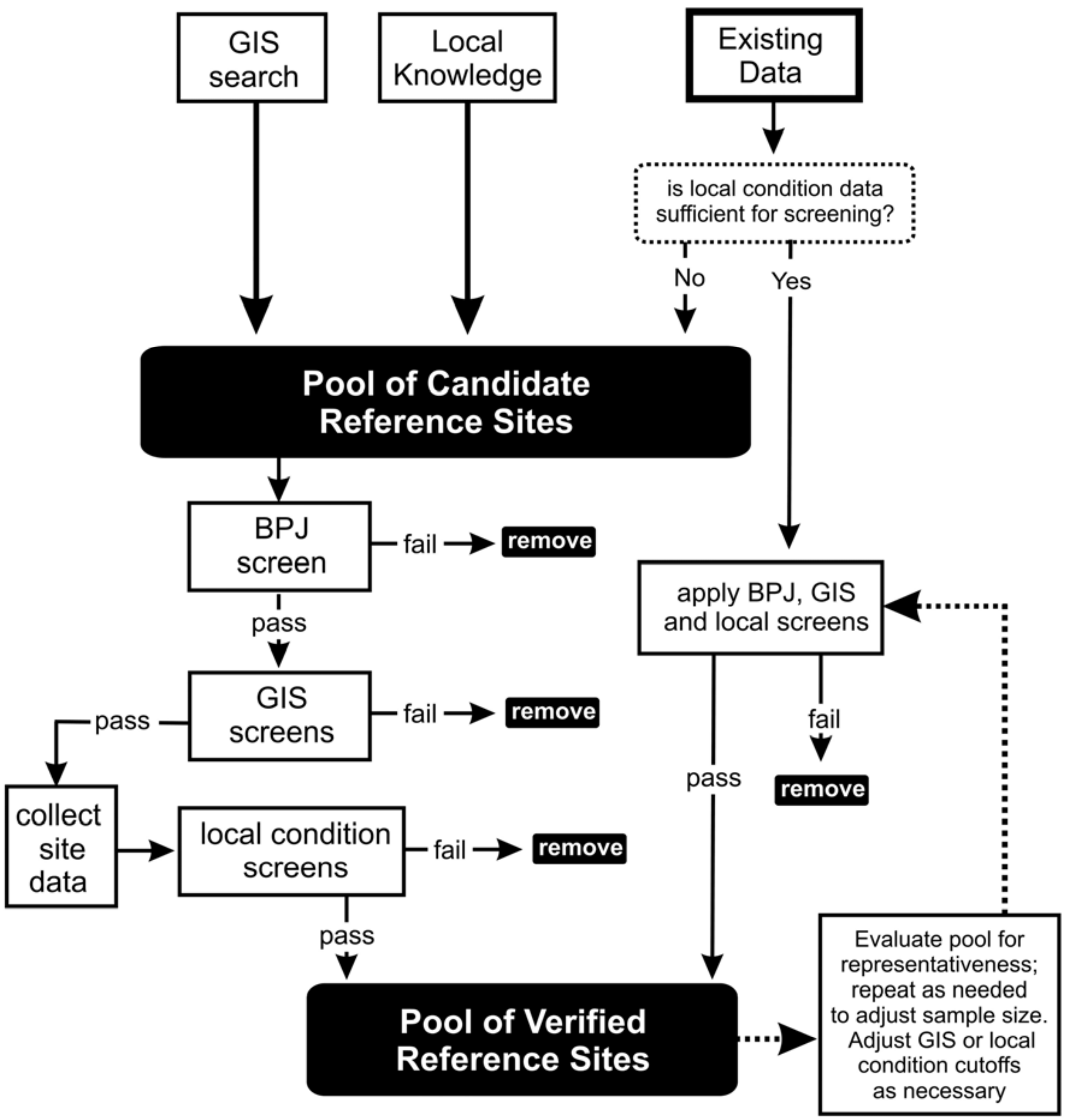

Figure 6. Schematic of the standard reference site selection and verification process.

APPENDIX 3

Table 1. Potential GIS data coverages for nonpoint sources.

NON POINT-SOURCE COVERAGES			
Information Type	**Data Source(s)**	**Notes**	**Coverage**
Landuse/Landcover	National Landcover Dataset (NLCD), MRLC	1992, 2001 satellite imagery, allows for 9-yr landcover change assessments	Statewide
Impervious Surface	NLCD, Others	Quality varies regionally	NLCD statewide, others patchy
Road Density	USFS, TIGER		Statewide, but patchy
Timber Harvest	CDF, THPs		
Vegetative Change/ Vegetative Change Cause (LCMMP)	USFS/CDF		Not Statewide
Population Density	Census Blocks, CDF	Produced in conjunction with decadal population censuses; censuses can be combined to estimate population change	Statewide
Grazing	Cattlemen's Association		Not Statewide
Fire History	CDF, USFS		Best for FS lands

Table 2. Potential GIS data coverages for point sources.

POINT-SOURCE COVERAGES			
Information Type	**Data Source(s)**	**Notes**	**Coverage**
Mining	USGS	Possibly outdated	Statewide
NPDES	EPA	Prone to inaccuracies	Statewide
303(d) listed streams	SWRCB	Every three years	Statewide
Water Diversions/ Extractions	USGS, NHD+	Possibly outdated	Statewide
Dams	CalWater	Doesn't include overflow info	Statewide
Stormwater Inputs	NHD+, Counties	Uneven coverages	Patchy
POTW	EPA	Prone to inaccuracies	Statewide
Landslide Datasets	CalTrans		Statewide

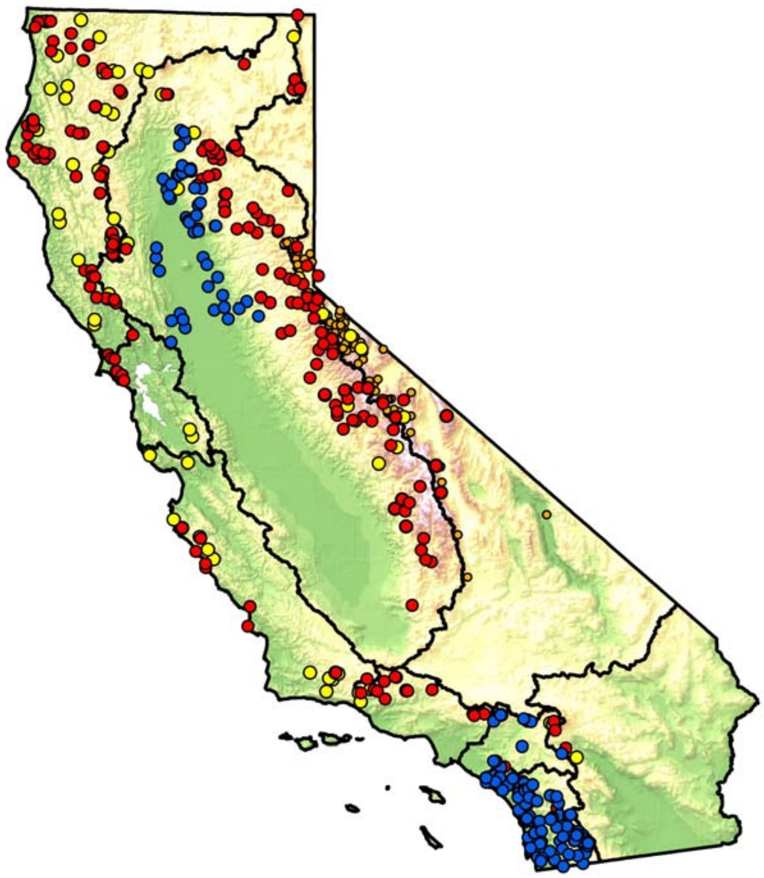

Figure 7. Partial set of bioassessment sites available for initial screens assigned to one of three tiers. Tier 1 sites (yellow circles) are EMAP and CMAP sites that passed a full suite of screens based on the most complete data for evaluation. Chemical and habitat thresholds were based on Stoddard *et al*. (2005) and landuse thresholds were based on Ode *et al*. (2005) and Rehn *et al*. (2005). Tier 2 sites (red circles) are USFS and Regional Water Board sites that have passed a less stringent screening process, but might very well be reference and need additional data before they either passed into Tier 1 or eliminated from the candidate pool. Tier 2 sites were screened based on land use, less extensive physical habitat data and limited or no chemical data. Tier 3 sites (blue circles) are cases in the Sacramento Valley, Sierra Nevada foothills and southern coastal California that probably need an alternative reference screening process (e.g., the factor ceiling approach). SNARL sites (orange circles in Eastern Sierra Nevada) used different screening thresholds, but are likely equivalent to Tier 1 sites.

2.0 Site Selection: Screening the candidate pool

Once a large set of sites is selected for the candidate pool, sites in the pool undergo a series of screening steps to either validate sites as appropriate reference sites or eliminate them from the pool. The major screening tools are: 1) expert opinion (BPJ), 2) landscape screens (GIS), and 3) local condition screens.

2.1 BPJ screens

While BPJ can play a role in identification supplementing the pool of candidate sites, it plays a bigger role in eliminating candidate sites. Sites should be eliminated on the basis of BPJ knowledge that there are known problems that aren't accounted for in GIS datasets. For example, GIS datasets may miss recent development, known pollutant spills, or nonpoint sources. This step should include coordination with local watershed groups, landowner groups and other stakeholders to eliminate inappropriate sites. The rationale for rejection should be documented.

2.2 Landscape scale screens (GIS)

Just as GIS techniques are essential for adding sites to the candidate pool (Figure 6), they also play a crucial role in reference site verification. The datasets and techniques used in this step are essentially the same as those used in searching for candidate watersheds/ stream segments, but the application of the tools differs somewhat. Whereas the GIS analyses were applied at a fairly coarse spatial scale in Section 1.2, GIS tools can be applied at multiple spatial scales during the screening stage.

The first step in the second GIS stage is to convert candidate watershed areas into specific sampling sites by selecting a common point on the stream segments in each watershed (e.g., the downstream confluence point), making them equivalent to other sites in the candidate pool (as in Figure 8a).

The chief benefit to the two-stage application of GIS techniques is that it gives us the opportunity to identify multiple sampling locations within reference watersheds.
While sites would normally be screened using stream confluence points as the candidate site locations, site locations could be moved to other points in the watersheds to identify additional reference sites within good watersheds or to avoid portions of the watershed with undesirable sources of human disturbance (Figure 8b).[11]

Using watershed delineation tools and local site buffering tools currently available for use with GIS software, polygons should be created to represent different spatial scales upstream of each site (e.g., the entire watershed draining to the site, the upstream area within a 5 km radius of the site, the area within a 200m buffer on either side of the stream within 1km upstream). Once created, these areas can be used as reporting units for

[11] Although the two stage application of GIS techniques gives us greater flexibility to identify multiple candidate stream reaches within each candidate watershed, an alternative strategy would be to eliminate the coarse search for watershed described in Section 1.2 and go straight to the more refined screening analysis indicated in Figure 8a.

ATtILA analyses. Metrics calculated for the different spatial scales can be screened as in Section 1.2.5.

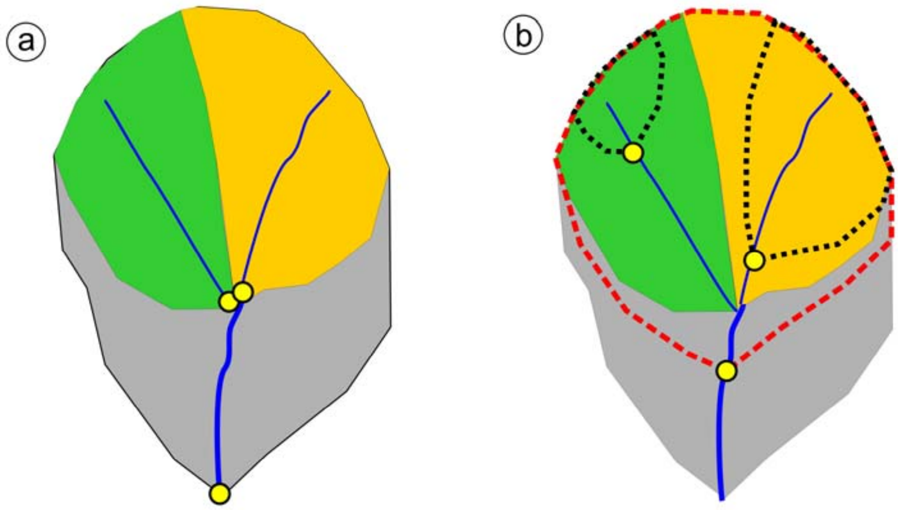

Figure 8. Illustration of alternative applications of the second stages of GIS analysis in the RCMP using a hypothetical second order watershed containing two first order watersheds: a) normal site locations represented by yellow circles, b) alternate site locations and their watershed boundaries (represented by dotted lines).

2.3 Local Condition Screens

Sites that have passed BPJ and GIS screens are then subjected to an evaluation of site scale stressors. Some of the local scale information can be obtained from aerial photography of sites, but the majority of this information will come from site visits and in some cases collection of water quality data.

2.3.1 Site scale data: Aerial photography

Aerial photography provides a unique view of potential site scale stressors. Digital orthophoto quadrangles (DOQs) are available for the entire state of California (DFG). Google Earth is another source of digital satellite imagery. DOQs and other sources of aerial photographic images can provide excellent information about local stressors not available through other sources, but are subject to the same timeframe limitations as other digital sources.

2.3.2 Site scale data: Site visits

The panel strongly recommended site visits as a crucial component of reference site verification. Once candidate list have been narrowed down to sites that meet BPJ, GIS and DOQ screens, land ownership should be determined for each site and owners contacted to obtain access permission and or sampling permits as needed. Site owners can also be contacted at this point to determine if there are any reasons for rejecting sites.

Field visits should be used to collect both qualitative (e.g., presence of obvious disturbances) and quantitative data (e.g., % intact riparian zone). Quantitative measures should focus on data that can be collected and analyzed cost-effectively.

2.3.3 Qualitative data

Visual assessments of site suitability should include a minimum set of observations:

- Upstream impoundments, or evidence of water withdrawal or diversion
- Evidence that the site is non-perennial
- Evidence of recent fire, flooding or landslides
- Local grazing impacts
- Presence of significant anthropogenic use (e.g., campgrounds, etc.)

2.3.4 Quantitative data

At a minimum, site visits should include characterization of physical habitat using the SWAMP Physical Habitat Procedures (Ode 2007) and conventional water chemistry. Physical habitat characteristics should include measures of both instream and riparian condition. SWAMP habitat procedures may be supplemented with riparian condition measures collected with the California Rapid Assessment Method (CRAM) for riverine wetlands. Water chemistry analyses should include the following analytes: chloride, turbidity, pH, total nitrogen, total phosphorus, conductivity, and alkalinity. Some chemical analytes may not be needed in all regions. For example, sulfate (a good indicator of mining activity) is not likely to be informative in xeric regions. One recommendation was to create a checklist of activities by region. Another option is to supplement with sediment and/or water column toxicity. While these tests may be expensive, they are less expensive than a screen for a long list of toxic constituents.

2.3.5 Combining site data for screening decisions

As with GIS screens (Section 1.2.5), there are many ways to combine site data to make determinations. The panel again recommended use of a hybrid approach in which site scale data is combined to calculate a multi-metric site condition score. The use of kill switches was also recommended for excessively high or low scores for individual habitat or chemistry.

3.0 Alternate strategies for selecting reference sites

While most regions of California can follow the standard approach for selecting reference sites, there are at least two large regions in California that lack sufficient high quality sites. The first is the Central Valley where natural landscapes have been almost entirely converted to agricultural and urban land uses. Most natural stream reaches in this region have been channelized or otherwise modified to support irrigation and flood control. The second is in coastal southern California (elevations below 1200 ft – upper elevations can follow standard model) where conversion to urban and suburban land uses has led to the channelization of most stream reaches. Recent studies in these regions demonstrate that at least some waterbodies in highly modified regions can support fairly rich BMI assemblages, even under considerable alteration and agricultural development (Griffith *et* *al*. 2003, deVlaming *et al*. 2004, deVlaming *et al*. 2005, Ode *et al*. 2005). Thus, there is enough range in biotic condition to differentiate degrees of impairment in these regions.

The panel recognized the unique limitations of these regions and recommended that a separate set of approaches be developed for them. Despite the differences in methodology, the goal of the alternate strategy is the same as the standard approach: to characterize the best attainable biological condition in these regions. This section outlines a set of approaches that the RCMP could follow. These fall into two general categories:

- Use a modified version of the standard approach
- Explore non-standard approaches

3.1 Modified use of standard approach

The first option is to use the set of techniques described for the standard approach, but to modify the way the techniques are applied. Modifications fall into two general types: 1) much greater emphasis on reach scale screening data, 2) use of less stringent criteria for rejecting sites.

One of the panel's philosophies is that potential reference sites in highly modified regions need a much larger amount of supporting data to verify their status than in less modified regions. In both the Central Valley and southern coastal California lowlands, streams exist in a landscape matrix with a universally high level of unnatural land uses. Furthermore, many streams have extensive flow manipulation, including water diversion, re-introduction, and inter-basin transfers that render watershed based tools irrelevant. For both these reasons, watershed based stressor analyses are less informative screening tools. Accordingly, much greater reliance should be placed on data collected from direct site visits than on remote sensing data. The panel recommended increased emphasis on riparian condition, instream habitat condition, and water column chemistry. In some cases, additional data (e.g., sediment and or water column toxicity) will be necessary to verify sites.

Selective relaxation of screening thresholds may also be an effective means of identifying the best available sites in a region. For example, acceptable road densities are likely to be much higher in southern coastal California than in other regions of the state. Likewise, acceptable local agricultural landuse percentages and acceptable levels of fine sediments are likely to be higher in the Central Valley than in less modified regions. While less stringent thresholds may help identify some of the best sites in highly modified regions, the use of kill switches is an essential safeguard against accepting unacceptably low thresholds. Specific cutoffs such as >10% local impervious surface, or toxin concentrations greater than the standards set by the California Toxic Rule may be more appropriate in these heavily modified landscapes.

A version of this modified standard approach was applied to search for reference sites in the Central Valley (Ode *et al*. 2005). Remote sensing data (e.g., landuse percentages) and other GIS datasets (e.g., pesticide application rates) was used as a coarse screening tool, but this data was de-emphasized in favor of riparian condition and instream habitat scores. This study identified approximately 20 potential reference creeks in the Sacramento Valley (see Figure 7), but these still need to be screened for water chemistry and toxicity before they are acceptable.

3.2 Non-standard approaches

Although modified use of the standard techniques can go a long way toward providing the data needed to adequately characterize biological expectations in these areas, it is unlikely to resolve the entire problem of identifying a sufficient number of candidate reference sites. The panel recommended the exploration of several different alternative, non-standard techniques:

- Select best sites using existing biological indices
- Species pool approach
- Factor-ceiling approach
- Model taxon preferences for limiting environmental gradients

All of the non-standard strategies suffer to a greater or lesser degree from circularity since the establishment of a biological reference site is being established with biological data. However, the extreme lack of reference sites in these regions requires us to consider accepting some circularity while adding additional steps to guard against the risks of circularity. The best way to guard against these risks is to use independent datasets to select the biotic response metrics.[12]

3.2.1 Use of existing indices to select sites with high quality biology

A straightforward alternate approach is to use existing biological assessment tools from the same region to identify sites that could be used to establish biological expectation in problem regions. [13] High scoring sites would be assumed to represent the "least disturbed" sites in the region. The method assumes that BMI assemblages in the target region have similar responses to anthropogenic stress as the region(s) for which the indices were created. Issues with circularity are mitigated by the fact that the scoring tools were derived objectively using independent datasets.

A variation on this approach is possible in regions where only a few reference sites can be identified (either using the standard methods or the modified standard described above). Under this variation, a model (either MMI or O/E) would be created using a small number of reference sites. Then new sites with similar BMI assemblages would be added to the reference pool and the model recalculated. This recursive approach results in more explanatory power because it is based on a larger number of reference sites, but it is inherently circular because the new sites are not chosen based on independent information.

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[12] Note also that some have argued that the circularity concern is less of a problem in highly modified systems than more pristine systems because relationships between metrics and stressors are simpler (Karr and Chu 1999).

[13]Examples of existing biological assessment tools include the Southern California IBI (Ode *et al*. 2005), northern California IBI (Rehn *et al*. 2005) and the California RIVPACS models (Hawkins unpublished).

3.2.2 Species pool

Another option is the species pool approach, which uses the total faunal diversity of a region (i.e., central valley or southern California coastal urban lowlands) to establish a biological condition axis. The process involves assembling a pool of all BMI taxa ever collected from the region, then using taxonomic richness as the measure of biological integrity at test sites. The inventory could be compiled from existing data sets, historical records (i.e., museums or other voucher collections), or directed field surveys. This technique assumes that richness is a good measure of condition, that there hasn't been extensive extinction of native fauna and that the constituent species in the pool are all potential colonists of any test stream.

The utility of this approach could be enhanced in at least two ways. The number of richness metrics could be increased by breaking richness out by taxonomic groups (midges, worms, mayfies, etc.), isolating the different information content in these groups. Further, the species pool could be modeled to associate expected taxa with key environmental gradients (i.e., substrate composition, elevation, etc.) and the proportion of taxa present at reference sites could be a potential target for attainment of reference state. If this approach were taken, then the species pool concept should be tested first in a region where identifying reference sites are not problematic as proof of concept.

3.2.3 Factor-ceiling approach

Carter and Fend (2005) developed a technique for defining a range of biotic expectation that takes into account the decrease in biotic condition caused by physical modification along an axis of increasing urbanization. In their example, a simple statistical technique (partitioned least squares regression, OLS) was used to identify the highest biotic scores along an urbanization gradient. Upper values define the range of expected biotic conditions for the region. Since a full urbanization gradient was used to take into account decreasing biotic potential with increasing urbanization, the resulting range of expected conditions is a conservative estimate of biotic potential for the region. While this approach could be used in both the Central Valley and southern coastal California lowlands, the method would work especially well in the Central Valley because the agricultural impact gradient is not as strongly confounded by elevation or other longitudinal gradients as the urban ones studied by Carter and Fend (2005).

The first step is to identify key measures of physical modification (hydrologic modification, channel modification, streambed modification) and to combine these into a multifactor axis of agricultural modification (i.e., the primary axis in a PCA of these stressors). The second step would be to identify appropriate metrics for detecting biotic impairment in valley streams.

3.2.4 Modeling taxon preferences for limiting environmental gradients

The final alternate strategy involves modeling taxon preferences for key environmental gradients, or limiting environmental differences (LED) and then using these relationships to select the most appropriate sites for setting biological benchmarks. Different habitat features (e.g., climate, channel morphology, water chemistry, substrate characteristics) can be thought of as acting as "filters" that select for particular species traits (Poff 1997).

This conceptual framework provides a way of accounting for the influence of both natural and anthropogenic factors on species distributions. Chessman and others (Chessman 1995, 2006, Chessman and Royal 2004, Chessman *et al*. 2008) recently developed a technique for using the tolerance or preference of individual taxa for key environmental filters (e.g., water temperature range, substrate composition, flow regime) to predict the assemblage of taxa that could be expected to occur at any test site under minimal human stress. Deviation from that expectation is used to infer degradation just as it is in predictive models (e.g., RIVPACS).

This is a promising approach; even the primitive assignment of taxa to simple preference classes used by Chessman and Royal (2004) resulted in stronger associations between their water quality assessments and independent measures of human disturbance than did the Australian predictive models developed from reference sites. They achieved similar results when applying the technique to fish assemblages (Chessman *et al*. 2007).

To adapt this to California's heavily modified regions, there is a need to develop models of the environmental affinities of Central Valley and southern coastal California lowland BMI taxa. It will likely take several years to collect enough samples to characterize individual BMI responses across key environmental gradients, but some of this data has already been collected and could be worked with now.

3.3 Combining approaches

The alternatives described in this section are not mutually exclusive; the RCMP could use more than one in each region. It is possible that not all approaches will work equally well in all regions and, as a result, different alternatives might be used in different regions. The panel was silent on which approaches, or which combinations of approaches should be prioritized.

The panel cautioned that using these non-standard approaches would require significant effort. Since these non-standard approaches have been used sparingly elsewhere, and essentially not at all in California, pilot studies looking into their applicability was recommended. The first step in the panel's recommendation was to evaluate existing datasets to determine if historical data exists for implementing any of these approaches. As mentioned in section 3.2.2, these approaches should be tested in a location where reference sites exist. Developing any non-standard approach needs to be ground-truthed before widespread use of the tool should be applied. Once this proof-of-concept occurs, then targeted data collection in one of the reference-poor regions can be initiated.

MANAGING THE REFERENCE POOLS

Accounting for natural variation

Classification of streams according to natural gradients can help partition natural sources of variation in biological assemblages and thereby improve our ability to detect deviation from reference condition (see Hughes 1995 for a review of the history of stream classifications). The RCMP needs to ensure that the regional reference site pools are representative of the most important regional gradients. The best way to test the representation of these gradients is through ordination of BMI datasets to determine which natural gradients explain most BMI variation in each region. Assessment of natural variation should include a periodic review of the suitability of the initial regional boundaries. The initial boundaries may either expand or contract and regions may need to be subdivided or merged as we gain more detailed information about the drivers of natural biological variation in each region.

However, since most regions do not have many reference sites to begin with, these analyses will have to take place iteratively as the program builds up a sufficient number of sites in each region. As initial guide, the panel recommended that the RCMP attempt to distribute sites to represent the following natural gradients:

- Stream size (stream order, discharge volume, etc.)
- Geology (with special attention to gradients in calcareous composition)
- Climate (temperature and precipitation)
- Elevation
- Reach slope (an important driver of stream morphology and substrate composition)
- Conductivity and natural nutrient gradients (associated with alkalinity)

The second component to site management is periodic review of sites in the reference pools to assess their continued suitability as reference sites. Conditions within stream reaches and in their upstream drainages can change over time (e.g., timber harvest, conversion of natural landscapes to agricultural or urban/suburban/exurban uses). Furthermore, we may discover sources of stress that were unknown when sites were initially added to the reference pools (e.g., discovery of point source discharges, mines, flow withdrawals/diversions, small-scale placer mining, etc.). Sites that fall into this category may be monitored to measure the impacts of these stressors, but they should be removed from the reference pools.

Dealing with natural disturbance

Natural disturbances such as forest fires, catastrophic floods and landslides can have a significant impact on biological assemblages and physical habitat conditions. As such, they can contribute considerable noise to reference distributions, thereby reducing the precision of biological assessment tools based on these distributions.

There are several competing philosophies for how to handle sites with recent natural disturbances. For example, Idaho's program flagged sites affected by natural disturbance to assess in parallel with other reference sites (Grafe 2004). In contrast, Oregon explicitly included these sites with other reference sites, as a means of incorporating natural disturbance as a component of natural variability (Drake 2003). The RCMP will keep these sites in the reference pools, but will not sample them after the disturbance. The appropriate time to avoid sampling disturbed reference sites is not currently known and should be the subject of targeted research or special study.[14]

[14] The San Diego Regional Water Quality Control Board has funded a multi-year project with the ABL to track biological assemblage recovery in reference and test sites following two large scale forest fires events in 2003 and 2007.

MONITORING STRATEGY

Monitoring Design

The primary question to be answered from the monitoring of the RCMP is "what is the expected natural composition of lotic freshwater organisms in each of the major biogeographical regions of California"? In order to answer this question, the panel agreed it is most important to gather information from a large number of sites in order to capture the full range of natural variability within a region. To collect this information in a spatially balanced and unbiased fashion, the panel advocated a probabilistic sampling design. Probabilistic designs were used in the REMAP, WEMAP, CMAP and PSA surveys in order to get unbiased estimates of stream condition and the approach for this design would be similar. In this case, the regional reference pool would represent the sample frame where sites would be selected at random for sampling. As in the PSA, these randomly drawn sites could be stratified to ensure the spatial distribution across natural gradients such as stream order, elevation, slope, geology, precipitation, or other factors.

An important secondary component to answering the monitoring question is to assess how the range of natural conditions changes over time. Certainly year-to-year variability can alter the distribution and abundance of organisms based on climatic conditions (i.e., wet vs. dry year, warm vs. cold year, etc.). Revisiting sites is the most powerful way to gather this type of temporal information. Two designs lend themselves to answering this question. The first would be to revisit a subset of the probabilistic sites. The panel favored this type of design, termed "rotating panel", because it provides both temporal and spatial variance terms. Urquhart and Kincaid (1999) and Larsen *et al*. (2004) describe the rotating panel strategy in more detail. However, a large number of potential reference sites are already being monitored on a regular basis. Provided these sites can pass the large- and local-scale screening criteria, the panel recommended sampling these sites as a cost-effective method to gain trends information at specific locations of interest. The main drawback to the targeted design, however, is the lack of ability to extrapolate to other reference locations.

Indicators and methods

Once the reference site pools are established, they can be sampled to meet the needs of a variety of programs. However, the panel agreed that a base program should monitor those indicators that are currently being used for SWAMP's statewide assessments (see PSA text box). These indicators include BMIs, physical habitat quality and basic water quality measurements. In some instances, enhancement of the indicators in certain regions or at certain sites may be needed to

Indicators sampled for the SWAMP Perennial Stream Assessment (PSA)

Biological
- BMIs
- Algae (diatoms, soft algae)
- CRAM riverine wetland methods

Physical Habitat
- SWAMP instream and riparian condition (derived from EMAP field protocols)

Chemical
- Nutrients (SRP, NO_2, NO_3,TP, TN, Si)
- Major ions (Cl^-, SO_4)
- SSC, turbidity
- pH
- Hardness, alkalinity, conductance

address local concerns. Region-specific enhancements were deemed acceptable as long as the base program is not handicapped to implement the enhancements. For example, additional biological indicators such as fish have been used by others (Hughes *et al*. 2005; Brown and Moyle 2005). Field and laboratory methods and quality assurance measures should also be consistent with SWAMP.

Number of reference sites

The appropriate number of sites to sample in each region depends on the extent of variation related to natural gradients, which is currently unknown for most regions. The panel therefore could not provide specific guidance on sample size. Instead the panel made two recommendations:

1. The RCMP should sample approximately 50 sites in each region to support assessments of natural variability. Intensification of sampling in initial years was recommended to establish the reference baseline, with potentially reduced intensity in later years.

2. The RCMP should conduct power analysis to determine the optimal sample size for assessing confidence in the statistical parameters of the distribution of biological metrics (Figure 9). For example, an assessment of variance at reference sites within a region can be calculated based on existing data (although not all regions have enough sites to support this at present). The inflection point of this power curve represents an efficient sample size where additional sites provide little improvement in confidence, yet fewer sites might dramatically broaden the confidence limits.

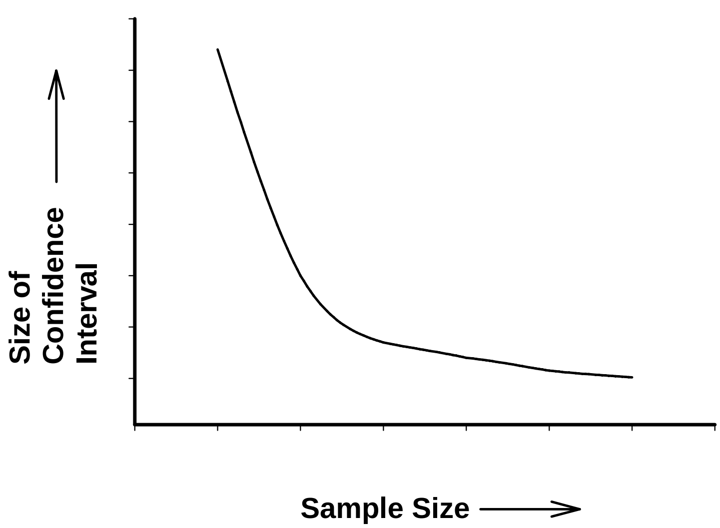

Figure 9. Example power curve defining sample sizes relative to site variability.

Sampling frequency
Sampling frequency affects trend detection. The optimal sampling frequency for trend detection is a function of sampling design. Trend detection as part of the probabilistic design is a function of number of sites (spatial variability), sampling frequency (temporal variability), amount of change to be detected, and other factors. The panel recommended a subset of probabilistic sites be sampled once within the appropriate index period for the region (should be consistent with the index period used for the SWAMP PSA). The recommended index period should capture a time frame where benthic macroinvertebrate communities are sufficiently stable to produce repeatable results, but prior to stress from late season flow reductions. Revisiting a subset of probabilistic sites each year will provide an estimate of interannual variability, thus improving large-scale trend detection. The proportion of revisited sites was not addressed specifically by the panel, but could be optimized using power analysis.

The panel agreed that targeted sites were an efficient way to assess long-term trend detection. Sampling frequency at targeted sites is a function of variability in the biological metrics, the amount of time required to detect a trend, and the amount of detectable change. The panel recommended that the RCMP use power analysis to establish the optimal sampling frequency (Figure 10). Once again, this could possibly be accomplished using data from existing sites that have been sampled for a number of years.

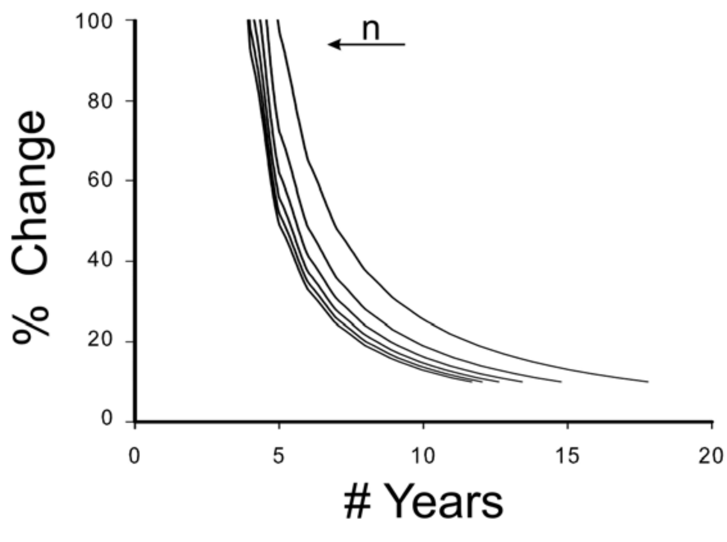

Figure 10. Theoretical power curves describing the relationship between the number of samples collected and the magnitude of detectable change at fixed sites. Individual curves represent different numbers of samples per year, with higher numbers toward the left of the figure.

ADDITIONAL RECOMMENDATIONS

Funding

Defensible bioassessment techniques and biocriteria require a reference condition program that can document both spatial and temporal variation. While the panel did not recommend a minimum level of funding, they advised that funding will need to be long term and stable. Several cost-effective strategies are available, but options discussed included trade-offs between probabilistic and targeted sites, optimizing sample size using power analysis (see previous section on sample size and frequency), and finding additional partners to help support the RCMP (see section below on collaboration). Regardless, SWAMP should prioritize some sampling effort every year to document annual variation in reference condition.

Inter-regional consistency

The RCMP should continue to focus on the issue of fostering consistency among the various regions of the state. Statewide assessments and comparisons among regions require a common currency for interpreting statewide assessments, and for inter-regional comparisons. However, this goal is complicated by the need for regional specific reference selection criteria. While the panel did not deliberate extensively on this topic, it recognized the importance of the issue and provided some initial guidance to help focus the thinking of the program. The main advice from the panel was that the objective of inter-regional consistency can probably not be resolved by the reference site selection process itself, but rather must be dealt with through data analysis and interpretation.

Development and application of assessment tools can be based on either regional reference pools or combined statewide reference pools. Regionalized assessment tools provide sensitivity to local environmental gradients and are more likely to pick up sites that deviate from the regional expectation. In contrast, statewide assessment tools would judge all of the state's sites on the same basis, but may reduce responsiveness to locally important gradients. Furthermore, we may have to accept that the performance of statewide analytical tools may vary regionally depending on the quality of the respective regional reference pools.

An example of an analytical solution is a hybrid approach in which both the regional and statewide indices are built and both tools are used to score test sites. Where both tools agree, there is relative certainty in the assessment of that site (i.e., both tools indicate reference-like or both indicate impacted). Where the tools disagree, a greater degree of relative uncertainty exists and additional information may be required to help interpret the status of that site (i.e., other indicators, additional sampling).

Collaborations/Coordination

Consistent with its policy to coordinate with other state and federal water quality monitoring efforts, SWAMP should seek opportunities to build partnerships with other state and federal agencies. Many of these entities have current reference programs (e.g., USFS, EPA, USGS), while others would benefit from joining an established reference program (e.g., Non-point Source Monitoring, State Parks, Irrigated Lands Program, Agricultural Coalitions, National Park Service, etc.). In addition SWAMP should explore ways to combine its bioassessment RCMP with other program components that would benefit from reference condition (e.g., CRAM, wetland monitoring, nutrient and sediment criteria monitoring).

The panel recommended exploration of ways to improve the types and quality of data used in GIS analyses. For example, the program could seek opportunities to coordinate with other state/federal/university efforts to enhance base layers like the NHD+ and stressor layers for quantification of grazing, timber harvest, pesticide application, etc. Further, the RCMP would should explore research efforts designed to improve prediction of specific stressor impacts and efforts to develop models that can be used to assess impact components that are not easily summarized by the ATtILA model. For example a model predicting sediment load (AnnAGNPS sedimentation model, USDA 2000) was applied by the University of Nevada, Reno. Other needs include estimating mining impacts, pesticide impacts and a means for summarizing the intensity of water manipulation within candidate areas.

Involving stakeholders in the process

It is often desirable to select sampling locations that occur on publicly owned land or land with easy access. Since it is important to sample streams from a truly representative set of sites within an area, it is often necessary to sample from reaches running through privately owned land. Reasonable efforts should be taken to obtain permission from landowners before rejecting candidate sites. This stage is very important and the quality of the final data set (and the ability to make inferences about reference conditions in the region of interest) will depend on the ability to obtain a representative set. The degree to which this stage is important varies regionally since some areas have more private ownership than others (e.g., western Sierra Nevada has many more publicly-owned lands than the interior chaparral).

Building effective relationships with local stakeholders (regional boards, watershed groups, landowner group, tribal groups, etc.) is clearly a critical part of making this reference site selection methodology work, especially in regions with a large degree of private ownership. To this end, implementation of this RCMP should include efforts to promote transparency in methods, encourage feedback and participation and explore opportunities to improve access to important privately held reference sites.

CONSIDERATIONS FOR OTHER FLOWING WATERS

The following section is not intended to be an exhaustive review of issues for defining reference conditions for these waterbodies, but a summary of the panel's preliminary guidance regarding issues that are likely to be important in these systems.

Large Rivers/ Non-wadeable streams
Large rivers are likely to require non-standard approaches to defining biological expectations because there are relatively few non-wadeable streams/rivers in the state and most receive the cumulative impacts of all human activities in their watersheds. Furthermore, several panelists suggested that standard chemical and physical habitat screening was unlikely to work in these systems. Screening criteria should include quantification of hydromodification, distance downstream from dams or other stressors.

Several of the alternative strategies could apply to these systems. Another alternative would be to target sampling at points along river just before they experience significant increases in sources of anthropogenic stress (e.g., where rivers in the western Sierra Nevada descend into the Central Valley).

Non-perennial streams
Non-perennial streams tend to have more variable biological assemblages than perennial streams. The standard approach should work for most of these systems statewide, but special attention should be given to classification of non-perennial streams by their degree of "intermittent-ness" in both space and time. The panel suggested that the RCMP should take advantage of current statewide vegetative mapping efforts to explore the potential for classifying non-perennial streams.

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MEMORANDUM

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DATE: 31 July 2009
TO: Phil Markle
FROM: Jerry Diamond, Ph.D.

SUBJECT: Reference conditions and bioassessments in southern California streams

All bioassessment methods depend on having appropriate reference conditions with which to base an assessment; i.e., bioassessment data for a given site cannot be accurately interpreted by themselves—interpretation or assessment of the site data is done within the context of the biology that can be expected to occur naturally, given the type of habitat present, the type of aquatic system, and the physiographic region (i.e., ecoregion) of the country (Stoddard et al., 2006). Identifying appropriate reference conditions for certain types of aquatic systems, habitats, and ecoregions can be problematic because of wide-scale human land use changes such as hydrological modification (e.g., dams, levees, concrete channelization), urbanization (e.g., increased runoff, removal of riparian vegetation, bank protection structures), and agricultural/ livestock effects (e.g., water removal for irrigation, removal of riparian vegetation).

Southern California (Los Angeles, San Diego and surrounding counties) is an area that has experienced intense land use changes over the past 50 years, particularly in terms of urbanization and its many environmental consequences (e.g., changes in the natural hydrology, changes in stream geomorphology, etc.). In particular, low gradient as well as low elevation streams in this region have been especially prone to land use effects. This situation has resulted in high uncertainty regarding appropriate reference conditions for low gradient and low elevation streams in this region.

This observation was identified in a Technical Report I and others at Tetra Tech prepared for the Los Angeles Regional Water Quality Control Board (Tetra Tech, 2005; 2006). In that report we evaluated stream biological condition with respect to a generalized human disturbance gradient in the region, as part of an EPA-funded project to evaluate the possibility of developing tiered aquatic life uses (TALU) for southern California coastal streams. Relying on SWAMP and other data for the region, we attempted to use the recently developed southern California IBI (SoCal IBI, Ode et al., 2005) to define certain attributes of the Biological Condition Gradient for the region, which could then be used to develop TALU (Davies and Jackson, 2006). We observed that the BCG should be different (i.e., expectations lower) for low versus high elevation streams in that project and that low elevation streams lacked a clear reference condition in this region.

Working with a Technical Advisory Committee (TAC) on this project (consisting of regional experts from California Fish & Game, State Water Resources Control Board, other Regional Boards, EPA Region 9, and universities), we identified a lack of appropriate reference sites for low elevation/low gradient streams as a critical data gap in moving forward with TALU. A fairly extensive search of existing biological data in the region by Tetra Tech and the TAC indicated that suitable reference sites at lower elevations and/or for lower stream gradients were not available with which to benchmark a biological condition gradient.

Subsequent to the above project, I have been working with the Southern California Coastal Water Research Project (SCCWRP) and the LA Regional Board in facilitating two workshops on TALU for the region. In the most recent stakeholder workshop (held June 2008), there was focused discussion on the issue of appropriate reference conditions, in which there was agreement that low gradient (rather than low elevation) was perhaps the most critical factor distinguishing stream biology in the region and that reference condition for low gradient streams (many but not all of which occur at low elevation) is a critical data gap (Schiff and Diamond, 2009). In fact, in the "road map" of projects developed from this workshop, defining reference condition for streams in this region was identified as one of the top priority needs.

Given the difficulty in identifying appropriate reference conditions for low gradient coastal streams in southern California, it is perhaps premature to set regulatory requirements based on biology observed at these types of sites. The TALU framework, as well as the regional stakeholder workshops (e.g., Schiff and Diamond, 2009) recognize that different hydrologic, geomorphic, and other habitat-related factors will dictate the biological characteristics that can be expected in a given stream. The type of aquatic life uses one can reasonably expect from a low gradient or modified stream in southern California, for example, are not the same as from a high gradient or natural stream, as our previous work has demonstrated. What is the expected biological condition for low gradient or modified streams in southern California is a question that needs more attention and, as noted by all stakeholders at the June 2008 workshop, incorporation of information using other assemblages (e.g., algae) in addition to macroinvertebrates.

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ATTACHMENT B
APPENDIX 5

Revised Analyses of Biological Data to Evaluate Tiered Aquatic Life Uses (TALU) for Southern California Coastal Streams

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December 8, 2006

DOC#1335290

Data Report: Revised Analyses of Biological Data to Evaluate Tiered Aquatic Life Uses (TALU) for Southern California Coastal Streams

Introduction

Under a previous work assignment with EPA Region 9 and the Los Angeles Regional Water Quality Control Board, Tetra Tech used available biological and habitat quality data (provided primarily by EMAP), as well as information provided by local and regional experts, to develop a preliminary Biological Condition Gradient (BCG), which is a framework that characterizes changes in biological condition going from undisturbed (reference) to very impaired conditions (Davies and Jackson, 2006). The range of potential impaired conditions encountered in the region constitutes the Generalized Stressor Gradient (GSG), which is a framework that characterizes changes in stressor attributes going from undisturbed to very impaired conditions (Davies and Jackson, 2006). In order to develop a defensible framework for tiered aquatic life uses (TALU), streams in the region need to be categorized with respect to their biological expectations considering the types of classes that either occur naturally or that are distinguishable based on what are major habitat alterations due to anthropogenic factors.

Since the initial work was completed by Tetra Tech, several other sources of macroinvertebrate and habitat data became available, primarily through California's Statewide Assessment and Monitoring Program (SWAMP) as well as other sources. These data provided substantially more information on the low elevation, urbanized streams in the region (e.g., in and around Los Angeles and San Diego), a major data gap identified by Tetra Tech in the previous work. As a result, we were able to more confidently identify the range of biological conditions currently observed in streams affected to varying degrees by anthropogenic alterations. Through these analyses, the revised results presented in this report should provide more confidence in terms of how streams might be classified in the region, and ultimately, potential tiered aquatic life use definitions.

Tetra Tech previously incorporated several suggestions from Technical Advisory Committee (TAC) members in the region regarding the types of attributes that should be considered in developing the BCG and the GSG for the region. As noted previously, certain attributes identified in EPA's national BCG framework were either modified or removed for the southern California region because they are either not relevant to this region or were better incorporated as part of the generalized stressor gradient (GSG). Key biological characteristics that were included in the BCG are: (1) Southern California IBI and component metrics developed by Department of Fish and Game (DFG) for macroinvertebrates; (2) fish assemblage information obtained from Drs. Jonathan Baskin, Thomas Haglund, and Camm Swift; (3) and algae diatom information obtained from EPA's Rapid Bioassessment Protocols and Western EMAP sources.

This revised report updates the macroinvertebrate attribute information for the BCG based on the new data evaluated. Presented here is a conceptual BCG that is intended to serve as a precursor to a final, fully calibrated BCG that could be used in the TALU framework or in Use Attainability Analyses (UAA). Other biological information was not updated in this exercise. We would note that new periphyton information being collected in the region by the Southern California Coastal Water Research Project (SCCWRP) and by Tetra Tech could be very useful in further refining the BCG in the future. We would also note that the TAC felt that the BCG attribute long-lived or regionally endemic species may be especially useful in terms of discriminating biological condition over the stressor gradient in this region. This attribute is characterized mostly in terms of vertebrate species information (number or types of fish, amphibian and reptile species) since these species are relatively long-lived and/or endemic to a particular drainage or watershed in this region. The TAC agreed that better information concerning these types of species would be very beneficial in refining the BCG and perhaps aquatic life uses as well.

Data Sources

Additional macroinvertebrate data used in these analyses were obtained from California Department of Fish and Game (Pete Ode) and from EPA Region 9 (Terry Fleming). Data for approximately 1700 benthic macroinvertebrate samples and physical habitat assessments were compiled, along with geographical coordinates at over 300 sites in southern California between 1998 and 2005. Biological data included data for the seven different metrics, which comprise the Southern California IBI (SoCal IBI), as well as the IBI score for each sample (Table 1). Habitat assessments were based on the Rapid Bioassessment Protocols (Barbour et al. 1999) and included data scores for the 10 different parameters on a 0-20 scale (0 poor, 20 optimal) as well as the total habitat score for each site (Table 1).

Table 1. Biological metrics and physical habitat parameters used in analyses.

Biological Metrics	**Physical Habitat Parameters**
EPT taxa	Epifaunal substrate
Intolerant taxa percent	Sediment deposition
Predator taxa	Embeddedness
Coleoptera taxa	Riffle frequency
Non-insect percent	Channel alteration
Tolerant taxa percent	Channel flow
Collector percent	Bank vegetative protection
	Bank stability
	Velocity/ depth regime
	Riparian zone width
Southern California IBI	**Total Habitat Score**

In addition to instream physical habitat measures, the stressor gradient was characterized by landscape influences on sampling locations. For each location, 5 km radius circles were delineated and land use/land cover (LULC) percentages (MRLC 1992) were calculated within these circles to represent general landscape activities in the vicinity of the sample sites. These LULC percentages were used to calculate a Landscape Development Intensity (LDI) index (Brown and Vivas 2006) that weights each land use type base on the energy that each uses. Potential LDI index scores range from 1 to 10 with 1 representing natural systems and 10 representing the most intense urban land uses. Agricultural land uses have LDI coefficients between 2 (low intensity pasture) and 7 (high intensity feed lots, dairy farms, etc.). Urban land uses have LDI coefficients that range between 7 (low density residential) and 10 (central business district). This LDI index is used as another indicator of the stressor gradient as it serves as a surrogate for chemical and hydrologic impacts, which may not be included in instream physical habitat measures. LDI has been used by Florida in its biological assessment program (Fore 2004) and is particularly useful for distinguishing an urbanized gradient.

Preliminary Stream Classification

Natural variations in streams of this region can be attributed generally to differences in elevation. Through basic knowledge of the study area, as well as inspection of aerial photographs, it was determined that an elevation of 1200 feet appeared to be a relatively reliable threshold for distinguishing between higher and lower gradient stream systems. Using this elevation threshold, four types of site classes were identified with which BCG attributes were evaluated:

1) natural high elevation foothills (>1200 ft),
2) natural low elevation (<1200 ft),
3) low elevation partially altered channel or riparian zone,
4) low elevation concrete-lined channel.

Sites were grouped into one of these categories based on visual inspection of aerial photographs of each site and its surrounding area. These four stream classes cover the range of stressor and biological conditions observed in the Southern California Bight region. In addition, these four classes were clearly distinguishable from each other visually and were thought to be distinct ecologically as well.

Stressor Measures in Relation to Stream Classes

Median habitat scores were related to natural and anthropogenic influences as represented by the four site classes (Figure 1). Habitat scores were also related to LDI index scores, demonstrating a relationship between habitat quality and overall landscape stress (Figure 2).

Macroinvertebrate Data

BCG attributes that were refined based on the updated macroinvertebrate data included attributes 3, 4, and 5. Other BCG attributes remained unchanged from the previous version developed by Tetra Tech because there were no new data or other information that would help further refine other BCG attributes. In conducting these analyses, we compiled relevant macroinvertebrate metric data for each attribute by stream class as defined in previous work and as noted above. One of the key questions examined in this exercise is whether the initial classifications used previously continue to be scientifically defensible given the more extensive biological data made available.

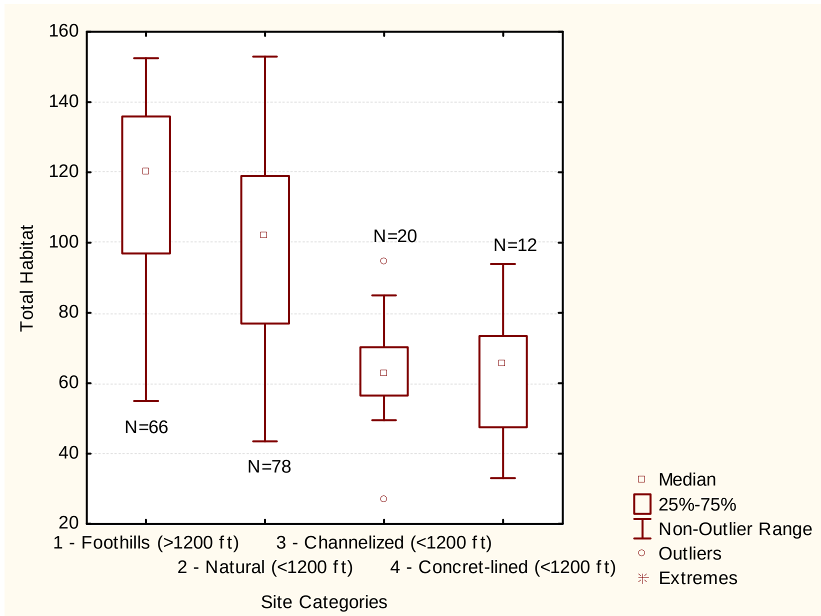

Figure 1. Total habitat scores organized among four site categories

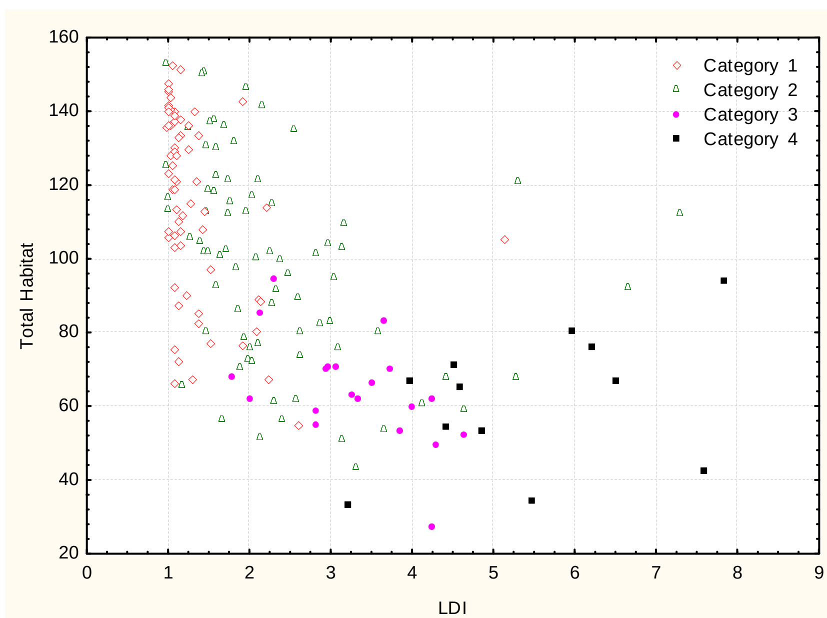

Figure 2. Total habitat scores versus LDI index scores organized among four site categories.

Scatterplots of the SoCal IBI and biological metrics versus habitat assessment score and LDI index score were used to examine relationships between habitat condition and overall landscape stress on macroinvertebrate assemblages. In addition, biological data were categorized according to the four site classes to illustrate variability within site classes in terms of response to stress. Non-parametric Kruskal-Wallis tests (at an alpha = 0.05) were used to statistically evaluate differences in results among the four site categories.

Results

Southern California IBI scores ranged from 0 to approximately 90 and about 60 percent of the sites were impaired according to the classifications developed by Ode et al. (2005) (i.e., IBI scores less than 40) (Figure 3). For the two selected metric distributions (Figure 3), about 8 percent of the sites had no EPT taxa and approximately 40 percent of the sites had percent non-insect less than 10%. Sites located above 1200 ft elevation generally had higher IBI and sensitive metric scores than those found below 1200 ft (Figures 4 and 5). Approximately 30 percent of the sites above 1200 ft were impaired, while 80 percent of the sites below 1200 ft were impaired and half of these were rated as very poor. For the non-insect percent metric, about 50 percent of the sites above 1200 ft had non-insect percents less than 20%, while about 70 percent of the sites below this elevation had values less than 20%. EPT taxa values had relatively similar distributions among the two elevation categories.

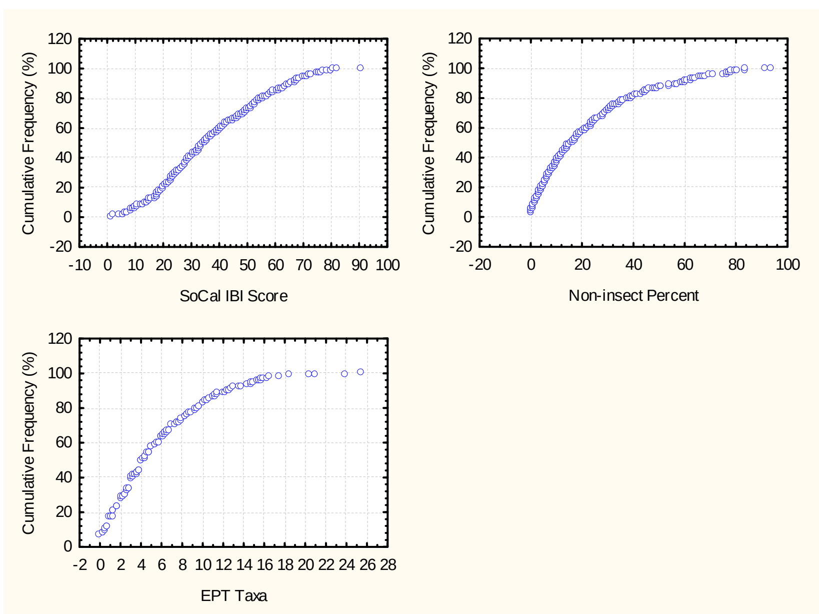

Figure 3. Cumulative frequency distribution plots for the SoCal IBI and two example metrics, intolerant percent and EPT taxa.

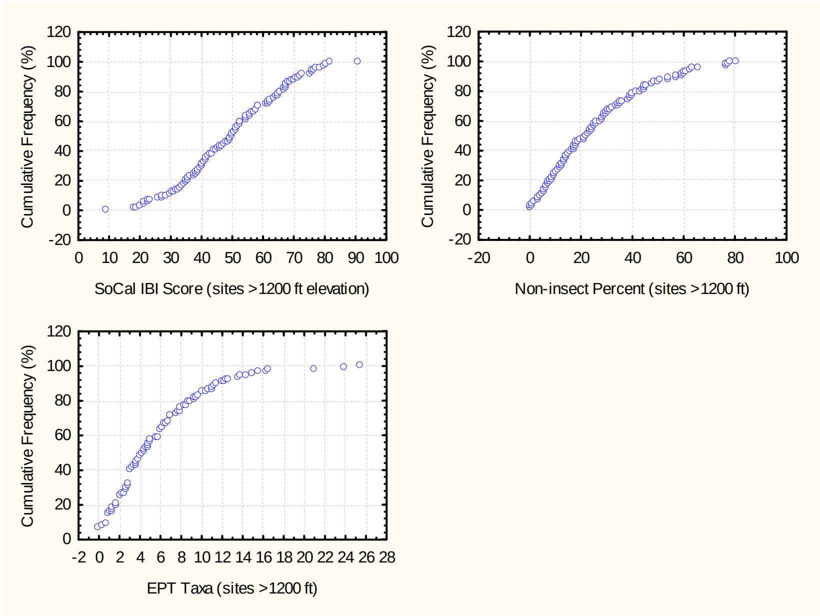

Figure 4. Cumulative frequency distribution plots for the SoCal IBI and two example metrics for sites located at elevations greater than 1200 feet.

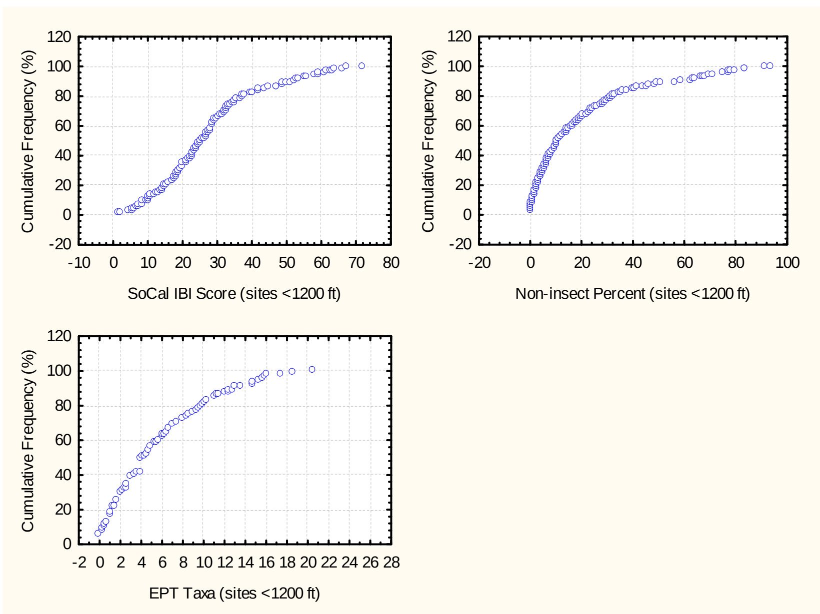

Figure 5. Cumulative frequency distribution plots for the SoCal IBI and two example metrics for sites located at elevations lower than 1200 feet.

Southern California IBI

As shown in Figure 6 the SoCal IBI scores were higher in natural channel sites (both >1200 ft and <1200 ft) than at human-altered sites (both partially altered and concrete lined categories). A non-parametric Kruskal-Wallis test confirmed that the two natural categories (1 and 2) were significantly different (p<0.05) from one another and each was significantly different from both of the human-altered site classes (3 and 4). SoCal IBI scores, however, were not significantly different between the two altered site classes. The following summarizes relationships regarding three of the BCG attributes that were subject to change based on the additional data in this analysis, and site classification. The three BCG attributes examined were: (1) sensitive ubiquitous taxa, (2) taxa of intermediate tolerance, and (3) tolerant taxa.

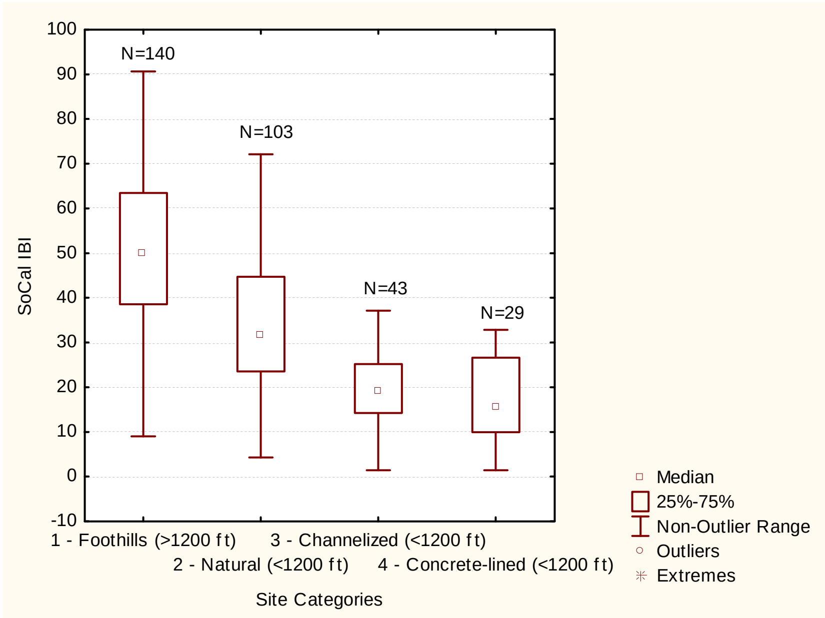

Figure 6. Southern California IBI scores in relation to the four site class categories used in this evaluation.

Attribute 3: Sensitive Ubiquitous Taxa

The Southern California IBI developed by DFG and others (Ode et al. 2005) includes four metrics that represent sensitive ubiquitous macroinvertebrate taxa: intolerant percent, number of EPT taxa, Coleoptera taxa, and number of predator species. All four sensitive ubiquitous taxa metrics showed similar patterns in response to the four site class categories (Figure 7). For intolerant percent, EPT taxa, and Coleoptera taxa, the two impacted classes of sites did not appear to be different from one another. For all four metrics, values for the two classes of natural sites were noticeably different from the two impacted classes. Additionally, the foothills class (i.e., category 1) was substantially different than the other natural site class (<1200 ft). A Kruskal-Wallis test on all the four metrics showed that all groups were significantly different (p<0.05) from one another, except the two altered classes which were statistically the same. Although predator taxa values among the two impacted classes (3 and 4) appeared different (Figure 4), the Kruskal-Wallis test indicated that this difference was not significant at an alpha level = 0.05.

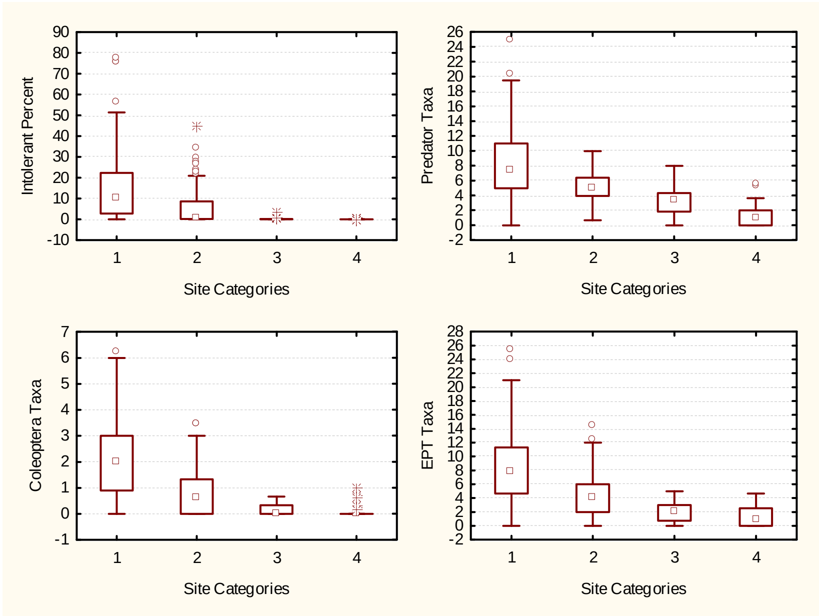

Figure 7. Intolerant percent, predator taxa, Coleoptera taxa, and EPT taxa reported in benthic samples as a function of four site class categories (see text for description of site categories).

Attribute 4: Taxa of Intermediate Tolerance

The SoCal IBI does not have a metric that includes only intermediate tolerant taxa. However the TAC recognized certain taxa that they considered to be representative of this attribute. These taxa included the caddisfly *Hydropsyche*, the mayfly *Baetis*, and elmid beetles. Dominance of these taxa is thought to signify fair – poor biological condition in this region. However, Figures 8 and 9 suggest otherwise – *Baetis* and *Hydropsyche* percent were lowest in site categories 3 and 4 (altered channels) and declined in response to increasing landscape disturbance as represented by LDI scores. Kruskal-Wallis tests confirmed these differences. Percent *Baetis* was significantly different ($p<0.05$) between category 1 and the two altered classes and category 2 was significantly different from category 4. The two natural stream class categories, as well as categories 2 and 3, and 3 and 4, were statistically the same. For percent *Hydropsyche*, the two natural categories were statistically the same, as were the two altered categories; otherwise, all categories were significantly different from one another.

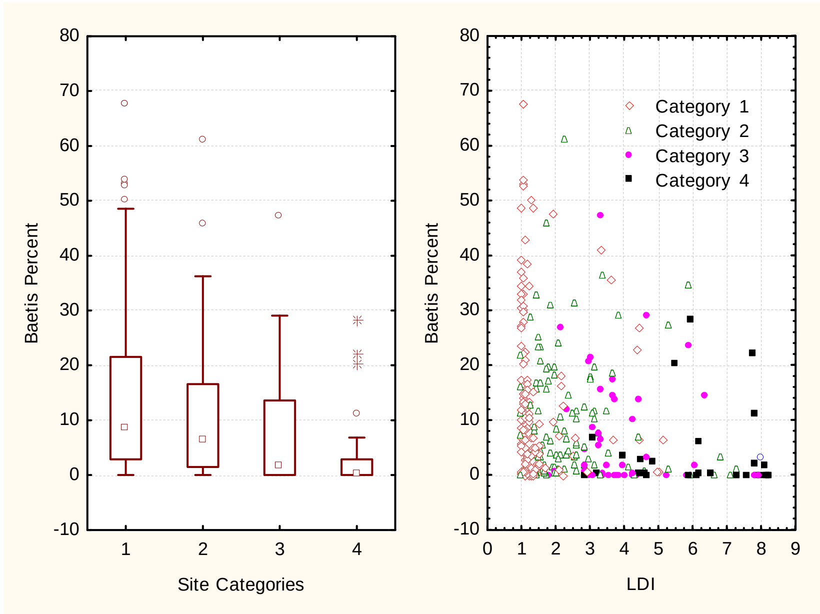

Figure 8. Baetis percent among four site categories and plotted versus LDI scores

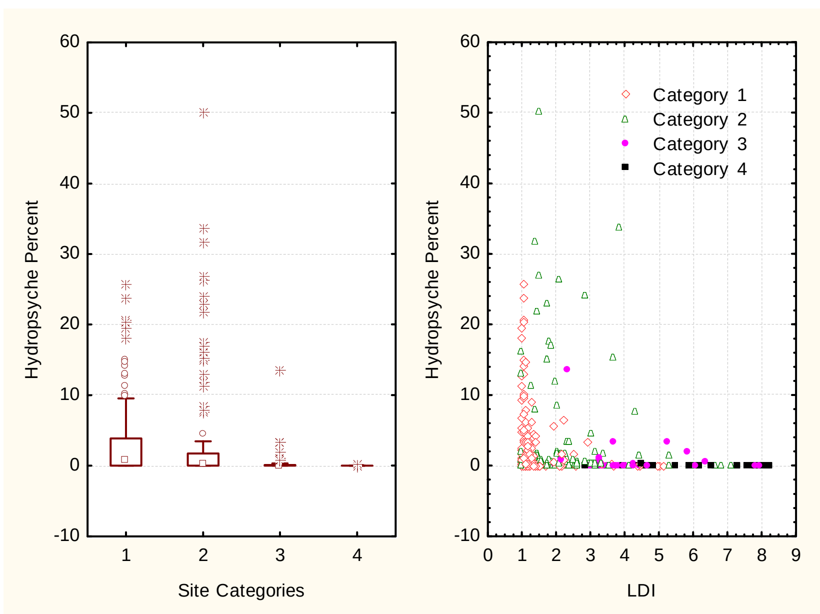

Figure 9. Hydropsyche percent among four site categories and plotted versus LDI scores

Attribute 5: Tolerant Taxa

The SoCal IBI includes three metrics that are indicative of tolerant taxa: percent collectors, number of non-insect taxa, and percent tolerant taxa. The percent collector metric showed a gradual increase from natural foothill (>1200 ft) streams (Category 1) to the concrete lined channels (Category 4) (Figure 10). Non-insect and percent tolerant metric scores were actually higher at the partially-altered sites than at the concrete lined sites. In fact, for these two metrics, concrete-lined channels appeared to be similar to both types of natural stream classes (Categories 1 and 2). A Kruskal-Wallis test on the non-insect taxa metric values indicated that categories 1 and 2 (natural sites) were not significantly different (p>0.05) from category 4 (concrete-lined channels); all other categories were significantly different from one another. For the percent tolerant metric, categories two and three were statistically the same as category 4, while category 1 was significantly different from all the other categories. A Kruskal-Wallis test on the percent collector metric indicated that all categories were significantly different from one another except categories 2 and 3 (low elevation natural channel and channelized), which were statistically the same.

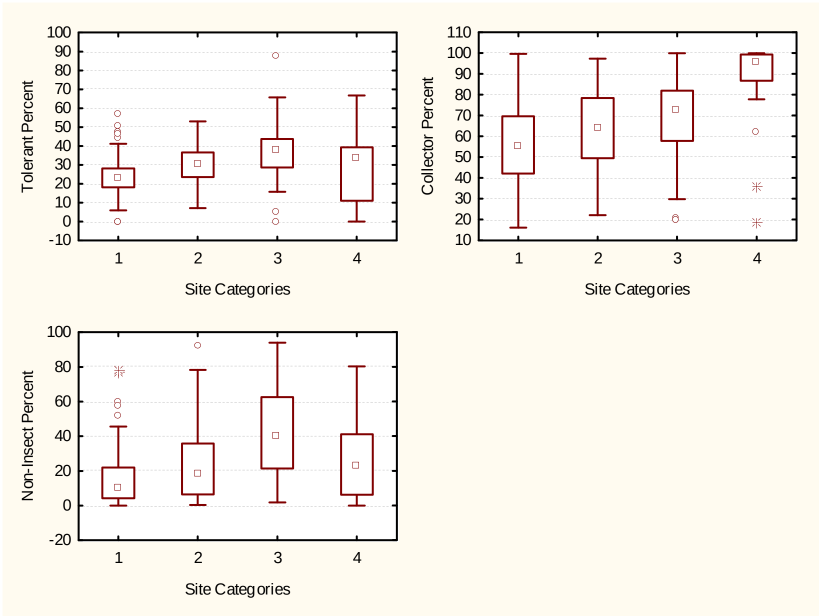

Figure 10. Percent tolerant taxa, percent collector taxa, and percent non-insect taxa reported in benthic samples as a function of four site class categories (see text for description of site categories).

Refinement of the BCG

Based on our method of site classification, we could not distinguish biologically, partially altered channels from concrete-lined channels for the majority of metrics, as well as the SoCal IBI; i.e., the concrete-lined channels can apparently achieve biological condition levels similar to those observed in partially altered low elevation streams. As we observed in the previous work, higher elevation streams have a higher biological expectation than lower elevation streams in the region, independent of the degree of channel alteration. In addition, the types of taxa often observed in the higher elevation cooler streams is different than those observed in the warmer lower elevation streams. This is borne out by the fishery information as well. While the exact elevation threshold to be used to separate low from high elevation stream classes is somewhat flexible (we used 1200 feet elevation), there are scientific data to support distinguishing higher elevation streams from lower elevation streams in terms of biological expectations. Use

Attainability Analyses might be necessary in some cases to clarify whether a borderline stream segment belongs to the lower or higher elevation stream class.

Figures 11 and 12 show relationships between the SoCal IBI, its component metrics, and increasing stress, as measured by either stream habitat quality score or the LDI index. The SoCal IBI and metrics were generally responsive to habitat degradation (Figure 11) and overall landscape alteration (Figure 12). Particular metrics that appeared most related to both habitat and LDI scores are percent tolerant taxa, predator taxa, and EPT taxa.

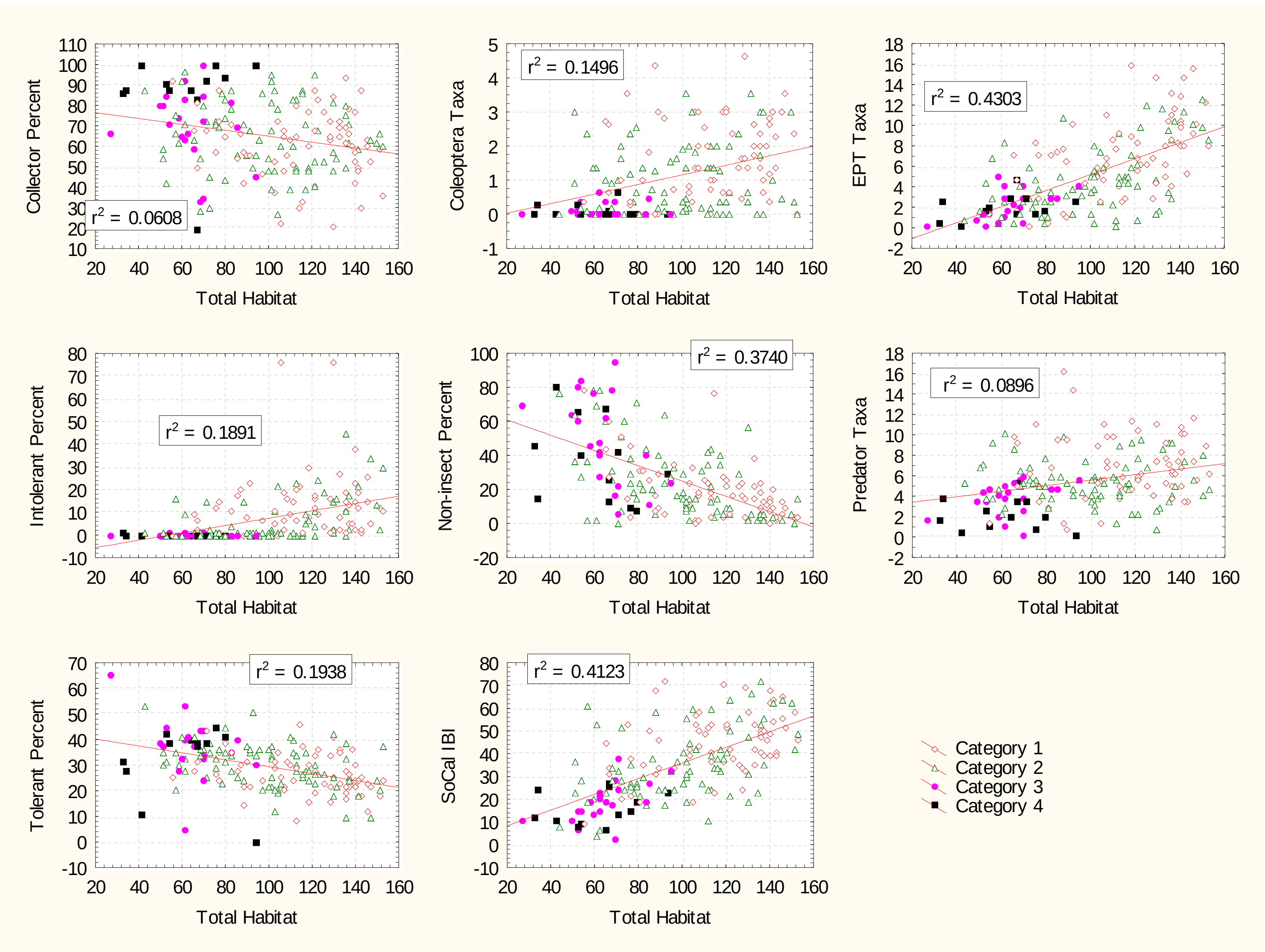

Figure 11. SoCal IBI and associated metrics versus total habitat scores organized among four site categories. All correlations were significant ($p<0.05$).

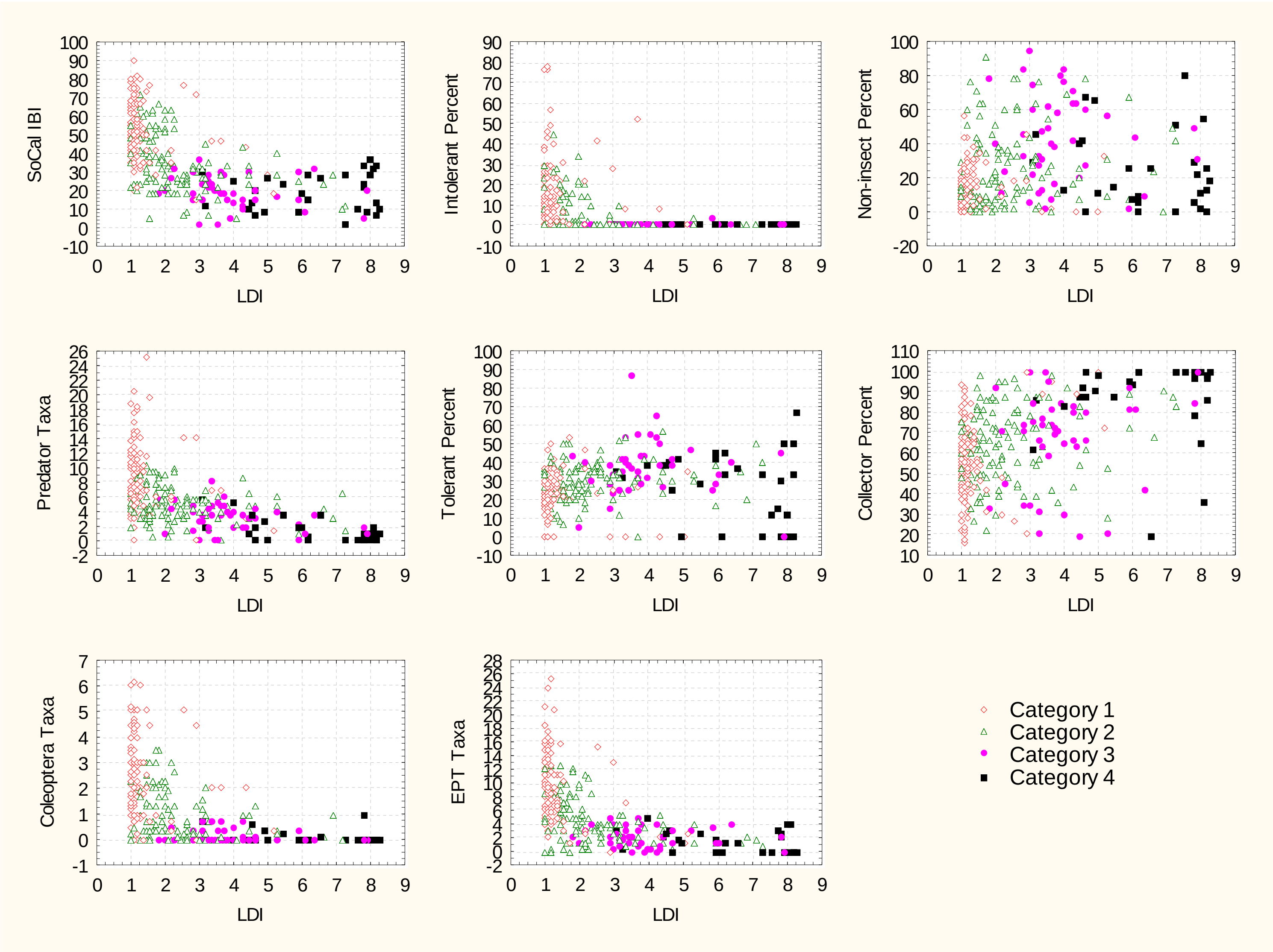

Figure 12. SoCal IBI and associated metrics versus LDI index scores organized among the four site class categories.

Tables 2 and 3 present the revised BCG incorporating the findings observed in the present analyses. In higher elevation streams, some sites appeared to be fairly pristine, as judged by a completely naturally vegetated land cover for many miles around the site. The macroinvertebrate assemblage at these sites showed all the signs of being minimally disturbed (i.e., true reference sites *sensu* Stoddard et al., 2006) and the TAC acknowledged this as well. Therefore, there is the possibility that the natural condition (i.e., BCG level 1) is known and quantifiable for Attributes III and V, and perhaps other attributes, for higher elevation streams in southern California (Table 2). Definitions for Attributes III and V in terms of macroinvertebrate indicators were updated based on the current analyses. Attribute IV (intermediate tolerant taxa) was not updated and it is not clear whether this attribute is relevant to southern California streams. Taxa that are thought to be intermediately tolerant (e.g., *Baetis*, *Hydropsyche*), did not display the expected trend with increasing stress, as measured by either habitat quality or LDI. Other studies have found that taxa of intermediate tolerance are found in roughly similar proportions across BCG tiers 2-5, representing a wide variety of conditions (Gerritsen and Leppo, 2004; Gerritsen and Jessup, 2006). Perhaps other faunal or algal indicators are more discriminating in terms of this attribute.

For lower elevation streams, it is not clear whether truly natural, unimpaired sites still exist in the southern California bight. However, at least a few low elevation sites displayed IBI and metric values approaching the highest scores found anywhere in the region. This may, of course, be a natural outcome of how the IBI was developed. As a placeholder, BCG level 1 (native condition) was defined for Attributes III and V for macroinvertebrates based on a compilation of the best metric scores observed for all low elevation sites combined (total of 175 sites; Table 3). Again, intermediately tolerant taxa (Attribute IV) may not be an informative attribute in terms of macroinvertebrates for this region. Number of Coeloptera (beetle) taxa is thought to be another indicator of sensitive ubiquitous taxa (Figure 7); however, the total number of taxa observed in the dataset (6 taxa) is few, making it difficult to discern fine differences with stressor level. Therefore, this metric was removed from the BCG table pending more information.

Among lower elevation streams, there are currently some differences in biological condition between natural and human-altered streams. However, while available habitat quality data suggests several factors that are different between the two types of streams (e.g., substrate heterogeneity and stability, channel sinuosity and complexity, riparian condition quality), it is unclear what is potentially attainable in the human-altered streams in the region (i.e., a least disturbed condition). When low elevation streams are examined with respect to increasing stress (as measured by either the habitat quality index or the LDI index), we can distinguish two separate classes corresponding to relatively natural channels and those that are altered hydrologically on the basis of certain metrics such as percent collectors. However, there appear to be more similarities than differences in terms of biological expectations between these two classes (Figure 10). Using the BCG framework, the best achievable condition (not necessarily best attainable) for altered low elevation streams in the region corresponds to a BCG level of 4, an LDI index score of approximately 4, and a SoCal IBI score of approximately 37 (Figure 12). The best achievable score for a given site, based on this dataset for the more natural channel low elevation streams appears to correspond to a BCG level of 2, an LDI index score of 2, and a SoCal IBI score of 72. No one site appeared to meet all of the indicator criteria identified under BCG level 1 for low elevation streams.

Table 2. Biological Condition Gradient Matrix: California Bight (High Elevation; >1200 ft)

	Biological Condition Gradient					
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	6 **Very Poor** Radical changes in structure of the biotic community and major loss of ecosystem function
Ecological Attributes	Native structural, functional and taxonomic integrity is preserved; ecosystem function is preserved within the range of natural variability	**Minimal** changes in structure due to loss of some rare native taxa; shifts in relative abundance of taxa but Sensitive-ubiquitous taxa are a dominant component; ecosystem functions are fully maintained through redundant attributes of the system;	**Some** changes in structure due to loss of sensitive or rare native taxa; shifts in relative abundance of taxa but Sensitive-ubiquitous taxa are common and abundant; ecosystem functions are fully maintained through redundant attributes of the system	**Major** changes in structure due to replacement of some Sensitive-ubiquitous taxa by more tolerant taxa,; overall balanced distribution of all expected major groups; ecosystem functions largely maintained through redundant attributes	Sensitive taxa are nearly absent; conspicuously unbalanced distribution of major groups from that expected; organism condition shows signs of physiological stress; system function shows reduced complexity and redundancy; increased build-up or export of unused materials	Extreme changes in structure; wholesale changes in taxonomic composition; extreme alterations from normal densities and distributions; organism condition is often poor; ecosystem functions are severely altered
I Historically documented, long-lived or regionally endemic taxa Relies on fish and other vertebrates; May need to break out by basin*	As predicted for natural occurrence except for global extinctions (e.g., unarmored 3-spine stickleback, Pacific Treefrog, California newt, or garter snakes present); steelhead and lampreys in foothills.	As predicted for natural occurrence except for global extinctions; 3-spine stickleback present in lowland;	Some may be absent due to global extinction or local extirpation; 3-spine stickleback rare or extirpated	Some may be absent due to global, regional or local extirpation	Usually absent; stickleback very rare or absent.	Absent

* LA Basin may have historically more endemic fish species than either San Gabriel, Malibu, San Diego drainages. Also need to distinguish upland from lowland sites. Trout more upland; sticklebacks and sculpins lowland. Most long-lived species extinct in region; may be similarity between long-lived or endemics and sensitive-rare species.

Table 2. Biological Condition Gradient Matrix: California Bight (High Elevation; >1200 ft)

Biological Condition Gradient						
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	6 **Very Poor** Radical changes in structure of the biotic community and major loss of ecosystem function
II Sensitive-rare taxa (currently rare)*	As predicted for natural occurrence, with at most minor changes from natural densities Sculpin (Cottus asper) (Ventura); lamprey adults in upland streams) red-legged frogs present; 3 spine armored stickleback	Virtually all are maintained with some changes in densities	Some loss, with replacement by functionally equivalent Sensitive-ubiquitous taxa	May be markedly diminished	Absent	Absent
III Sensitive-ubiquitous taxa [% intolerant individual EPT]	As predicted for natural occurrence, with at most minor changes from natural densities Partially armored Stickleback common; speckled dace species present in upland streams. Trout present in higher elevation streams. > 40% Intolerant; > 22 EPT taxa; > 20 Predator taxa	Present and abundant; > 16 EPT taxa > 14 predator taxa; > 30% intolerants Diatoms main form of periphyton; Achnanthes oblongella, ventralis; Cymbella amphioxys, gracilis, Amphora inariensis	Common and abundant; ≥10 EPT; ≥ 11 predator; >20% intolerants	Present but some replacement by functionally equivalent taxa of greater tolerance. ≤10 EPT, ≤ 11 predator, < 20% intolerants	Frequently absent or markedly diminished; less sensitive EPT (e.g., Baetidae) may be present but not more sensitive taxa. < 7 EPT; < 6 predator; < 4% intolerants	Absent ≤4 EPT taxa; <2% intolerant; <3 predator taxa

Table 2. Biological Condition Gradient Matrix: California Bight (High Elevation; >1200 ft)

Biological Condition Gradient						
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	
IV Taxa of intermediate tolerance	As predicted for natural occurrence, with at most minor changes from natural densities Native sucker present Western toad Common stickleback	As naturally present with slight increases in abundance	Often evident increases in abundance Diatom species include: Achnanthes biasolettiana, Cymbella sinuata, Denticula tennis, Fragilaria construens, Navicula capitata.	Common and often abundant; relative abundance may be greater than Sensitive-ubiquitous taxa	Often exhibit excessive dominance	May occur in extremely high OR extremely low densities; richness of all taxa is low
V Tolerant taxa [non-insect taxa %tolerant taxa Collectors]	As naturally occur, with at most minor changes from natural densities Arroyo chub present <10% tolerant; <5% Non Insect taxa; >40% Intolerant <30% collectors	As naturally present with slight increases in abundance; <45% collectors; >30% intolerants; <10% non-insects; coleopteran taxa present; <15% tolerant taxa Arroyo chub present	May be increases in abundance of functionally diverse tolerant taxa; <50% collectors; >20% intolerants; <15% non-insects; <25% tolerant Arroyo chub present	May be common but do not exhibit significant dominance; few coleopteran taxa; >15% non-insects; >25% tolerant taxa, >50% collectors; <20% intolerant taxa Diatom indicators include: Nitzchia palea, Navicula atomus, minima, Fragilaria capucina, Cymbella affinis, Stephanodiscus. Attached green algae more prolific – Cladophora, Stigeoclonium, Oedogonium – as well as blue-greens such as Oscillatoria, Ababena Arroyo chub present	Often occur in high densities and are dominant; high percentage of collectors and non-insect taxa; few predator or EPT taxa >60% collectors; >30% tolerant taxa; >20% non-insect taxa; <10% intolerant taxa Arroyo chub less abundant	Comprise ≥ one-third of the assemblage; often extreme departures from normal densities (high or low); no coleoptera, sensitive EPT taxa, and few predator taxa. Mostly collector taxa and often high proportion of non-insect taxa >75% collectors; >40% non-insect taxa; >40% tolerant taxa; <2% intolerant taxa Arroyo chub scarce

Table 2. Biological Condition Gradient Matrix: California Bight (High Elevation; >1200 ft)

Biological Condition Gradient						
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	
VI Non-native or intentionally introduced taxa Include riparian vegetation	Non-native taxa not present	Non-native taxa may be present, but in few numbers and very few species represented	Introduced non-native taxa may be more common in some assemblages (e.g. fish, amphibians, or macrophytes).	Non-native taxa fairly numerous but may not dominate assemblage	Some assemblages (e.g., fish, amphibians, or macrophytes) are dominated by non-native taxa (e.g., brown trout, Cottus asperus in upland)	Often dominant; may be the only representative of some assemblages (e.g., plants, fish, amphibians).
VII Organism Condition (especially of long-lived organisms) More data needed*[*]	Any anomalies are consistent with naturally occurring incidence and characteristics	Any anomalies are consistent with naturally occurring incidence and characteristics	Anomalies are infrequent	Incidence of anomalies may be slightly higher than expected	Biomass may be reduced; anomalies increasingly common	Long-lived taxa may be absent; Biomass reduced; anomalies common and serious; minimal reproduction except for extremely tolerant groups

[*] Percent fish anomalies (DELTS) higher in more stressed systems in the Central Valley (USGS report); should be useful attribute for LA region but unclear whether there are sufficient data available.

Table 2. Biological Condition Gradient Matrix: California Bight (High Elevation; >1200 ft)

Biological Condition Gradient						
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	
VIII Ecosystem Functions	All are maintained within the natural range of variability. Algal as well as plant source of energy.	All are maintained within the natural range of variability	Virtually all are maintained through functionally redundant system attributes; minimal increase in export except at high storm flows	Virtually all are maintained through functionally redundant system attributes though there is evidence of loss of efficiency (e.g., increased export or decreased import)	There is apparent loss of some ecosystem functions manifested as increased export or decreased import of some resources,. Shift to almost entirely algal production: % Collector-filterers dominate the macroinvertebrate assemblage indicative of filamentous algae and DOC as the major energy sources.	Most functions show extensive and persistent disruption

* For southern California streams, may work in opposite direction? Limited connectance naturally, at least in uplands; greater connectance is artificially derived – leads to increase in exotics and decrease in natives.

Table 3. Biological Condition Gradient Matrix: California Bight (Low Elevation; <1200 ft)

	Biological Condition Gradient					
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	6 **Very Poor** Radical changes in structure of the biotic community and major loss of ecosystem function
Ecological Attributes	Native structural, functional and taxonomic integrity is preserved; ecosystem function is preserved within the range of natural variability	**Minimal** changes in structure due to loss of some rare native taxa; shifts in relative abundance of taxa but Sensitive-ubiquitous taxa are a dominant component; ecosystem functions are fully maintained through redundant attributes of the system;	**Some** changes in structure due to loss of sensitive or rare native taxa; shifts in relative abundance of taxa but Sensitive-ubiquitous taxa are common and abundant; ecosystem functions are fully maintained through redundant attributes of the system	**Major** changes in structure due to replacement of some Sensitive-ubiquitous taxa by more tolerant taxa,; overall balanced distribution of all expected major groups; ecosystem functions largely maintained through redundant attributes	Sensitive taxa are nearly absent; conspicuously unbalanced distribution of major groups from that expected; organism condition shows signs of physiological stress; system function shows reduced complexity and redundancy; increased build-up or export of unused materials	Extreme changes in structure; wholesale changes in taxonomic composition; extreme alterations from normal densities and distributions; organism condition is often poor; ecosystem functions are severely altered
I Historically documented, long-lived or regionally endemic taxa Relies on fish and other vertebrates; May need to break out by basin*	As predicted for natural occurrence except for global extinctions (e.g., unarmored 3-spine stickleback, Pacific Treefrog, California newt, or garter snakes present); steelhead and goby in coastal reaches, stickleback and sculpin in lowlands	As predicted for natural occurrence except for global extinctions; 3-spine stickleback present in lowland	Some may be absent due to global extinction or local extirpation; 3-spine stickleback rare or extirpated	Some may be absent due to global, regional or local extirpation	Usually absent; stickleback very rare or absent.	Absent

* LA Basin may have historically more endemic fish species than either San Gabriel, Malibu, San Diego drainages. Also need to distinguish upland from lowland sites. Trout more upland; sticklebacks and sculpins lowland. Most long-lived species extinct in region; may be similarity between long-lived or endemics and sensitive-rare species.

Table 3. Biological Condition Gradient Matrix: California Bight (Low Elevation; <1200 ft)

	Biological Condition Gradient					
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	6 **Very Poor** Radical changes in structure of the biotic community and major loss of ecosystem function
II Sensitive-rare taxa (currently rare)*	As predicted for natural occurrence, with at most minor changes from natural densities Sculpin (Cottus asper) (Ventura) lamprey ammocoetes in lowland streams; red-legged frogs present; Speckled dace – lowlands; 3 spine armored stickleback	Virtually all are maintained with some changes in densities	Some loss, with replacement by functionally equivalent Sensitive-ubiquitous taxa	May be markedly diminished	Absent	Absent
III Sensitive-ubiquitous taxa [% intolerant, prediator taxa]	As predicted for natural occurrence, with at most minor changes from natural densities Partially armored Stickleback common; speckled dace species present in upland streams. Trout present in higher elevation streams. > 40% Intolerant; > 12 EPT taxa; > 14 Predator taxa	Present and abundant; > 10 EPT taxa, > 10 predator taxa; > 20% intolerants Diatoms main form of periphyton; Achnanthes oblongella, ventralis; Cymbella amphioxys, gracilis, Amphora inariensis	Common and abundant; ≥ 8 EPT; ≥ 6 predator; > 10% intolerants	Present but some replacement by functionally equivalent taxa of greater tolerance. ≤8 EPT, ≤ 6 predator, < 10% intolerants	Frequently absent or markedly diminished; less sensitive EPT (e.g., Baetidae) may be present but not more sensitive taxa. < 3 EPT; < 4 predator; < 5 % intolerants	Absent ≤1 EPT taxa; ≤ 1% intolerant; ≤ 2 predator taxa

Table 3. Biological Condition Gradient Matrix: California Bight (Low Elevation; <1200 ft)

Biological Condition Gradient						
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	6 **Very Poor** Radical changes in structure of the biotic community and major loss of ecosystem function
IV Taxa of intermediate tolerance	As predicted for natural occurrence, with at most minor changes from natural densities Native sucker present Western toad Common stickleback	As naturally present with slight increases in abundance	Often evident increases in abundance Diatom species include: Achnanthes biasolettiana, Cymbella sinuata, Denticula tennis, Fragilaria construens, Navicula capitata.	Common and often abundant; relative abundance may be greater than Sensitive-ubiquitous taxa	Often exhibit excessive dominance	May occur in extremely high OR extremely low densities; richness of all taxa is low
V ***Tolerant taxa*** [non-insect taxa %tolerant taxa Collectors]	As naturally occur, with at most minor changes from natural densities Arroyo chub present <15% tolerant; <5% Non Insect taxa; <40% collectors	As naturally present with slight increases in abundance; <50% collectors; >30% intolerants; < 8% non-insects; coleopteran taxa present; <20% tolerant taxa Arroyo chub present	May be increases in abundance of functionally diverse tolerant taxa; <60% collectors; <12% non-insects; <25% tolerant Arroyo chub present	May be common but do not exhibit significant dominance; few coleopteran taxa; >12% non-insects; >20% tolerant taxa, >60% collectors Diatom indicators include: Nitzchia palea, Navicula atomus, minima, Fragilaria capucina, Cymbella affinis, Stephanodiscus. Attached green algae more prolific – Cladophora, Stigeoclonium, Oedogonium – as well as blue-greens such as Oscillatoria, Ababena Arroyo chub present	Often occur in high densities and are dominant; high percentage of collectors and non-insect taxa; few predator or EPT taxa >75% collectors; >33% tolerant taxa; >20% non-insect taxa; Arroyo chub less abundant	Comprise ≥ one-third of the assemblage; often extreme departures from normal densities (high or low); no coleoptera, sensitive EPT taxa, and few predator taxa. Mostly collector taxa and often high proportion of non-insect taxa >90% collectors; >45% non-insect taxa; >40% tolerant taxa; Arroyo chub scarce

Table 3. Biological Condition Gradient Matrix: California Bight (Low Elevation; <1200 ft)

Biological Condition Gradient						
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	6 **Very Poor** Radical changes in structure of the biotic community and major loss of ecosystem function
VI Non-native or intentionally introduced taxa <u>Include riparian vegetation</u>	Non-native taxa not present	Non-native taxa may be present, but in few numbers and very few species represented	Introduced non-native taxa may be more common in some assemblages (e.g. fish, amphibians, or macrophytes).	Non-native taxa fairly numerous but may not dominate assemblage	Some assemblages (e.g., fish, amphibians, or macrophytes) are dominated by non-native taxa (e.g., bluegill, bass, African clawed frog, carp in lowland streams).	Often dominant; may be the only representative of some assemblages (e.g., plants, fish, amphibians).
VII Organism Condition (especially of long-lived organisms) More data needed*[*]	Any anomalies are consistent with naturally occurring incidence and characteristics	Any anomalies are consistent with naturally occurring incidence and characteristics	Anomalies are infrequent	Incidence of anomalies may be slightly higher than expected	Biomass may be reduced; anomalies increasingly common	Long-lived taxa may be absent; Biomass reduced; anomalies common and serious; minimal reproduction except for extremely tolerant groups

[*] Percent fish anomalies (DELTS) higher in more stressed systems in the Central Valley (USGS report); should be useful attribute for LA region but unclear whether there are sufficient data available.

Table 3. Biological Condition Gradient Matrix: California Bight (Low Elevation; <1200 ft)

Biological Condition Gradient						
	1 **Natural or native condition** Historical reference condition in many cases	2 **Very Good** Minimal changes in the structure of the biotic community and minimal changes in ecosystem function Least disturbed conditions – current reference condition	3 **Good** Evident changes in structure of the biotic community and minimal changes in ecosystem function	4 **Fair** Serious changes in structure of the biotic community and minimal changes in ecosystem function	5 **Poor** Severe changes in structure of the biotic community and moderate changes in ecosystem function	6 **Very Poor** Radical changes in structure of the biotic community and major loss of ecosystem function
VIII Ecosystem Functions	All are maintained within the natural range of variability. Algal as well as plant source of energy.	All are maintained within the natural range of variability	Virtually all are maintained through functionally redundant system attributes; minimal increase in export except at high storm flows	Virtually all are maintained through functionally redundant system attributes though there is evidence of loss of efficiency (e.g., increased export or decreased import)	There is apparent loss of some ecosystem functions manifested as increased export or decreased import of some resources,. Shift to almost entirely algal production: % Collector-filterers dominate the macroinvertebrate assemblage indicative of filamentous algae and DOC as the major energy sources.	Most functions show extensive and persistent disruption
* For southern California streams, may work in opposite direction? Limited connectance naturally, at least in uplands; greater connectance is artificially derived – leads to increase in exotics and decrease in natives.						

Generalized Stressor Gradient (GSG)

The GSG attributes and characteristics developed for this project were based on qualitative information compiled from various regional references, from TAC members, and from knowledge developed as part of the arid west GSG (see Table 4). Southern California streams differ from most other arid west systems in the degree of natural flashiness in undisturbed reaches, the amount of channel braiding that occurs naturally, and the numbers of exotic species that profoundly affect the distribution of endemic biota. Therefore, departures from "natural" or minimally impaired systems (Level 1) are characterized in terms of the degree of departure from the natural hydrograph, the degree of channel and flood plain alteration, and the degree and types of exotic species present. Similar to results from other regions of the country, it is generally thought that Level 1, or completely natural streams, are unlikely to exist in southern California, except perhaps in remote foothill areas. Furthermore, because the hydrology is naturally variable in this region, it may be difficult to quantitatively characterize Level 1 in any case. The TAC suggested several changes to the national GSG framework to make it more relevant to southern California streams. These include:

- Habitat should be divided into two attributes: instream habitat and riparian habitat. The former includes substrate condition, channel morphology, and the presence of barriers or channel alterations such as culverts. Riparian habitat includes riparian vegetation condition (including native or lack of native species) and lateral connectivity with floodplain. Tetra Tech obtained and included metrics from the California Rapid Assessment Method (CRAM) for wetlands that pertain to riparian condition as well as hydrology.
- Water Quality should be divided into two attributes: conventional and naturally-occurring pollutants and anthropogenic toxics. The TAC agreed that tiered uses will not allow for water quality degradation. However, natural water quality characteristics could be a stressor.

Table 4. Stressor Condition Gradient Matrix: California Bight

	Stressor Condition Levels			
Attribute	**1**	**3**	**4-5**	**6**
Flow	Natural hydrograph; includes periodic seasonal floods and very low flows (dry conditions in some cases); dry season flow from natural sources; rising water has unrestricted access to floodplain; Most of channel characterized by equilibrium conditions.	Moderately changed hydrograph; more consistent flows seasonally through treated wastewater inputs and other sources; some irrigation withdrawals or groundwater removal for other human purposes; noticeable change in flashiness; lateral excursion of rising waters partially restricted by unnatural features; Some aggradation or degradation present but not severe.	Significantly changed hydrograph; both managed and natural flow factors present; stormwater runoff dramatically increases flows temporarily; lateral excursion of rising waters partially restricted by unnatural features; Most of channel actively degrading or aggrading.	Severely changed hydrograph; flow human-controlled; peaking flows, "rafting flows", or water diversions common; stream is all treated wastewater effluent flow;; diversions such that stream is dry periodically; stream flow result of dam releases; rising waters completely contained within artificial banks; Channel has completely artificial hydrogeology and equilibrium.
Instream Habitat	Natural substrate and channel sinuosity; Braided channels common in lowlands; natural cover available for fish and other aquatic life.	Substrate somewhat modified (often tending to be smaller in size); channel morphology may be slightly modified.	Natural bottom but concrete sides or altered bottom. Substrate size typically fine. Culverts or instream structures present – clear effects on channel morphology	Severely changed channel morphology; channelized; concrete sides and bottom; substrate radically altered.
Riparian Habitat	lateral connection between stream and riparian corridor; native riparian vegetation predominates; underwater willow roots or other riparian plants serve as habitat for aquatic life; 75-100% of stream has riparian buffer; average buffer width ≥ 100m; intact soils.	some exotic-invasive riparian vegetation; connection with flood plain/riparian corridor mostly intact; 50-75% of stream has riparian buffer; average buffer width 60-99m intact or moderately disrupted soils.	25-50% of stream has riparian buffer; average buffer width 30-60m; moderate-extensive soil disruption.	exotic vegetation only if any at all; no connection to flood plain; < 25% of stream has riparian buffer; average buffer width < 30m; barren ground or highly compacted soils.
Conventional Water Quality parameters and naturally occurring chemicals	DO generally near saturation in upland streams – generally > 5 mg/L in lowland streams; temperature cool in upland streams – generally < 30 °C in lowland streams in the summer.	DO and temperature may be slightly altered but still satisfactory for native aquatic life.	Altered DO and/or temperature regimes; elevated concentrations of metals or other constituents naturally	DO and/or temperature radically altered – temperature often > 30° C in summer; conductivity, salinity, or dissolved solids generally much higher than typical for supporting aquatic life; metals or other chemicals naturally high and known to be toxic to aquatic life

Table 4. Continued

	Stressor Condition Levels			
Attribute	**1**	**3**	**4-5**	**6**
Anthropogenic Toxics	No anthropogenic toxics	Infrequent pollutant exceedences of standards; generally non-toxic conditions	Occasional exceedences of WQ objective(s); Stormwater runoff may decrease water quality in certain segments or over short time periods.	Toxics exceed water quality objectives; multiple toxic chemicals co-occur or multiple exceedences of a WQ objective
Watershed Condition	All natural land cover; natural longitudinal connectivity and connectivity with ground water; Contiguous natural riparian buffer between segments.	Mostly natural land cover – some human developed areas; longitudinal connectivity mostly in tact – some fragmentation of habitat or barriers	Mostly human land uses, Urban intensity moderate (30-50 out of 100); longitudinal connectivity fragmented, interrupted; agricultural uses may be relatively predominant	Nearly all human land uses; urban intensity > 50/100; connectivity severely altered; agricultural land uses dominant
Invasive Species	Exotics or introduced species absent. Riparian vegetation as naturally occurs.	A few non-invasive exotics may be present (e.g., crayfish, fathead minnow), including riparian plant species; but generally has little effect on native species or riparian habitat.	Some non-invasive exotics combined with one or two aggressive exotic species (e.g., brown trout; Tamerisk; Arrando).	Invasive, predatory, or aggressive exotic species common (e.g., bass, bluegill, African clawed frog, bull frog). Clear evidence of extirpation of native species due to exotic species. Highly altered riparian habitat due to invasive species present.

- Energy source attribute has questionable relevance to southern California streams. The TAC suggested deleting this attribute pending further discussions.
- Watershed condition attribute was added. This includes land uses and longitudinal and vertical connectivity issues. The urban intensity index, which Tetra Tech calculated for several sites in the Region is one descriptor that is useful here. The CRAM connectivity metric is also relevant here.
- Invasive species attribute was added. This includes riparian plants as well as fauna.

Urbanization, Hydrology and SoCal IBI

There also appears to be some separation in the GSG based on flow regimes and hydrology; streams with more constant flows year-round (e.g., effluent dominated streams) appear to have a higher likelihood of harboring exotic species. Highly urbanized areas are often subject to much greater wet weather runoff than normal resulting in much higher peak flows and a very altered hydrograph.

Plotting the SoCal IBI against the LDI, there are sites that appear to be better than most within its class of urban intensity (see labels in Figure 13). One possibility is that while potential urban sources are present (e.g., residential housing is relatively dense, many roads), the actual level of stressors is less because of the way road runoff and other human-derived stressors are routed. Another possibility is that the stream has certain features that help protect it from urban-related stressors (e.g., riparian vegetation). A third possibility is that sites with lower IBI scores for a given LDI are affected by non-urban stressors as well (e.g., agriculture derived stressors) and are therefore, subject to more stressors than those sites with better IBI scores. Future efforts should plan to compile what is known about these sites so that we can identify factors that mitigate urban effects and better define the GSG.

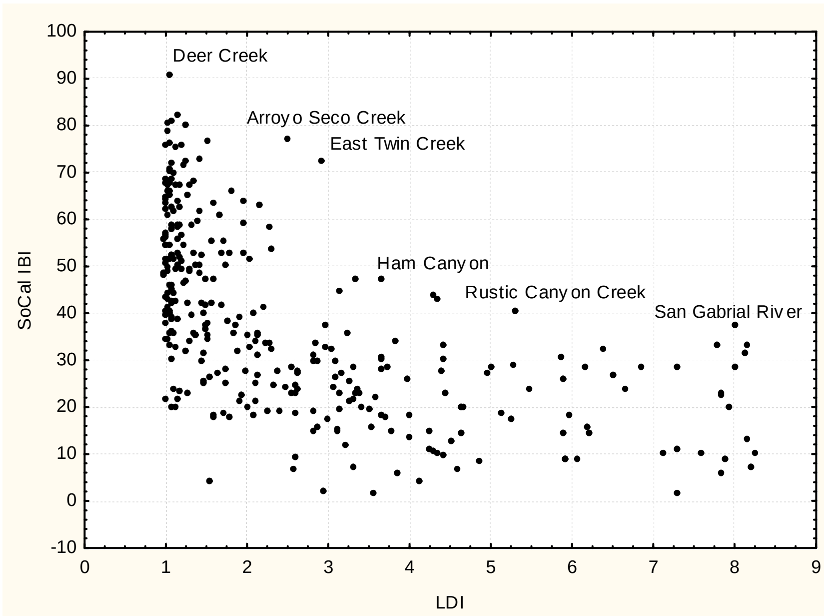

Figure 13. Plot of the southern California macroinvertebrate (SoCal) IBI in relation to the LDI. Higher IBI scores indicate better biological condition. Higher LDI values indicate greater landscape disturbance and probable urban stressors.

The results presented here can be described as a conceptual development of a Southern California BCG based on the existing SoCal IBI and its associated biological metrics. Although the conceptual BCG presented here is a promising step, a fully calibrated BCG is necessary in order for the biological and stressor data to be used in tiered aquatic life uses, as well as for use attainability analyses.

It is recommended that a workshop be organized to initiate development of a calibrated BCG. Individuals involved in the workshop should have extensive knowledge on the type of biological assemblage being investigated and should understand its responses in pristine to severely stressed conditions. Generally, these workshops last two to three days, depending on participants' familiarity with TALU and BCG concepts. The strong relationships of these biological measures with stress (as described by habitat quality and the LDI index), as well as the variation in biology among the two natural and two altered site classes, suggest that generating a calibrated BCG would be possible using the currently available data. To do this, macroinvertebrate data (and to the extent feasible, other types of biological data) need to be explored in more detail to identify specific taxa that are common, as well as sensitive, to the stressors found in the Southern California Bight region. Additionally, the knowledge of local experts must be used in order to reduce uncertainty associated with ambiguous or incomplete data. It may also be necessary to assemble a more comprehensive GSG based on a larger assemblage of data types (i.e., stressors).

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ATTACHMENT B
APPENDIX 6

IDENTIFYING BARRIERS TO TIERED AQUATIC LIFE USES (TALU) IN SOUTHERN CALIFORNIA

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and
Jerry Diamond

Southern California Coastal Water Research Project

Technical Report 590 - June 2009

DOC#1335291

ATTACHMENT B
APPENDIX 6

Identifying Barriers to Tiered Aquatic Life Uses (TALU) in Southern California

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June 2009

Technical Report 590

DOC#1335291

PREFACE

The goal of this document is to explore the use of a new environmental management tool in southern California known as Tiered Aquatic Life Use or TALU. TALU focuses on the traditionally difficult regulatory problem of maintaining balanced biological communities. The existing California State regulatory framework only lists broad, categorical biological expectations such as warmwater (WARM) or coldwater (COLD) habitat. TALU has the potential to refine the biological expectations within each of these broad categories based on a variety of factors including physical habitat, hydrology, or level of habitat alteration. More detailed expectations tailored to the specific habitat could dramatically improve environmental managers' ability to assess biological impairment and set appropriate benchmarks for improvement.

The goal of this document was to create a workplan for implementing TALU in southern California. We compiled existing information about TALU and, by working with local stakeholders, identified some of the largest technical and potential policy barriers for implementation. This was not an easy task since southern California stakeholder opinions, sensitivities, and personal agendas can dramatically differ. TALU is a powerful tool that can be utilized as a positive step towards conservation and restoration or, alternatively, abused as a means of limiting regulatory oversight. Ultimately, this report lists 13 projects that should be undertaken to help resolve these barriers and develop scientifically defensible tiered aquatic life uses, and integrate these tiered uses into the existing water quality standards program to the betterment of the environment.

This document does not focus on the many non-technical factors that will be fundamental for TALU to be a successful management tool. These factors, which can be political and procedural, are built into the State and Federal regulatory policy development process. Many times, divisive policy issues are a function of perception rather than fact. It is the aim of this document to ensure that the all of the facts are available to evaluate the viability of TALU as a meaningful regulatory tool.

ACKNOWLEDGEMENTS

Attendees at the TALU Workshops held November 27, 2007 (1) and June 19, 2008 (2) at the Southern California Coastal Water Research Project.

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Evan Hornig (US EPA Office of Water) [1]
Scott Johnson (ABC Laboratories, Inc.) [1, 2]
Michael Lyons (Los Angeles Regional Water Quality Control Board) [1, 2]
Phil Markle (Los Angeles County Sanitation District) [1]
Rafael Mazor (Southern California Coastal Water Research Project) [1, 2]
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Sofia Mohaghegh (City of Los Angeles) [1]
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Participants TALU workshop June 19, 2008, Southern California Coastal Water Research Project, Costa Mesa, CA.

LIST OF ACRONYMS

ACOE Army Corps of Engineers
BCG Biological condition gradient
COLD coldwate r habitat
CSUSM California State University San Marcos
DWR Department of Water Resources
EMAP Environmental monitoring and assessment program
EPA Environmental Protection Agency
EWH exceptional warmwater habitat
GSG Generalized stressor gradient
IBI Index of biological integrity
MWH modified warmwater habitat
NOAA National Oceanic and Atmospheric Administration
NPDES National Pollutant Discharge Elimination System
PSA Perennial Stream Assessment
SANDAG San Diego Association of Governments
SCAG Southern California Association of Governments
SCCWRP Southern California Coastal Water Research Project
SFEI San Francisco Estuary Institute
SMC Storm water Monitoring Coalition
SNARL Sierra Nevada Research Laboratory
SWAMP Surface water ambient monitoring program
TALU Tiered aquatic life use
USFS United Sates Forest Service
WARM warmwater habitat (California)
WWH warmwater habitat (Ohio)

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BACKGROUND

What are Tiered Aquatic Life Uses (TALU)?

All states, including California, have designated uses (known as beneficial uses in state terminology) that protect aquatic life. California has several different beneficial uses relevant to protecting aquatic life including warmwater and coldwater habitat, and protection of different life stages such as fish migration and spawning.[1] Most ecosystem managers recognize that the more specific the designated use definition, the clearer it is to describe attainment goals and ensure maintenance and protection of the designated use. EPA also acknowledged this fact and, in response, developed a framework for states to develop Tiered Aquatic Life Uses (TALU).

TALU recognizes different management goals for waterbodies within a given waterbody class and these goals are defined based on detailed information on biological condition and stressor intensity. An example of TALU would be the three tiers of warmwater use defined by the Ohio EPA (OEPA, 2008): exceptional warmwater habitat (EWH), warmwater habitat (WWH), and modified warmwater habitat (MWH). All of these tiers are part of a designated use for warmwater habitat, but each of these tiers is associated with different biological expectations based on detailed knowledge of these systems. EWH has a higher expectation of biological condition (i.e., the types of flora and fauna that should be present represent higher water quality and higher habitat quality) than WWH, which in turn, has a higher biological expectation than MWH.

It is important to recognize that tiered uses are defined based on fundamental differences in structural or hydrological condition, not the current biological or water quality condition. Instead, biological expectations for each tiered use are based on knowledge of what biota is capable of occurring in a waterbody given the fundamental structural or hydrological template that exists. In this way, environmental managers utilize TALU to achieve effective stewardship of beneficial uses by: (1) identifying high quality waterbodies and preventing the gradual degradation of these waterbodies; and (2) identifying restoration benchmarks for degraded biological condition in waterbodies given their structural and hydrologic condition.

Southern California is a tremendously valuable location for examining the application of TALU because of its wide array of biological habitats, extensive structural and hydrologic modification, and regulatory agencies' desire to regulate on biological as well as chemical condition. Streams, coastal lagoons, and bays support sensitive aquatic species, diverse wildlife, and unique habitats. As a result, southern California needs a more refined way of defining Aquatic Life Uses. For example, coastal perennial streams in southern California can range widely in terms of the degree of urbanization, hydrologic regime, and habitat alteration. The TALU framework could be a powerful tool to refine the WARM designated beneficial use and to better reflect attainable aquatic life goals for different stream conditions.

[1] Categorical aquatic life beneficial uses that are designated for waterbodies in California include: Warm Freshwater Habitat; Cold Freshwater Habitat; Inland Saline Water Habitat; Estuarine Habitat; Wetland Habitat; Marine Habitat; Rare, Threatened, or Endangered Species; Migration of Aquatic Organisms; and Spawning, Reproduction, and/or Early Development.

Initial Steps of the TALU Process in Southern California

There has been some exploration of TALU concepts in southern California. These initial steps have included a pilot study (Tetra Tech, 2005; 2006) and a subsequent public workshop. Between 2005 and 2007, the pilot study gathered a group of experts to discuss the technical underpinnings of a TALU framework for southern California coastal streams. No new data were collected as part of this effort, but relevant available biological data were compiled to conceptualize the two primary components of TALU: (1) the biological condition gradient (BCG); and (2) the generalized stressor gradient (GSG).

The BCG describes how ten general ecological attributes of aquatic ecosystems change in response to increasing levels of stressors. These attributes include several common aspects of community structure (e.g., pollution sensitive species, endemic long-lived species) organism condition, ecosystem function, and biological attributes related to stream connectivity and the larger watershed scale. The gradient can be considered analogous to a field-based dose-response curve where dose (x-axis) = increasing levels of stressors and response (y-axis) = biological condition (Figure 1). The BCG is divided into six levels of biological condition along the stressor-response curve, ranging from observable biological conditions found at no or low levels of stressors (Level 1) to those found at high levels of stressors (Level 6).

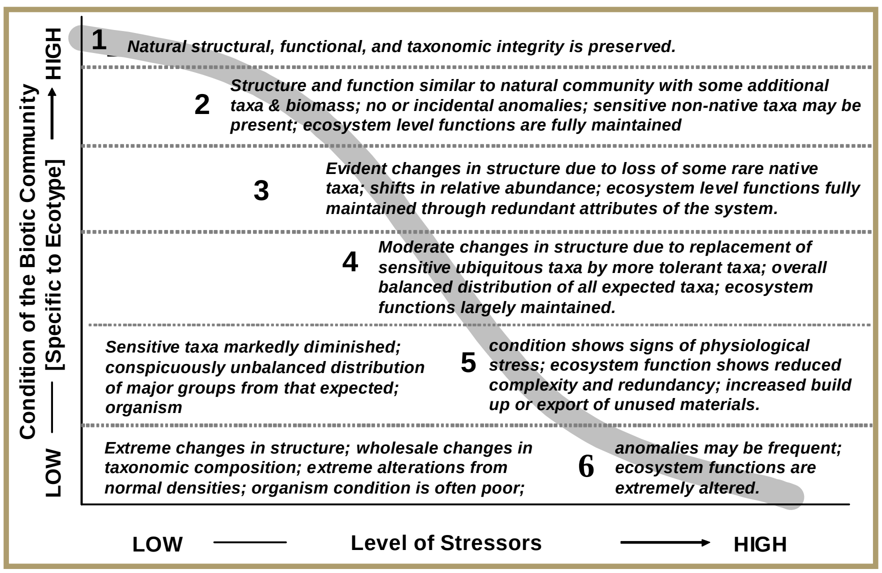

Figure 1. Conceptual model of the Biological Condition Gradient.

The GSG describes the stressor gradient present in the region of interest. Stressors are physical, chemical, or biological factors that adversely affect aquatic biota. Stressors can occur at different scales including instream, within the riparian area and floodplain, or within the watershed. Understanding the linkages between stressors and the response of aquatic biota will help determine existing and potential biological conditions of the aquatic biota. Multiple stressors are usually present and the GSG on the x-axis seeks to represent the cumulative influence of stressors, much as the y-axis generalizes biological condition.

The primary outcome of the pilot study was that TALU could be created in the unique stream environments of southern California. Although much work was left to be accomplished, a BCG and GSG were conceptualized, as well as potential tiered use definitions for perennial streams in the region. The BCG was based largely on the existing Southern California Index of Biological Integrity (IBI; Ode *et al.* 2005) and its associated biological metrics, while the GSG was based primarily on physical habitat measurements and watershed scale disturbance metrics. Relationships were identified between types of coastal perennial streams in southern California, observed aquatic life condition, and preliminary tiered aquatic life uses, along with their corresponding biological expectations.

Several uncertainties were also identified during the pilot study regarding the BCG, GSG, and biological expectations for different tiers. Examples of key uncertainties included defining truly natural conditions in areas where little natural condition remains. Identifying unimpaired sites is vitally important for setting the upper range (i.e. Level 1) of the BCG. Another key uncertainty was the efficacy of additional indicators such as fish or amphibians. One additional uncertainty was optimizing metrics for quantitatively expressing the GSG.

In November, 2007, the Los Angeles Regional Water Quality Control Board sponsored a stakeholder workshop on TALU. The goal of the workshop was two-fold: (1) communicate the findings of the pilot study; and (2) garner input from stakeholders on the viability of TALU as a management tool. Presentations by the US EPA Office of Water and Region IX, the Los Angeles Regional Water Board, and Tetra Tech (US EPA's technical contractor) laid out the rationale, approach, and goals of TALU. The participants were educated about the TALU framework with insight provided by the results of the Southern California pilot study.

The primary outcome of the stakeholder workshop was an earnest interest in TALU. Break-out discussions identified a multitude of issues that were classified into four general areas: (1) determining reference conditions, best attainable conditions, and levels within the BCG; (2) defining stressor gradient metrics; (3) protecting high quality sites and encouraging restoration of degraded sites; and (4) clarifying the regulatory process for developing TALUs.

Identifying Barriers

In June 2008, a second workshop was held to further investigate the specific barriers to implementing TALU in southern California. The workshop was comprised of 12 invited participants representing a cross-section of stakeholders including regulatory, regulated, scientific, and non-governmental sectors (please see Acknowledgements). The group focused on a single goal: design a workplan to overcome the barriers associated with TALU development. Ultimately, the workplan will provide guidance to regulatory and regulated stakeholders that outline the steps necessary to develop TALU in a way that is scientifically defensible and feasible for management. There were three chief considerations asked of participants:

- What are the primary data gaps or information needs?
- How do we combine data gaps into unique project designs?
- What are the factors for prioritizing projects to fill data gaps?

In an effort to constrain the scope of the workplan, the workshop participants immediately decided to limit the scope to perennial wadeable streams in the southern California region.

The workshop ideas and concerns fell into one of three areas including biological, stressor, and implementation related data gaps. The biological-related data gaps included identifying appropriate indicators, adequate representation of reference conditions and range of impact (for defining the BCG scale), capturing natural temporal variation (seasonal/interannual), and specific biological responses to changes in flow (hydromodification).

The stressor related data gaps included improving the understanding and quantification of the human disturbance gradient (to build the GSG), improving the information for quantifying and defining stressor gradients at both the local and watershed scales (e.g., physical habitat and GIS/land use, respectively), and identifying site specific factors that influence stressor impact on aquatic life (e.g., best management practices).

The implementation related issues included identifying appropriate habitat breaks for TALU application, development of appropriate criteria, setting tiers, determining values for nonbiological indicators (i.e. water quality objectives) for the tiers, and integrating TALU with other state or federal regulatory programs.

There were several factors the workshop participants utilized for prioritizing project concepts. These included availability of data/information for compilation as opposed to new data collection, estimated cost, time for completion, and perceived importance in providing defensibility of TALU structure. Ultimately, 14 projects were derived for the workplan based on these criteria.

Table 1. Summary of data gaps or information needs identified at the June 19, 2008 technical meeting regarding the advancement of Tiered Aquatic Life Uses (TALU) in southern California coastal perennial streams and proposed projects that address these gaps.

DATA GAP	PROPOSED PROJECTS
Biology-related	
• The BCG needs to include more than one type of indicator, so that expected responses to human development are accurately evaluated	• Project #1: Develop algal indicators of biological condition for perennial coastal California streams; • Project #2: Develop riparian vegetation and habitat indicators suitable for BCG development
• Natural condition needs to be defined for each stream classifications to determine Level 1 for the BCG	• Project #3: Define minimally impacted (natural) biological condition for coastal perennial streams and determine appropriate stream classification factors
• Temporal variability needs to be captured in the BCG	• Project # 4: Determine seasonal and interannual variability for relevant biological indicators and identify appropriate ranges of indicators for BCG development
• Representation of biological sites needs to be broad and complete enough to ensure accurate BCG development	• Project #5: Characterize range of available biological indicator information and identify gaps in BCG
• Biological expectations for hydrologically modified streams need to be defined	• Project #6: Determine appropriate BCG for different degrees of hydrologic modification
Stressor-related	
• Need to evaluate if recent changes in physical habitat sampling methods provide useful information for quantifying the GSG	• Project #7: Evaluate and develop a refined set of physical habitat measures that help develop the GSG
• Better base maps are needed for quantifying stressor information	• Project #8: Develop refined base maps of stressor information
• Need to better define and integrate landscape and reach scale stressors to quantify the human disturbance gradient	• Project #9: Research and evaluate different indices of human disturbance as GSG surrogates
• Need to understand why individual outlier sites have unpredictably good or bad biological condition	• Project #10: Examine BMP effects on biological condition
Implementation-related	
• Need to translate science to policy when setting stream classifications and tiered uses	• Project #11: Determine appropriate implementation criteria for identifying stream classes and tiered uses
• Consider biocriteria as a means to evaluate whether tiered uses are being achieved	• Project #12: Integrate BCG development and TALU with potential biocriteria
• Examine how other water quality objectives should be tiered along with biological uses (e.g., DO, temperature)?	• Project #13: Determine potential tiered water quality objectives
• Need to link TALU with other regulatory programs (TMDL, 401/404, stormwater) • State-wide implementation vs. region-specific approaches need to be evaluated	• Project #14: Link TALU with other regulatory programs

SPECIFIC PROJECTS

Project 1:	**Develop algal indicators of biological condition for perennial coastal California streams**
Issue:	Previous BCG development efforts were based primarily on macroinvertebrate data and assessment tools. However, macroinvertebrate data and assessment tools alone may not be sufficiently sensitive and robust to characterize perennial coastal California streams. Several examples exist including low gradient streams. Therefore, BCG development should include more than one type of indicator so that expected responses to human disturbance are accurately evaluated. Algae often respond differently to stressors, particularly nutrients, than macroinvertebrates. Therefore, inclusion of algal indicators will provide a more comprehensive BCG.
Tasks:	1. Compile existing algal data for southern California. 2. Segregate algal data and related assessment tools into various habitat types, including consideration of elevation, stream gradient, and degree of channelization. 3. Identify whether sufficient algal data is available for reference sites in southern California to develop an algal indicator. If not, identify sites and collect data as needed. 4. Correlate algal data and related assessment tools with physical or chemical stressors, land use, etc. Other stream systems can provide insight into these relationships. 5. Determine if algal data show sufficient sensitivity to stressors in southern California to serve as useful indicators of human impacts. 6. If algal indicators are sufficiently sensitive to act as useful indicators of biological condition in perennial southern California streams, select an indicator, or suite of indicators, to develop the BCG for algae. This process should be reviewed using an expert panel to verify BCG attributes for algae. 7. Set detection, precision, and accuracy estimates for the algal index developed.
Product:	Identification of algal indicators and expected changes with increasing stress. Detailed description of BCG for algal indicators.
Information Available:	Algal bioassessment methods and data collection are currently underway as part of SWAMP program. Some data is available through Western EMAP. A South Coast periphyton IBI is currently under development at SCCWRP. Additional sampling could be conducted to fill in gaps or verify correlations, as needed.
Estimated Cost:	$ 100,000 to 500,000, depending upon whether sufficient data are available
Schedule:	Two to three years, depending on availability of data
Potential Collaborators:	SCCWRP, EMAP, SWAMP, SNARL, CSUSM

Project 2:	**Develop riparian vegetation and habitat indicators suitable for BCG development**
Issue:	During the BCG Pilot Study for southern California coastal streams, the Technical Advisory Committee clearly recognized that riparian vegetation/habitat is a useful indicator of biological condition. However, use of riparian vegetation/habitat as an indicator of biological condition must be approached cautiously, as lack of vegetation/habitat can also be considered part of the stressor gradient. Preliminary work using the California Rapid Assessment Method (CRAM) was used as a placeholder absent any other standardized riparian quantification method. However, more work is needed to refine the usefulness of riparian vegetation and habitat indicators in TALU development, including identifying reference conditions and determining whether quantifiable metrics can be developed that characterize the condition gradient in response to stressor intensity.
Tasks:	1. Examine current status of CRAM to see if quantitative metrics of disturbance have been assessed. 2. If not, collate existing CRAM information along with metrics of stress or disturbance level. 3. Determine appropriate riparian/waterbody classifications (habitats) for which individual natural conditions will be defined. These could include high elevations streams, low elevation/high gradient streams, and low elevation/low gradient streams. 4. Identify specific changes in riparian indicators with stressor intensity, characterizing natural conditions as well as conditions under various levels of stress. During this process, develop a means to consider lack of vegetation due to hydrologic modification as a stressor. Identify BCG thresholds for riparian condition using CRAM. 5. Assess whether CRAM serves as an appropriate and sufficiently sensitive metric for riparian vegetation/habitat in southern California perennial coastal streams. If CRAM does not appear to be a good metric, assess whether other metrics should be used instead.
Product:	Identification of riparian indicators and expected condition gradient with increasing stress. Detailed BCG for riparian indicators.
Information Available:	Current on-going work on CRAM, including the State’s Wetland Monitoring Program; 404/401 monitoring for restoration/mitigation projects. SWAMP/Perennial Stream Assessment monitoring.
Estimated Cost:	$100,000 to 500,000, depending upon whether sufficient data are available
Schedule:	Two to three years, depending upon availability of data
Potential Collaborators:	SCCWRP, SFEI, CA Coastal Conservancy, US ACOE, Southern CA Wetland Recovery Project

Project 3:	**Define minimally impacted (natural) biological condition for coastal perennial streams and determine appropriate stream classification factors.**
Issue:	BCG development depends on having Level 1 (natural condition) defined, even if it is not represented in the region at present. The Pilot Study suggested that high elevation streams were a different class from low elevation streams, but this may not be the case and the exact elevation cutoff is unknown. The separation of stream classifications is driven largely by ecotonal gradients of physical factors and biological assemblages in the absence of stressors, i.e. a comparison of reference conditions. Identifying different classes of streams is critical because this is what determines ultimate biological expectations (i.e., low elevation or low gradient stream biological assemblages may never look like those of a high elevation or high gradient stream, even with outstanding habitat and water quality).
Tasks:	1. Compile biological indicator data, water quality data, pertinent classification metadata (elevation, gradient, geology, etc.), and stressor data. 2. Identify sites and data that are believed to represent natural conditions (Level 1) using the stressor data. If unstressed sites are unavailable, then alternative approaches can be evaluated including using sites outside of the Southern California Bight, historical information, museum archives, etc. 3. Evaluate the degree to which biological expectations differ between different coastal streams in southern California and determine classes. This is typically accomplished using multivariate statistical techniques. 4. Verify stream class determination and Level 1 attribute conditions using expert opinion.
Product:	Database of macrobenthos, other biological indicators, and pertinent physical and stressor information. Statistical analysis of biological assemblages sufficient to delineate stream classes. List and range of data for biological metrics, physical, and stressor information that characterizes Level 1 of the BCG for different classes of streams in the region.
Information Available:	Macroinvertebrate data are available from a wide range of sources including SWAMP, EMAP, SMC, NPDES monitoring, amongst others. Sufficient data may also be available for other indicators such as algae, riparian condition, and fish. (See projects 1 and 2.) SWAMP is also creating a Reference Condition Management Plan that will directly address this issue in future years.
Estimated Cost:	$150,000 - $250,000
Schedule:	One to two years.
Potential Collaborators:	SWAMP, SMC, USFS, EMAP

Project 4:	**Determine Seasonal and Interannual Variability for Relevant Biological Indicators and Identify Appropriate Ranges of Indicators for BCG Development**
Issue:	A comprehensive and accurate BCG depends, in part, on understanding and incorporating natural variability in the biological condition of the indicators. All biological indicators have some variability between seasons and between years resulting from differences in hydrological or climate regime, or innate differences in population recruitment or mortality rates. To a large extent, this type of variability has not been evaluated, creating an information gap in terms of uncertainty in biological indicator thresholds for different levels of the BCG.
Tasks:	1. Compile biological indicator data for individual sites over time. Preferably, each site will have multiple seasons and/or multiple years of record. 2. Characterize and quantify the variability of biological data, including individual metrics and composite metrics for various indicators. 3. Identify multi-year variability for given index periods and evaluate the need for a single index period in BCG development for a given indicator. Quantify appropriate ranges for individual indicators under natural conditions (Level 1 of the BCG) as well as for various stress levels.
Product:	Time-series data for specific biological indicators and sites, and statistics for seasonal and inter-annual variability based on different classes of streams. Identification of appropriate ranges of indicators to be used in setting Level 1 of the BCG.
Information Available:	Multi-year site data for macrobenthic assemblages are collected largely by NPDES permittees, although the data for reference sites may be limited. EMAP has revisited a subset of sites. The USFS has revisited some sites, but many are not in the southern California region.
Estimated Cost:	$100,000-$200,000 if data are available
Schedule:	One year
Potential Collaborators:	SWAMP, EMAP, USFS, NPDES permittees

Project 5:	**Characterize range of available biological indicator information and identify gaps in biological condition gradient**
Issue:	BCG development depends on having a complete understanding of how various biological indicators change with increasing stressor intensity. While the character of natural conditions and extremely stressed conditions is often known with some precision, changes in biological condition with intermediate levels of stress are not often as well characterized, yet this information is crucial to having a useful BCG for TALU development. Without sufficiently represented gradients of biological condition, inappropriate thresholds for BCG levels may be established. Therefore, it is critical that datasets of appropriate indicators cover the entire range of biological conditions in response to stressors. If gaps are present in the data (i.e., not enough intermediate-stressed sites), additional sampling will be needed.
Tasks:	1. Compile data sets for biological indicators, physical habitat, and stressor data. This may coordinate well with Projects 1-3. 2. Characterize the distribution of data for biological indicators and determine potential breaks or groups that may define thresholds for BCG levels, based on response of the data to stressors. Identify areas of the distribution in which there are relatively few sites represented or parts of the distribution in which there are sharp changes in indicator condition. 3. Determine if locations of missing data represent areas where thresholds will be placed. These areas of the gradient would be the prioritized data gaps for additional sampling.
Product:	Compiled data set of biological, physical habitat, and stressor information. Graphs and tables describing the distributions of each indicator. Prioritized list of data gaps requiring additional sampling.
Information Available:	For a focus on macroinvertebrates, spatially distributed data sets are preferred such as SWAMP, EMAP, PSA, SMC, USFS and others.
Estimated Cost:	$50,000 to $150,000; perhaps >$500,000 if additional sampling is included.
Schedule:	One year for data compilation and analysis
Potential Collaborators:	SWAMP, EMAP, PSA, SMC, USFS and others

Project 6:	**Determine appropriate BCG for different degrees of hydrologic modification**
Issue:	Hydromodification is one of many potential stressors. However, the pervasiveness of hydrologic modification in southern California and the significant degree to which it can impact biota makes it a particularly important stressor. Since hydrologic modification represents a stressor condition that is difficult to reverse in the short- to medium-term, this may be one basis upon which TALU is considered for southern California coastal streams (i.e., for low gradient/low elevation streams, assign tiers based on degree of hydromodification such as full channelization, concrete sides with soft botton, and unchannelized). Therefore, understanding how biological expectations change with hydrologic modification is an essential step towards refining the BCG and developing TALU in the region.
Tasks:	1. Compile biological, physical habitat, stressor condition, and water quality data as well as hydromodification attributes from existing data. This can include various biological indicators (benthic macroinvertebrates, algae, riparian vegetation, fish, amphibians, etc.) and could be done in coordination with Projects 7, 8, and 9. Develop metrics of hydrologic modification that can be scaled from natural (no modification) to extreme modification. 2. Develop a relationship between biological metrics or IBI and hydromodification metrics. 3. Verify relationships and identify a refined and comprehensive BCG that takes these relationships into account, using an expert review panel. The expert panel should help derive decision rules for weighting different data and determining BCG level based on various biological datasets (i.e., macroinvertebrates, algae, riparian vegetation, fish, amphibian, etc.).
Product:	A refined BCG based on level of hydrologic modification. Proposed tiered aquatic life uses based on varying levels of hydrologic modification.
Information Available:	SCCWRP, Counties of Ventura and Los Angeles, and the SMC are currently working on hydrologic modification projects related to erosion. For a focus on macroinvertebrates, spatially distributed data sets are preferred such as SWAMP, EMAP, PSA, SMC, USFS and others
Estimated Cost:	$50,000 to $150,000; perhaps >$500,000 if additional sampling is included.
Schedule:	Two to three years. One and one half years for data compilation and the remainder for developing the BCG
Potential Collaborators:	SWAMP, EMAP, PSA, SMC, USFS and others

Project 7:	**Evaluate and develop a refined set of physical habitat measures that help develop the GSG.**
Issue:	Physical habitat quality should be an important factor in determining biological condition expectations. Until recently, most physical habitat sampling followed protocols that were semi-quantitative and subject to large sampler-to-sampler variance. The Pilot Study showed that these highly variable, semi-quantitative physical habitat measurements were insufficiently robust for developing a predictable GSG. More quantitative, less variable, physical habitat protocols have recently been developed and are now being implemented throughout the region. These new protocols may be more useful in developing the GSG since they are more quantitative, but no one has examined their results critically for this type of TALU application.
Tasks:	1. Compile physical habitat data for sites using the new protocols along with biological data, as available. 2. Characterize the statistical distribution of various physical habitat measures. It may be useful to examine multi-metric indices of physical habitat condition. It may also be useful to differentiate the data by stream classification and degree of hydromodification. 3. Determine relationships between physical habitat metrics and biological measures. Recommend the physical habitat metrics that best predict biological responses. 4. Pilot test recommended metrics at a range of sites to evaluate the utility of the proposed physical habitat metrics.
Product:	Series of correlation plots or matrices of physical habitat metrics and biological responses. Recommend validated physical habitat metrics for use in developing the GSG.
Information Available:	EMAP has the most quantitative physical habitat measurements. SWAMP and the Perennial Stream Assessment have developed new methods for physical habitat that are derived from the EMAP protocols. The SMC will be using the SWAMP protocols in the upcoming years and the data generated could serve as the validation data set.
Estimated Cost:	$200,000 - $500,000, not including additional data collection
Schedule:	Two to three years
Potential Collaborators:	EMAP, SWAMP, PSA, SMC

Project 8:	**Develop refined base maps of stressor information**
Issue:	Development of a reliable GSG is dependent upon having accurate stressor information. Moreover, this information will help define the tiers for TALU implementation. Currently, insufficient stressor information exists with which to draw relationships with existing biological indicators. For example, macroinvertebrate data are available for many sites in the region, but associated stressor information is not complete. This stressor information comes in many varieties, but can be broken into two types: watershed scale and reach scale. Watershed stressors focus on large-scale cumulative impacts such as upstream land use. Reach stressors focus on local impacts such as physical habitat, flow, or water quality.
Tasks:	1. Compile data on watershed scale stressors. This may include, but is not limited to, land use, imperviousness, flow augmentation or diversions as well as associated structures (i.e., dams, reservoirs, etc.), and point source discharges. 2. Compile data on reach scale stressors. This may include, but is not limited to, stream bed material (i.e., fully channelized, concrete-lined with soft bottom, unchannelized), nonpoint source inputs, road crossings and associated structures (i.e., bridges, culverts, Arizona crossings). 3. Place all of this information into a GIS platform for use in future projects. Use the GIS to create maps of the stressor distributions. 4. Evaluate maps to ensure they are using the most up-to-date information and identify sites needing follow-up reconnaissance to ensure desired accuracy.
Product:	GIS layers and base maps of watershed and reach scale stressors.
Information Available:	Much of the watershed scale stressor information is currently available and compiled. Less information has been compiled for reach scale stressors.
Estimated Cost:	$250,000 to $500,000
Schedule:	One to three years, depending on number of stressors and scale.
Potential Collaborators:	DWR, SCAG/SANDAG, most public works and flood control agencies, NOAA.

Project 9:	**Research and evaluate different indices of human disturbance as GSG surrogates**
Issue:	There are myriad of biological stressors, which often have cumulative impacts on southern California streams. Successful TALU delineations depend on having a clear understanding of these stressors and their gradations (i.e., the GSG). Through the process of defining GSG attributes, stakeholders can determine which stressors are controllable (and therefore, not an appropriate aspect of tiered uses) and which are not readily controllable (and might make for good attributes to use in defining tiers). Previously, only landscape scale stressors were evaluated. However, these large-scale stressor evaluations were incomplete and virtually no reach-scale stressors appeared adequate for describing biological response in the biological indices examined to date (i.e., macroinvertebrates). The goal of this project is to improve the GSG for developing TALU.
Tasks:	1. Compile the existing knowledge of stressor indices from the literature, particularly those used in other water programs. 2. Use the existing knowledge from task 1 to create metrics to characterize stressors. This may include multi-metric approaches. 3. Evaluate the biological responses along each stressor metric gradient to identify the best (most predictive) approach. Conduct this process with several types of biological responses to determine the most sensitive biological response to stress. 4. Verify the pros and cons of potential stressor metrics and select preferred approach using an expert review panel. 5. Create a GIS map of stressor metrics for perennial streams region wide.
Information Available:	There are a number of stressor metrics recently developed and published in the literature. Land cover data are readily available, but should be checked for currency and accuracy (see Project 8). Hydrologic as well as physiochemical data are available from several sites and time periods. Where data do not exist, a targeted sampling program may be required.
Product:	Literature review of existing approaches to stressor identification. Series of correlation plots or matrices of stressor metrics and biological responses. Recommended GSG options for use in developing TALU.
Estimated Cost:	$200,000 - $400,000
Schedule:	Two to three years
Potential Collaborators:	SWAMP, NPDES permittees, USGS, DWR

Project 10:	**Examine BMP effects on biological condition**
Issue:	Condition assessments from the Pilot Study indicated that some sites had relatively “good” biological condition considering the level of stressors such as surrounding land use. Similarly, some sites had relatively “poor” biological condition despite an apparent lack of significant stressor sources. The initial assumption has been that unique, site-specific circumstances help dictate the outlier conditions of these sites. To determine whether site-specific circumstances are the cause of the outlier conditions, sites that are uncharacteristically “good” or “bad” should be examined to determine if this is a result of specific practices, such as BMPs or the presence of industrial discharges. This analysis can help determine whether the indicators are appropriate, and potentially identify the key physical and/or hydrologic factors that can help improve degraded sites.
Tasks:	1. Using the compiled data set from Projects 6, 8, and 9, look for anomalous sites that do not fit the BCG/GSG relationship. 2. Conduct site reconnaissance to determine site-specific factors, including BMPs or specific discharges, if any. 3. Based on BMPs or other factors that yielded better than expected biological condition, recommend approaches that may help improve other lower quality sites (e.g., BCG Level 5 or 6). An alternative is to work with agencies that are preparing to install BMPs to test BMP effectiveness. 4. Recommend procedures for handling outlier or anomalous sites within a TALU framework.
Product:	Report with maps showing outlier sites and evaluation of factors causing site-specific condition. Create a list of BMPs that will improve biological condition at these sites. Guidelines for dealing with outlier sites in TALU implementation where site-specific factors need to be accounted for.
Information Available:	SWAMP and the Perennial Stream Assessment have a large number of sites that can contain outliers for investigation. SCCWRP has just completed an assessment of BMPs for habitat restoration.
Estimated Cost:	$100,000 to $200,000, more if sampling or BMP construction is required.
Schedule:	One to two years
Potential Collaborators:	SWAMP, EMAP, PSA

Project 11:	**Determine appropriate implementation criteria for identifying stream classes and tiered uses**
Issue:	BCG and GSG-related projects will determine appropriate classes of perennial streams in Southern California, within which more specific aquatic life uses can be defined. To implement this classification, there needs to be objective science-based criteria for distinguishing classes so that water quality standards can clearly identify to which class a given segment belongs. However, there are policy implications for how stream classifications are attributed. It is this intersection of science and policy that requires thoughtful implementation to ensure equity, effectiveness, and cost efficiency. Several questions need to be answered such as, if classification is based on elevation (or gradient), what is the specific cutoff for high vs. low elevation streams (or high vs. low gradient); are there exceptions to this classification; and how is this classification scheme best applied to ensure efficient implementation of TALU? Similarly, TALU tier thresholds are derived from application of scientific information, but these thresholds need to be re-evaluated once they are applied to actual stream reaches to ensure the biological expectations are appropriate.
Tasks:	1. Compile, summarize, and analyze statistically the database from Projects 3, 4, 6, 8, and 9 will be to identify stream classes that should be considered for separate TALU "regions". This will be done in a pilot watershed. 2. Conduct GIS analysis and create a map of stream classification assignments and proposed tiered uses in the pilot watershed. 3. Evaluate the stream assignments to confirm appropriate classes and tiered uses within each class using a task force of scientists, regulatory and regulated agency staff, as well as nongovernmental organizations. While the goal is not to agree on every stream reach assignment, this project will help to define a framework for conducting the public process in the remainder of the region.
Product:	Framework document detailing the criteria and process for assigning stream classifications and tiered uses.
Information Available:	Results of Projects 3, 4, 6, 8, and 9
Estimated Cost:	$75,000 – 150,000
Schedule:	One year
Potential Collaborators:	Regulatory agencies and regulated stakeholders

Project 12:	Integrate BCG and TALU development with potential biocriteria
Issue:	Formulation of tiered aquatic life uses will be most useful if there are appropriate criteria available to ensure protection of waterbodies within each tier. Currently, no biocriteria have been established as regulatory water quality standards for southern California streams although the Southern California IBI for macroinvertebrates has been suggested. On-going algae work, including that proposed in Project 1, could provide information with which to develop biocriteria for algae, if algae criteria can be developed that serve as good indicators of biological condition. If appropriate biocriteria can be formulated, they could be used as measurement benchmarks with which to evaluate impairments and restoration progress as well as document protection of different aquatic life uses.
Tasks:	1. Establish a task force consisting of regulatory, regulated, and nongovernmental agencies to provide a context for biocriteria interpretation. This group may best be served by using a regulatory agency as the lead. 2. Create a framework that maps the relationship between beneficial uses in basin plans, biocriteria, use attainability analysis, and antidegradation policies. Data compiled and used as part of this workplan should help immensely. 3. Write a consensus-based white paper outlining the regulatory model that can be used as the basis for integrated policy development.
Product:	White paper outlining the regulatory model that can be used as the basis for integrated policy development
Estimated Cost:	$75,000-$150,000
Schedule:	One to two years
Potential Collaborators:	Regulatory agencies and regulated stakeholders

Project 13:	Determine potential tiered water quality objectives
Issue:	In developing tiered aquatic life uses, it may be appropriate to modify water quality objectives to reflect what is necessary to obtain and maintain aquatic life uses for that tier. For example, if a high quality tiered aquatic life use is identified (and supported by both BCG and available biological condition data), it may be critical to have more stringent water quality objectives for certain parameters, such as oxygen, temperature, sediment, and possibly certain chemical pollutants, than are necessary for more standard aquatic life uses. Likewise, if a tiered use is identified for highly modified waterbodies, it may be desirable to modify objectives in cases where a less stringent objective may be adequately protective. Tiered or modified water quality objectives may not be appropriate for certain types of parameters. While there have been some evaluations of this issue at the national level, no guidance has been developed. If and how objectives are modified in concert with TALU will have a direct bearing on how TALU is implemented.
Tasks:	1. Convene a workshop consisting of regulatory agencies, resource agencies, and invited scientists to discuss appropriate actions in tasks 2-3 below. 2. Evaluate what EPA and others have considered, and list the pros and cons of different strategies for dealing with tiered water quality objectives. 3. Identify a preliminary list of parameters for possible tiering, as well as a list of parameters for which tiered objectives would be inappropriate. 4. Identify a pilot study to test the feasibility of tiered water quality objectives. Where possible, actual data for parameters should be examined from segments representing all tiers.
Product:	Topical Workshop. Position paper recommending results of evaluation and parameters potentially subject to tiering, if any. Design for Pilot Study.
Estimated Cost:	$50,000 to $75,000
Schedule:	Six months to one year
Potential Collaborators:	Regulatory and regulated entities.

Project 14:	**Link TALU with other regulatory programs**
Issue:	Local, State, and Federal regulatory programs do not operate in isolation from one another. Water quality standards, biocriteria, total maximum daily loads (TMDLs), NPDES permitting, 401/404 certification for streambed alteration are just a few examples. Optimizing the interplay between regulatory programs and regulatory agencies will help reduce redundancy and increase effectiveness of the regulatory framework. This will be particularly important in determining if TALU should be initiated at the local, regional, or statewide level.
Tasks:	This project will require two tasks. First, a policy committee should be gathered to help evaluate optimal implementation strategies. This policy committee should contain representatives from regulatory, regulated, and environmental advocacy organizations. Regulatory program representation should include RWQCB, SWRCB, and EPA. Second, the committee should draft an implementation workplan to coordinate efforts.
Product:	Implementation strategy workplan.
Information Available:	There are other examples that can serve as a model for this Committee including the State’s Sediment Quality Objectives.
Estimated Cost:	$100,000 to $200,000
Schedule:	Two years
Potential Collaborators:	Regulatory and regulated entities

PROJECT INTEGRATION AND SYNTHESIS

The projects outlined in the previous section are designed to address major data gaps in our understanding of biological responses to stressors in southern California perennial streams and how the stressor axis of the BCG should be constructed and applied. These projects are necessary to formulate a scientifically defensible framework upon which tiered aquatic life uses can be developed and implemented. To make the most efficient use of available resources, certain projects should be completed or at least largely completed prior to others. Ideally, regulators and stakeholders would cooperatively lay out the TALU development framework in order to make the process efficient, effective, and transparent. To that end, we see projects being conducted in four phases, understanding that there will be (and should be) some overlap in the timing of different phases so that the process is as efficient as possible.

In the first phase, basic information is needed regarding biological responses to stressors, characterizing the stressor gradient, and the types of data available for BCG analyses. Therefore, Project #3 (natural condition definition and appropriate classification) and Project #5 (characterize range of biological condition data available) should be initial priorities. Unless these projects are addressed, subsequent BCG or GSG-related projects may be flawed or incomplete. Simultaneously, Project #7 (improve physical habitat measures to develop the GSG), Project #8 (improved base maps for stressors), and Project #9 (evaluate indices of human disturbance) should also be first phase projects of high priority. Results of Projects 7, 8, and 9 will be instrumental in developing a sound GSG axis with which subsequent BCG development can occur. The outcome of the first phase of projects will be:

- A better understanding of how natural condition should be described biologically
- Available data or information to characterize Level 1 of the BCG (at least for macroinvertebrates)
- Degree to which the full range of biological condition is represented using available site data for the southern California
- Preferred ways to characterize the stressor gradient and data refinements needed to define and quantify the GSG
- Refinements to physical habitat metrics and results that will feed into the GSG characterization and provide useful information for other programs and applications
- More informative base maps to allow better characterization of the range of stressor intensity represented using current biological sites

A second phase of projects would build on the ones noted above, refining the BCG further using other assemblage data (algae, Project #1, and riparian vegetation, Project #2). The inclusion of algae and riparian vegetation condition attributes is considered key to making the BCG more robust and scientifically defensible. The inclusion of these assemblages, as well as macroinvertebrates (and fish or other vertebrates to the extent possible), will ensure that a broader range of effects of stressors are included in the BCG and properly interpreted. The timing of these projects would also allow completion of current algal and CRAM data collection efforts, which will be instrumental in completing Projects 1 and 2. Results of Phase 2 would be a more comprehensive BCG that can now be refined in Phase 3 using expert consensus and site-specific information.

The third phase of projects would further refine and ultimately complete previous work in the form of more complete, robust BCG characterization (Project #6), and consideration of ways that may be effective in restoring certain tiers of aquatic life uses in some cases (Project #10, evaluate effects of BMPs and other site-specific factors on biological condition). The analysis of more site-specific biological-stressor relationships (Project #10) is neither necessary, nor desirable when formulating the BCG for a region (Phases 1 and 2) but is useful once a regional BCG is developed and the beginnings of implementation are being considered. Site-specific relationships can also be helpful in validating the BCG and determining the types of stream conditions that may be highest priority for restoration efforts.

The fourth and final phase of projects addresses TALU implementation issues (Projects 11, 12, and 13). In order to develop appropriate implementation criteria for stream classification, tiered uses, biocriteria, and appropriateness of tiered water quality objectives, a well-characterized and accepted BCG (including a robust GSG) is critical. The science provided in the first 3 phases will help guide appropriate implementation strategies. While biocriteria can be developed without TALU, implementation of biocriteria in the context of TALU is likely to have greater environmental benefits, be easier for regulatory agencies to implement in the long run, and be more defensible to stakeholders. Phase 4 projects could start as Phase 2 projects are being completed, once better information becomes available to characterize the BCG and GSG. However, Phase 4 implementation projects are not likely to be completed until after BCG development is complete (Phase 3).

While approximate costs are provided in the project descriptions, the estimates are by no means rigorous and there are many opportunities for cost savings by leveraging among projects and outside studies. For example, there are at least eight projects that rely on compiled databases of biological condition, hydrology, physical habitat, and stressor information. Obviously, this needs only to be done once and, even then, portions will be done in individual project development (i.e., stressor specific information, Project 8). Another example would be the formation of expert panels and task force committees. Virtually every project would benefit from the use of independent, multi-sector review as a means for oversight, validation, and transparency. These committees are crucial to success, but a new committee is not needed for every study. One committee could take on the challenge of several projects, especially if the projects are similar in nature such as those described within each of the implementation phases. Finally, the potential collaborators for these projects were repeated over and over again. An integrated approach with multiple agencies attacking these data gaps will increase the cost leveraging necessary to overcome the hurdles to achieving TALU.

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Environ Monit Assess
DOI 10.1007/s10661-009-1033-3

ATTACHMENT B
APPENDIX 7

Bioassessment tools in novel habitats: an evaluation of indices and sampling methods in low-gradient streams in California

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Received: 19 December 2008 / Accepted: 3 June 2009

Abstract Biomonitoring programs are often required to assess streams for which assessment tools have not been developed. For example, low-gradient streams (slope ≤1%) comprise 20–30% of stream miles in California and are of particular interest to watershed managers, yet most sampling methods and bioassessment indices in the state were developed in high-gradient systems. This study evaluated the performance of three sampling methods [targeted riffle composite (TRC), reach-wide benthos (RWB), and the margin–center–margin modification of RWB (MCM)] and two indices [the Southern California Index of Biotic Integrity (SCIBI) and the ratio of observed to expected taxa (*O*/*E*)] in low-gradient streams in California for application in this habitat type. Performance was evaluated in terms of efficacy (i.e., ability to collect enough individuals for index calculation), comparability (i.e., similarity of assemblages and index scores), sensitivity (i.e., responsiveness to disturbance), and precision (i.e., ability to detect small differences in index scores). The sampling methods varied in the degree to which they targeted macroinvertebrate-rich microhabitats, such as riffles and vegetated margins, which may be naturally scarce in low-gradient streams. The RWB method failed to collect sufficient numbers of individuals (i.e., ≥450) to calculate the SCIBI in 28 of 45 samples and often collected fewer than 100 individuals, suggesting it is inappropriate for low-gradient streams in California; failures for the other methods were less common (TRC, 16 samples; MCM, 11 samples). Within-site precision, measured as the minimum detectable difference (MDD) was poor but similar across methods for the SCIBI (ranging from 19 to 22). However, RWB had the lowest MDD for *O*/*E* scores (0.20 versus 0.24 and 0.28 for MCM and TRC, respectively). Mantel correlations showed that assemblages were more similar within sites among methods than within

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methods among sites, suggesting that the sampling methods were collecting similar assemblages of organisms. Statistically significant disagreements among methods were not detected, although *O*/*E* scores were higher for RWB samples than TRC. Index scores suggested impairment at all sites in the study. Although index scores did not respond strongly to several measurements of disturbance in the watershed, percent agriculture showed a significant, negative relationship with *O*/*E* scores.

Keywords Low-gradient streams · Bioassessment · Multimetric indices · Multivariate indices · RIVPACS · Habitats · California · Methods comparison

Introduction

Large-scale biomonitoring programs are often confronted with the need to assess habitat types for which assessment tools have not been developed. This problem is severe in large heterogeneous regions like California (Carter and Resh 2005). Developing and maintaining unique assessment tools for multiple habitat types may be prohibitively expensive and may impede comparisons of results from different regions. Therefore, assessing the applicability of tools in diverse habitat types is a critical need for large biomonitoring programs.

In Southern California, biomonitoring programs use tools like the Southern California Index of Biotic Integrity (SCIBI, Ode et al. 2005), which were developed using reference sites that were predominantly in high-gradient (i.e., >1% slope) streams. However, low-gradient streams are a major feature in alluvial plains of this region (Carter and Resh 2005). According to the National Hydrography Dataset (NHD Plus), approximately 20–30% of stream miles in California have slopes below 1% (US Environmental Protection Agency and US Geological Survey 2005). Several biomonitoring efforts in California specifically target low-gradient streams, as these habitats are subject to numerous impacts and alterations (e.g., Stormwater Monitoring Coalition Bioassessment Working Group 2007), even though the applicability of assessment tools created and validated in high-gradient streams has not been tested.

Low-gradient streams differ in many respects from high-gradient streams (Montgomery and Buffington 1997). For example, bed substrate is typically composed of fines and sands, rather than cobbles, boulders, or bedrock. In California and other semiarid climates, low-gradient channels are often complex, with ambiguous and dynamic bank structure. Frequent floods create new channels and cause streams to abandon old ones (Carter and Resh 2005). For bioassessment programs, an important distinction between high- and low-gradient streams is the scarcity of riffles and other microhabitats that are typically targeted by macroinvertebrate sampling protocols (e.g., Harrington 1999).

In this study, we evaluated application of three sampling methods and two bioassessment indices for use in low-gradient streams in California. We assessed sampling methods for efficacy (the ability to collect sufficient numbers of benthic macroinvertebrates), comparability (community similarity and agreement among assessment indices), sensitivity (responsiveness of the indices to watershed disturbance), and precision of the assessment indices.

Methods

Study areas

Twenty-one low-gradient sites were sampled in several regions across California (Table 1, Fig. 1). Most sites were in heavily altered rivers, although a few had protected watersheds. Slopes were estimated from the National Hydrography Dataset Plus (NHD+, US Environmental Protection Agency and US Geological Survey 2005) or from digital elevation models (for Jack Slough, Wadsworth Canal, and the Santa Ana River, which lacked associated data in the NHD+). All sites were on reaches defined in the NHD+ that had slopes of 1% or less.

Sampling

At each site, three sampling methods were used to collect benthic macroinvertebrates: targeted riffle composite (TRC), reach-wide benthos (RWB),

Table 1 Low-gradient sites included in the study

Site	Watershed	County	Watershed size (km^2)	Stream order	% Developed		% Agricultural		% Open space	
					Shed	Local	Shed	Local	Shed	Local
Within Central and Southern California										
Central Coast										
S	Aptos Creek[a]	Santa Cruz	200	3	18	92	0	0	82	8
S	Salinas River 1	Monterey	10,940	6	14	71	0	1	86	28
S	Salinas River 2[a]	Monterey	10,666	7	5	28	7	61	88	11
S	Salinas River 3	Monterey	9,141	7	5	13	4	27	90	60
S	San Lorenzo River	Santa Cruz	378	4	5	7	6	56	88	37
S	Santa Maria River[a]	Santa Barbara	1,844	6	4	4	6	0	91	96
South Coast										
S	Agua Hedionda Creek[a]	San Diego	80	3	76	77	0	0	24	23
S	Las Virgenes Creek[a]	Los Angeles	63	3	19	29	0	0	81	71
S	Rio Hondo[a]	Los Angeles	325	3	70	83	0	0	30	17
S	Santa Ana River	Riverside	1,965	6	25	78	1	0	74	22
S	Santa Clara River 1	Los Angeles	817	4	14	68	0	0	86	32
S	Santa Clara River 2	Los Angeles	1,107	5	16	76	0	1	84	23
S	Santa Clara River 3	Los Angeles	1,107	5	16	75	0	5	84	20
S	Santa Margarita River 1[a]	San Diego	1,856	6	13	48	3	0	84	52
S	Santa Margarita River 2[a]	San Diego	1,888	6	14	24	3	0	83	76
Outside Central and Southern California										
Bay Area										
X	Butano Creek	San Mateo	234	3	11	34	0	0	89	66
X	Redwood Creek[a]	Marin	44	2	4	10	2	24	94	67
Central Valley										
X	Jack Slough	Yuba	Unclear	3		7		91		2
X	Morrison Creek[a]	Sacramento	114	3	40	100	4	0	56	0
X	Pleasant Grove Creek	Placer	40	3	69	34	3	16	28	50
X	Wadsworth Canal	Sutter	Unclear	Unclear		12		87		1

Two sites in the Central Valley (Jack Slough and Wadsworth Canal) had ambiguous watersheds which could not be delineated. In addition, Wadsworth Canal had an ambiguous stream network, and stream order could not be determined. These ambiguities are in cells marked "Unclear"

S Assessed with the Southern California Index of Biotic Integrity, *X* not assessed with an index of biotic integrity

[a]Triplicate samples collected

and the margin–center–margin modification of RWB (MCM). The three sampling methods differed in the degree to which they targeted the richest microhabitats (e.g., riffles or vegetated margins). The TRC and RWB samples are similar to methods used in the nationwide Environmental Monitoring and Assessment Program (EMAP, Peck et al. 2006), and both methods are currently used in California's bioassessment programs (Ode 2007). MCM, a modification of RWB, is intended to capture marginal habitats not sampled by RWB and has been adopted for use in low-gradient streams in California (Ode and van Buuren 2008). Samples were displaced up- or downstream by 1 m when necessary to avoid interference among different methods. At 12 sites, triplicate samples were collected for each method (Table 1).

For the TRC method, 11 equidistant transects were established along the 150-m reach, and three 1-ft^2 areas of streambed were sampled at three randomly selected transects. At each transect, field crews targeted the richest microhabitats, and a total of 9 ft^2 of streambed in three riffles were sampled. This method is similar to the targeted riffle composite method used by EMAP, which sampled a total of 8 ft^2 of streambed from four to eight riffles (Peck et al. 2006). A second difference was the fixed reach length of 150 m, in contrast to EMAP, which had a variable reach length set at 40 times the wetted width.

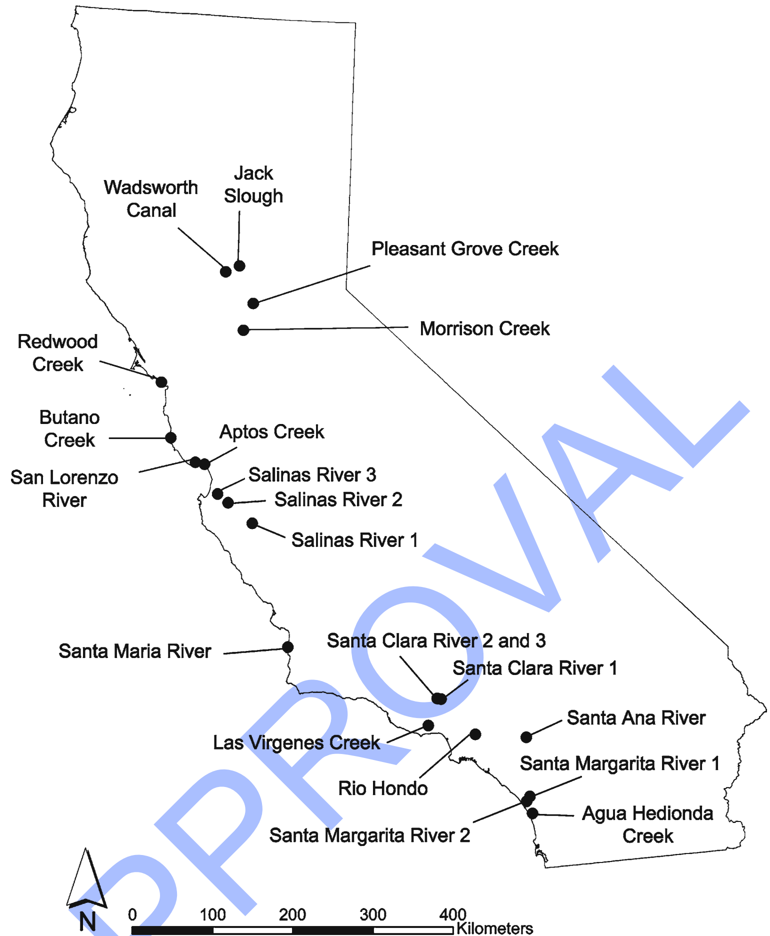

Fig. 1 Location of study sites

In contrast to TRC, which allowed the field crew to sample the richest microhabitats within transects, the RWB method distributed sampling locations systematically. For RWB, 11 equidistant transects were established along the 150-m reach, and one sample was collected with a D-frame kicknet along each transect at 25%, 50%, or 75% of the stream width (with the position changing at each transect). A total of 11 ft^2 of streambed was sampled. This method is similar to the Reach-Wide Benthos method used by EMAP, except that EMAP used variable reach length set to 40 times the wetted width (Peck et al. 2006).

The MCM method was identical to RWB with minor modification. Instead of collecting samples at 25%, 50%, and 75% of stream width, samples were collected at 0%, 50%, and 100%. Unlike RWB, MCM samples from margins, which in low-gradient streams often contain the richest, most stable microhabitats (e.g., vegetated margins). As with RWB, 11 ft^2 of streambed were sampled.

Benthic macroinvertebrates were sorted and identified to the Standard Taxonomic Effort Level 1 (i.e., most taxa to genus, with Chironomidae left at family) established by the Southwestern Association of Freshwater Invertebrate Taxonomists (Richards and Rogers 2006). When possible, at least 500 individuals were identified in each sample.

Data analysis

Bioassessment metrics and indices were calculated for each sample and analyzed to evaluate the efficacy, comparability, sensitivity, and precision of the three sampling methods.

Calculation of indices and metrics

The Southern California Index of Biotic Integrity (Ode et al. 2005) was calculated for 15 sites located on coastal drainages from Santa Cruz to San Diego Counties. No indexes of biotic integrity (IBIs) were calculated for the two sites in the Bay Area and the four sites in the Central Valley because no IBIs for these regions were available at the time of the study. Furthermore, small sample sizes in these regions and unknown comparability of IBIs for different regions would limit the utility of including these sites. In order to calculate the SCIBI, benthic macroinvertebrate data were processed according to the requirements of the index. For example, samples containing more than 500 individuals were randomly subsampled with replacement to obtain 500 individuals per sample.

Calculation of O/E scores

O/*E* scores were calculated for all sites using a predictive model developed for the state of California (Charles P. Hawkins, personal communication, Western Center for Monitoring and Assessment. Accessed online March 30, 2007: http://129.123.10.240/wmcportal/DesktopDefault.aspx). These scores are the ratio of observed to expected taxa and are based on only those taxa with a probability of occurrence ≥50%. The original identifications were converted to operational taxonomic unit (OTU) names used in the models, and ambiguous taxa (i.e., those that could not be assigned to an OTU and those that could not be adequately identified, such as early instars), as well as all Chironomidae larvae, were eliminated. The resulting sample counts were reduced to 300, if more than 300 individuals remained after removal of ambiguous taxa. Sites were assigned to the appropriate submodel based on climate (i.e., low mean annual precipitation and high mean monthly temperature), which were used to predict expected taxa occurrence (*E*) using longitude, percent sedimentary geology in the watershed, and log mean annual precipitation. Climatic data were obtained from the Oregon Climate Center (accessed online March 30, 2007: http://www.ocs.orst.edu/prism), and geological data were obtained from a generalized geologic map of the USA (accessed online March 30, 2007: http://pubs.usgs.gov/atlas/geologic). Details of these predictive models can be found in Ode et al. (2008).

The two sites in the Central Valley were located in streams with ambiguous watersheds and therefore required that percent sedimentary geology be estimated, rather than calculated by geographic information system (GIS). For this study, percent sedimentary geology was estimated at 100%. Using other values of percent sedimentary geology (i.e., 0%, 20%, 40%, 60%, and 80%) had little effect on *O*/*E* scores (i.e., coefficient of variation of scores within each sample at the two Central Valley sites <2%, data not shown), perhaps as a result of the low numbers of observed taxa at these sites.

Evaluation of sampling methods and indices

Efficacy To assess the efficacy of the sampling methods, we calculated the percent of samples for each method that collected at least 450 individuals (within 10% of the minimum number for calculating the SCIBI) or at least 270 individuals (within 10% of the minimum number for calculating *O*/*E*, counting only unambiguous taxa). In bioassessment applications, smaller samples would be rejected and represent wasted resources. In order to minimize the effects of pseudoreplication, the percent of samples containing an adequate number of individuals was calculated for each site, then averaged across all 21 sites. This rate estimated the likelihood of collecting adequate samples from the population of sites in the study. McNemar's test was used to test differences between methods (paired within sites) for statistical significance (Zar 1999; Stokes et al. 2000). Because McNemar's test required binary data, within-site rates were rounded to 1 or 0 at replicated sites. A Bonferroni correction was used to account for multiple tests across methods (i.e., $\alpha = 0.05/3 = 0.017$).

Comparability To see if the different sampling methods collected similar types of organisms, we compared community structure between sampling methods using a Mantel test (Mantel 1967). Mantel tests provide a measure of correlation (Mantel's *R*) between two sampling methods.

Sorensen distance was used as a dissimilarity measure. For sites where multiple samples were collected, mean distances were used; that is, matrices comprised mean or observed distances between pairs of sites, not samples. All samples were included in this analysis, regardless of the number of individuals collected. Significance was tested against correlation values for 999 runs with randomized data. A Bonferroni correction was used to account for multiple tests across methods (i.e., $\alpha = 0.05/3 = 0.017$). PC-ORD [Version 5.12] was used to run Mantel tests (McCune and Mefford 2006).

To determine the relative influence of sampling method on assessment indices, a variance components analysis was used to determine how much of the variability was explained by differences among sites, sampling methods, and their interaction. Restricted maximum likelihood (REML) was used to calculate variance components because of the unbalanced design. SAS was used for all calculations (using PROC VARCOMP method = REML, SAS Institute Inc. 2004). Unlike the mean-square method of estimating variance components, REML ensures that all components are greater than or equal to zero (Larsen et al. 2001). Because sites were a fixed factor and not a random factor, the variance component attributable to site must be considered a finite, or pseudo variance (Courbois and Urquhart 2004). Only sites where all three sampling methods were represented (after excluding samples containing inadequate numbers of organisms) were used in this analysis.

To assess agreement among the sampling methods, mean SCIBI and *O*/*E* values were calculated and regressed for each pair of methods. Slopes were tested against 1 and intercepts to 0 ($\alpha = 0.05$); Theil's test for consistency and agreement, which is based on differences between sampling methods, was used as an additional test of comparability (Theil 1958). Pairwise differences between mean SCIBI and *O*/*E* scores were regressed against log watershed area and stream order to see if these gradients contributed to the observed disagreements. A Bonferroni correction was not used for either analysis in order to increase the ability to detect disagreements. Bias was not explicitly assessed because none of the methods could be assumed to represent a true value. Only samples with adequate numbers of individuals were used in this analysis.

Sensitivity The sensitivity of the assessment indices to watershed alteration was assessed by correlating mean SCIBI and *O*/*E* scores against land cover metrics, including percent open, developed, and agricultural land within the watershed (for all sites with unambiguous watersheds; Table 1). This analysis assumed that the biology of the streams respond to these alterations of the watershed. Open water was excluded from all calculations. Land cover data was obtained from the National Land Cover Database (US Geological Survey 2003). Relationships were assessed by calculating the Spearman rank correlation, which is robust to non-normal distributions and extreme values in land cover metrics (Zar 1999). Only samples with the minimum number of individuals for each index were used in this analysis. Data from each sampling method were analyzed independently. A Bonferroni correction was used to account for multiple comparisons ($\alpha = 0.05/6 = 0.008$) across two indices and three land cover classes within each method.

Precision Precision was evaluated by calculating the minimum detectable difference (MDD) of each sampling method for SCIBI and *O*/*E* scores (Zar 1999; Fore et al. 2001). The MDD was calculated using the mean-squared error (MSE) from a nested analysis of variance (replicates within site) as an estimate for average within-site variance. Because within-site, within-method replication was required, we only used site-by-method treatments where at least two samples had adequate numbers of individuals. These estimated variabilities were applied to a two-sample *t* test ($\alpha = 0.05$, $\beta = 0.10$) with three replicates in each sample. Additionally, we calculated the coefficient of variation (CV) of the indices for each method, averaged across sites.

Results

A total of 135 samples were collected at 21 sites throughout the state, of which 15 were in Southern and Central Coastal California. All three methods were used at each site, and a total of 196 taxa were identified. SCIBI and *O*/*E* scores were low at most sites for all sampling methods (Fig. 2). Apart from one site (Aptos Creek), mean SCIBI scores were well under 39 (the threshold for impairment designation). *O*/*E* scores indicated impairment in nearly every sample, as all scores were below the impairment threshold of 0.66 in all but three samples.

Efficacy

Efficacy was low for all methods, and many samples contained fewer than the required number of individuals. Although each sample was supposed to contain at least 500 individuals, only 46 of 135 samples met this target. Another 34 samples had at least 450 individuals, the minimum required for calculation of the SCIBI. However,

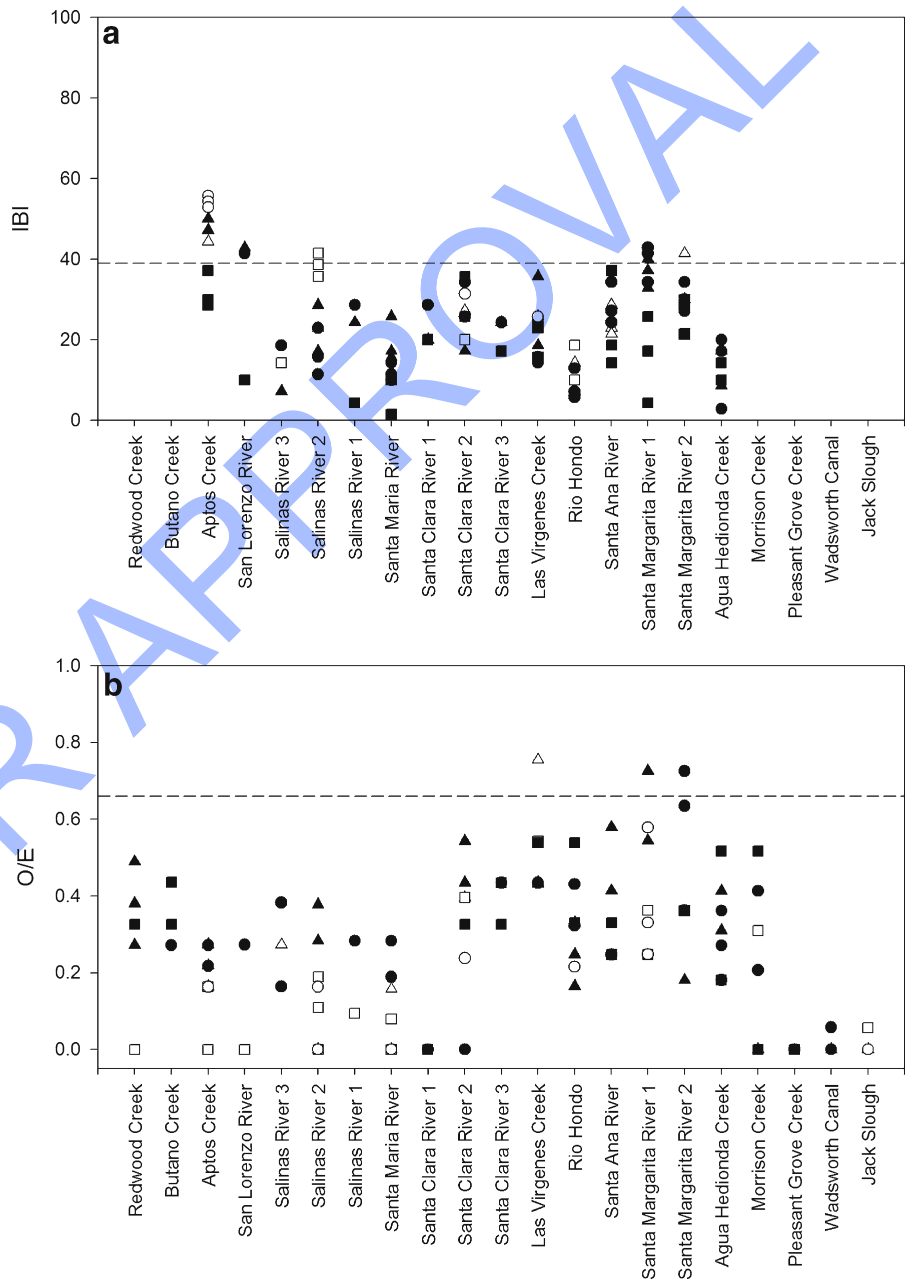

Fig. 2 SCIBI (**a**) and *O*/*E* (**b**) scores by site and method. *Each point* represents an individual sample. *Triangles* represent MCM samples. *Squares* represent RWB samples. *Circles* represent TRC samples. *Black symbols* are samples containing sufficient individuals for index calculation, and *white symbols* are samples containing insufficient individuals for index calculation. *Dashed lines* represent the threshold for identifying impairment with each index (i.e., 39 for the SCIBI, and 0.66 for the *O*/*E*)

55 samples had fewer than 450 individuals, meaning that IBIs calculated for these samples may not be valid. Furthermore, 55 samples had fewer than 270 unambiguously identified individuals, meaning that *O*/*E* scores may not be valid for these samples.

Several samples had extremely low counts (e.g., four individuals; Table 2). Most of these samples were collected by the RWB sampling method. Nearly half (22 out of 45) of RWB samples had fewer than 450 individuals. In contrast, only two MCM samples and six TRC samples had fewer than 450 individuals. The adjusted efficacy rate for the MCM method (54%) was twice that of RWB (27%) for collecting at least 450 individuals, and TRC was nearly as high (46%). However, these differences fell short of statistical significance once Bonferroni corrections were applied (i.e., $p > 0.017$). The rates were slightly higher for collecting 270 individuals (i.e., 67%, 32%, and 67% for MCM, RWB, and TRC, respectively), and these differences were statistically significant (McNemar's test $p = 0.0039$).

Comparability

Comparability of sampling methods was good, both in terms of multivariate community structure and in terms of index scores. Mantel's test showed significant correlations among benthic macroinvertebrate communities collected by all three sampling methods (Table 3). However, the RWB method had weaker correlations with both TRC (0.40) and MCM (0.45) compared to the higher correlation observed between TRC and MCM (0.69). In all cases, the correlations were significant ($p < 0.002$).

Variance components analysis showed that the methods were highly comparable and that site accounted for nearly all of the explained variance in both indices. The analysis of SCIBI scores included seven sites and 26 samples, and the analysis of *O*/*E* scores included ten sites and 52 samples. Site accounted for 100% of the explained variance in SCIBI scores and 95% in *O*/*E* scores. Method and the interaction of site and method explained none or negligible components of the variance in these indices (0–5%).

Table 3 Mantel correlations between sampling methods

Method 1	Method 2	Mantel's *r*	*P*
RWB	MCM	0.45	0.001*
RWB	TRC	0.40	0.002*
MCM	TRC	0.69	0.001*

*$p < 0.017$ statistical significance

Significant disagreements between pairs of sampling methods were not observed for either index (Table 4, Fig. 3). Slopes for all three comparisons were not significantly different from 1, and no intercepts were significantly different from 0. Consistency among SCIBI scores was best (i.e., slope closest to 1) between the MCM and TRC methods (slope 0.96) and worst for the MCM and RWB methods (0.62). In contrast, consistency among *O*/*E* scores was best between the MCM and RWB methods (slope 0.97) and worst for the RWB and TRC methods (slope 0.72). Theil's test confirmed the lack of significant disagreements among IBI and *O*/*E* scores between pairs of methods. No differences between sampling methods were significantly related to log watershed area or stream order (regression slope and intercept $p > 0.05$).

Sensitivity

Sensitivity of both indices to gradients in land cover was poor, although to some extent, the relationships were affected by sampling method, spe-

Table 2 Number of organisms collected by each sampling method

	Total		≥450 organisms			≥270 organisms		
Method	Samples	Sites	# Samples		Rate	# Samples		Rate
MCM	45	21	34	76%	54%	32	71%	67%
RWB	45	21	17	38%	27%	14	31%	32%
TRC	45	21	29	64%	46%	30	67%	67%

Rate Site-adjusted estimate of sampling success rate

Table 4 Regressions of mean IBIs and *O*/*E* scores for each method

Index	Method 1 (x)	Method 2 (y)	*n*	r^2	Slope	SE	*p*	Intercept	SE	*p*
SCIBI	MCM	TRC	14	0.77	0.96	0.15	0.803	2.52	3.96	0.537
	MCM	RWB	7	0.45	0.62	0.25	0.194	6.31	5.53	0.305
	MH	TRC	7	0.74	1.18	0.28	0.540	−0.30	5.63	0.959
O/*E*	MCM	TRC	14	0.78	0.86	0.13	0.284	0.02	0.04	0.633
	MCM	RWB	8	0.90	0.97	0.13	0.816	0.02	0.04	0.653
	RWB	TRC	8	0.71	0.72	0.19	0.185	0.06	0.06	0.401

Slopes were tested against 1 and intercepts were tested against 0
SE Standard error

cific cover type, and geographic scale (Table 5, Fig. 4). For example, *O*/*E* scores were strongly and negatively correlated with agricultural land cover in the watershed (Spearman's Rho ranged from −0.46 to −0.89 across sampling methods). However, most relationships between index scores and land cover metrics were not statistically significant (i.e., $p < 0.008$). Only the relationship between *O*/*E* scores from RWB samples were significantly correlated with agricultural land use in the watershed (Rho = −0.89, $p = 0.003$). Although the direction of correlation often met expectations (e.g., percent open space in the watershed versus SCIBI, Fig. 4c), a few showed no clear relationship (e.g., percent developed land in the watershed vs. *O*/*E*, Fig. 4d).

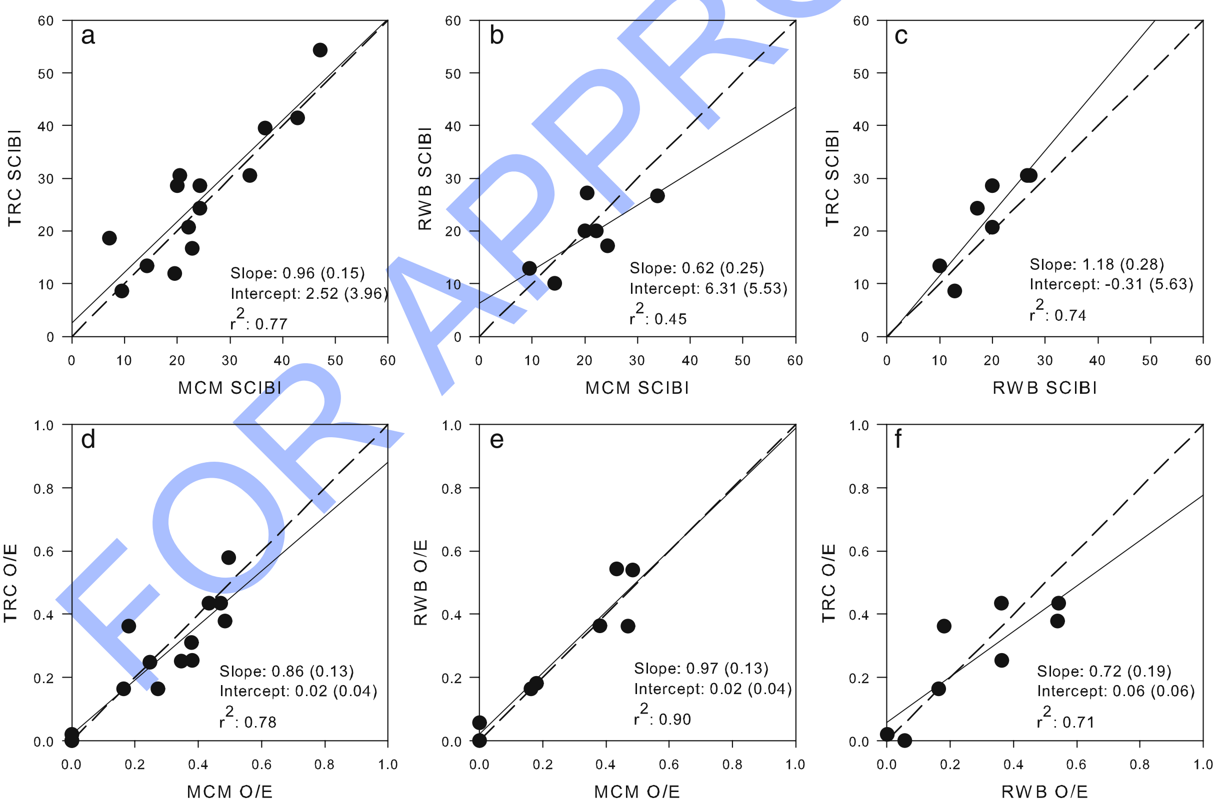

Fig. 3 Agreement between the sampling methods for the SCIBI (**a–c**) and *O*/*E* scores (**d–f**). *Each point* represents the mean index score at a site. *Solid lines* represent linear regressions, and *dashed lines* represent perfect 1:1 relationships. *Numbers in parentheses* are standard errors. Slopes were tested against 1, and intercepts were tested against 0. *$p < 0.005$ indicates significant results

Table 5 Spearman rank correlations (Rho) between bioassessment indices and landscape metrics

Index	Land cover	Method	Watershed			1-km radius		
			n	Rho	*p*	*n*	Rho	*p*
SCIBI	% Developed	MCM	15	−0.08	0.783	15	0.11	0.685
		RWB	7	−0.75	0.054	7	−0.59	0.159
		TRC	14	−0.32	0.914	14	0.20	0.487
	% Open	MCM	15	−0.04	0.892	15	0.09	0.742
		RWB	7	0.62	0.139	7	0.67	0.102
		TRC	14	−0.04	0.890	14	−0.08	0.782
	% Agricultural	MCM	15	0.06	0.842	15	−0.11	0.689
		RWB	7	0.12	0.799	7	0.22	0.628
		TRC	14	0.00	0.991	14	−0.02	0.954
O/*E*	% Developed	MCM	15	0.14	0.640	15	0.35	0.202
		RWB	8	−0.28	0.509	8	−0.07	0.866
		TRC	17	0.23	0.370	17	0.31	0.222
	% Open	MCM	15	−0.05	0.857	15	0.01	0.980
		RWB	8	0.40	0.333	8	0.17	0.693
		TRC	17	−0.24	0.355	17	0.02	0.948
	% Agricultural	MCM	15	−0.67	0.009	15	−0.24	0.388
		RWB	8	−0.89	0.003*	8	−0.15	0.719
		TRC	17	−0.46	0.064	17	−0.31	0.220

$*p < 0.008$ statistical significance

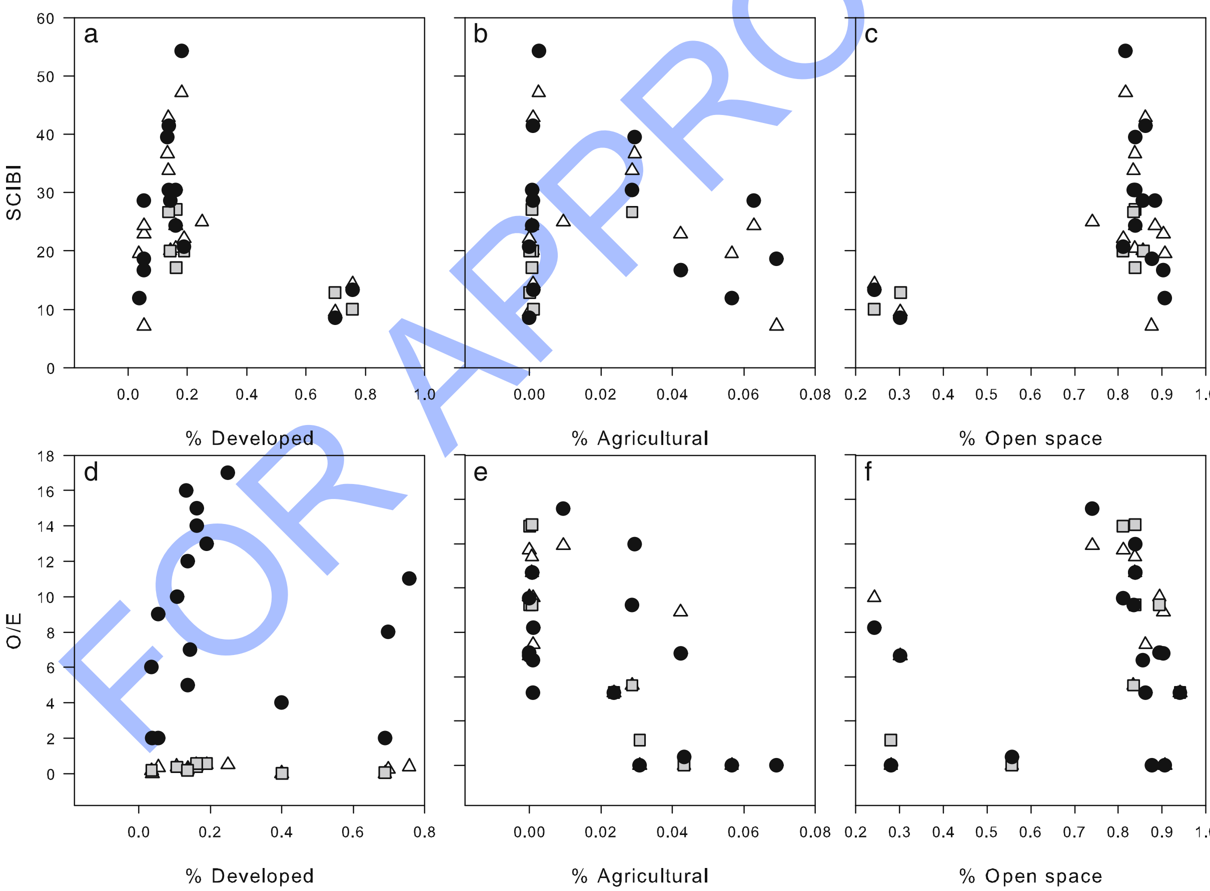

Fig. 4 Index scores versus landcover metrics. *Each point* represents the mean of all samples collected by one method at each site. *Gray triangles* represent MCM samples. *Black squares* represent RWB samples. *White circles* represent TRC samples

Table 6 Within-site variability (expressed as mean square error, MSE) and minimum detectable difference (from a two-sample, two-tailed t test with $n = 30$, $\alpha = 0.05$, and $\beta = 0.1$) for each of the sampling methods

Index	Method		*df*	SS	MSE	*F*	*p*	MDD
SCIBI	TRC	Sites	7	2,507	358	12.5	>0.0001	19
		Residuals	15	430	29			
	RWB	Sites	3	403	134	3.7	0.0701	22
		Residuals	7	254	36			
	MCM	Sites	8	1,745	218	8.0	0.0002	19
		Residuals	16	437	27			
O/*E*	TRC	Sites	8	0.625	0.078	12.7	>0.0001	0.28
		Residuals	13	0.074	0.006			
	RWB	Sites	3	0.115	0.038	14.5	0.0037	0.20
		Residuals	6	0.016	0.003			
	MCM	Sites	9	0.860	0.096	20.9	>0.0001	0.24
		Residuals	17	0.078	0.005			

df degrees of freedom, *SS* sum of squares, *MSE* mean square error, *MDD* mean detectable difference

Precision

Sampling method affected the precision of both the SCIBI and *O*/*E* scores (Table 6). For example, the RWB sampling method had the largest MDD for the SCIBI (i.e., 22 versus 19 for the other two methods). However, RWB provided the lowest MDD when *O*/*E* scores were used (i.e., 0.20 versus 0.28 for TRC and 0.24 for MCM). CVs showed similar trends, with similar variability in the SCIBI among methods (ranging from 22% to 27%), and lower CVs for RWB when *O*/*E* scores were used (i.e., 12% versus 20% for MCM and 45% for TRC).

The low number of samples containing adequate numbers of individuals meant that estimates of within-site variance were sometimes based on very small samples. For example, only four sites in the region of the SCIBI had multiple samples with sufficient numbers of organisms collected by the RWB method. This problem was less severe for estimates based on *O*/*E* scores because fewer individuals per sample are required for index calculation and because sites in the Central Valley and Bay Area could also be used.

Discussion

Low-gradient streams are distinct from other streams in many aspects, such as substrate material, bed morphology, and the distribution of microhabitats (Montgomery and Buffington 1997). As a consequence of these differences, traditional bioassessment approaches in California that were developed in high-gradient streams with diverse microhabitats have limited applications in low-gradient reaches. The sampling methods evaluated in this study differed in the extent to which they targeted the richest microhabitats (such as riffles or vegetated margins). For example, the TRC method allows field crews to select the richest microhabitats specifically. In contrast, the RWB method may systematically undersample or miss these habitats entirely, as the richest areas in low-gradient streams are typically found at the margins (Montgomery and Buffington 1997). The MCM method, a modification of the RWB method, was designed so that these margins could be targeted.

Caution should be used when applying sampling methods or assessment tools that were calibrated for specific habitat types (e.g., high-gradient streams) to new habitats (e.g., low-gradient streams). Our evaluation of assessment tools unveiled a number of shortcomings that weaken application of these tools in low-gradient streams, including the inability to collect adequate numbers of organisms, poor sensitivity of assessments, and low precision of the sampling methods. Significant disagreements among the methods were not detected, although power was low because of the low number of samples. The inability of the RWB sampling method to collect an adequate number of individuals in nearly half of all samples makes it unsuitable for low-gradient streams, even though this method is widely used by bioassessment programs in California (Ode 2007) and across the USA (Peck et al. 2006). Although biomonitoring programs must assess a diverse range of habitat types with the tools they have available, we recommend that these programs invest in evaluating tools in novel habitats where monitoring activities occur.

Variance components analysis of assessment indices showed that differences among sites explained more of the variance in index scores than differences among sampling methods, suggesting that similar types of benthic macroinvertebrates are collected by the different methods. However, analysis of disagreements among the methods indicated that some samples collected by RWB were distinct from those collected by TRC, and samples collected by MCM were intermediate between the other two. For example, samples collected by TRC had lower *O*/*E* scores than samples collected by MCM, which in turn were lower than those collected by RWB. However, differences among these methods did not reach statistical significance.

Other studies comparing single, targeted habitat sampling methods (e.g., TRC) to multi-habitat sampling methods (e.g., RWB) have shown similar results. For example, MDDs reported in other studies (or calculated from reported variabilities) were comparable to those reported here, although generally larger (Rehn et al. 2007; Blocksom et al. 2008). However, these studies found that multihabitat sampling reduced variability in multimetric indices, whereas we found that variability was lower for the single-habitat method (i.e., TRC; Table 7). As in Rehn et al. (2007), we found that TRC samples had higher *O*/*E* scores than RWB samples but that the strength of disagreement was inconsistent in the largest watersheds.

The generally weak response of the indices to landcover metrics suggests that the SCIBI and *O*/*E* may not be sensitive to variability in watershed-scale disturbance in low-gradient streams. This conclusion is tempered by small sample sizes that limited power, and sensitivity to reach-scale degradation was not explored in this study for lack of data. Several studies have shown the strong impact of reach-scale factors on benthic macroinvertebrates, which may exceed the influence of watershed-scale stressors (e.g., Hickey and Doran 2004; Sandin and Johnson 2004). Furthermore, most of the watersheds in the study were highly altered, particularly those in the region of the SCIBI, and we may not have adequately sampled portions of the disturbance gradient to which these indices are more sensitive. Several studies have found that biota responds to disturbance gradients ≤10% development in a watershed, but responses above this gradient are muted (e.g., Hatt et al. 2004; Walsh et al. 2007). Agricultural land cover, which was low in most watersheds (<10%) showed strong responses with the indices, suggesting that the study was able to capture portions of this gradient to which both the SCIBI and *O*/*E* were sensitive.

The low numbers of organisms collected from the low-gradient streams in the study may reflect the naturally low population densities of benthic macroinvertebrates in these reaches. The River Continuum Concept predicts that higher order streams with larger watersheds have a lower energy base because of reduced allochthonous input as well as depressed autochthonous productivity (Vannote et al. 1980). This lower energy base would be expected to support reduced biomass. However, observation of the sites in this study suggests that the lack of stable microhabitats (e.g., riffles and vegetated margins) may account for the

Table 7 Minimum detectable differences in multimetric indices

Index type	Method	Present study	Rehn et al. (2007)	Blocksom et al. (2008)	
Multimetric index	Single-habitat	19.2 (SCIBI)	19.7 (SCIBI+NCIBI)	19.88 (VSCI)	29.79 (MBII)
	Multi-habitat	22.6 (SCIBI)	15.5 (SCIBI+NCIBI)	17.37 (VSCI)	17.91 (MBII)
Predictive model	Single-habitat	0.28 (*O*/*E*)	0.22 (*O*/*E*)	nt	nt
	Multi-habitat	0.20 (*O*/*E*)	0.19 (*O*/*E*)	nt	nt

SCIBI Southern California Index of Biotic Integrity, *NICIBI* Northern California Index of Biotic Integrity, *VSCI* Virginia Stream Condition Index, *MBII* Macroinvertebrate Biotic Integrity Index, *O*/*E* California *O*/*E* Index, *nt* not tested

ATTACHMENT B
APPENDIX 7

reduced numbers of macroinvertebrates, as few species are adapted to the shifting sandy substrate found in most low gradient streams in California. A well-known but extreme example of the impact of shifting sandy substrates on maintaining low densities of benthic macroinvertebrates is the migrating submerged dunes in the lower Amazon River (Sioli 1975; Lewis et al. 2005). Although very high productivity of Chironomidae and other benthic macroinvertebrates has been observed in low-gradient sandy rivers of the southeastern USA, this productivity was attributed to snags and other stable microhabitats, more than to the shifting sandy substrate (Benke 1998). Thus, the vast majority of the macroinvertebrate activity in a large reach of river was found in small areas containing snags (Wallace and Benke 1984). Snag microhabitats are arguably less common in streams of the arid Southwest, which lack dense riparian forests to contribute snag-forming woody debris and may be less likely to be sampled using a systematic sampling method like RWB.

Bioassessment programs are often required to make do with available tools to fulfill regulatory mandates, yet they lack resources to evaluate the tools for applications in all habitats of concern. Although all sampling methods in this study suffered from poor efficiency in collecting organisms, the MCM method greatly improved efficacy and reduced the frequency of rejected samples. Furthermore, the lack of significant disagreements and inconsistencies suggests that the MCM method produced results that were comparable to the other methods already in use in California, which may facilitate integration of historical data sets (Cao et al. 2005; Rehn et al. 2007). Therefore, we recommend the use of MCM in low-gradient streams in California as a substitute for the currently preferred method (i.e,. RWB). In conclusion, bioassessment programs can improve data quality and avoid unnecessary expenses by explicitly evaluating assessment tools when assessing novel habitat types.

Acknowledgements We thank the Aquatic Bioassessment Laboratory of the California Department of Fish and Game for laboratory processing and identification; Aquatic Bioassay and Consulting, Weston Solutions, Inc., and California Regional Water Quality Control Boards for field sampling; and Chuck Hawkins for assistance with predictive models. This project was partially supported by the Stormwater Monitoring Coalition of Southern California.

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From: Markle, Phil
Sent: Monday, June 16, 2008 3:27 PM
To: 'clai@waterboards.ca.gov'
Cc: 'jnewman@waterboards.ca.gov'; Heil, Ann
Subject: SGR Estuary Copper Study Update

C.P.,

We are continuing our evaluation of the EPA 200.8 and EPA 1640 copper analysis comparison study using San Gabriel River Estuary (SGRE) samples and have recently collected enough data to make some basic statistical comparisons. These results may have some implications regarding your modeling efforts so I thought I would update you on our progress. Also, we are continuing to observe salinities of >20 ppt in the upper estuary samples (RA-2) collected at mid-depth, mid-tide, and mid-channel so we are still very interested in the modeled salinity profiles once you have them available.

Figure 1 on the attached MS Word file contains the mean total copper results and standard deviation from all SGRE samples analyzed from February 2008 through May 2008 (17 samples for the EPA 200.8 method and 13 samples for the EPA 1640 method). The "red" bars reflect the total copper results from routinely collected samples analyzed with the EPA 200.8 method. These data are representative of the sampling and analytical procedures historically employed for NPDES monitoring purposes and are therefore representative of the data used in the original listing determination and subsequently used as parameters for your model calibration and verification analysis. The "green" bars contain total copper results obtained using the EPA 1640 method from SGRE samples collected from the same locations and during the same sampling period (note: the EPA 1640 method also specifically requires the use of "clean hands" sampling procedures which was employed for these analyses). Statistically significant differences were observed between the "red" EPA 200.8 and the "green" EPA 1640 method results (t-test, $p = 0.035$) with the EPA 1640 method resulting in average total copper concentrations over 35% lower than those obtained using the EPA 200.8 method with routinely collected samples. Although the use of "clean" sampling procedures with the EPA 200.8 method ("grey" bars) resulted in lower total copper concentrations compared to the results obtained using the EPA 200.8 method with routinely collected samples, these differences were not statistically significant. These findings indicate that even though the use of "clean" sampling may have some effect on the total copper results, the only statistically significant reductions were associated between the analytical methods. These results are significant considering that the model was developed, calibrated, and verified using historical total copper (converted to dissolved copper using the default 0.83 translator) obtained using the EPA 200.8 method from samples routinely collected. The implications are that the model may be over-estimating the actual dissolved copper concentrations in the estuary by over 35% due to the well-documented sodium interferences attributable to metal analysis using the EPA 200.8 method in samples with elevated salinity.

Figure 2 includes data comparing the actual dissolved copper concentrations measured in the SGRE from February 2008 through May 2008 using the EPA 1640 method to total copper data obtained during the same time period using the EPA 200.8 method (with routine sample collection) converted to dissolved copper using the 0.83 default translator. As is clearly demonstrated in this Figure, estimating dissolved copper in samples with elevated salinity using total copper concentrations measured using the EPA 200.8 method results in a significant over-estimation of the actual dissolved concentration as measured directly with the EPA 1640 method. Furthermore, all of the EPA 1640 dissolved copper measurements were above the reporting limit for the method resulting in no "estimated" values.

As I mentioned at the beginning of this e-mail, we are continuing this study and I will provide you with additional updates as more data become available. In the meantime, feel free to contact me if you have any questions or suggestions.

Phil

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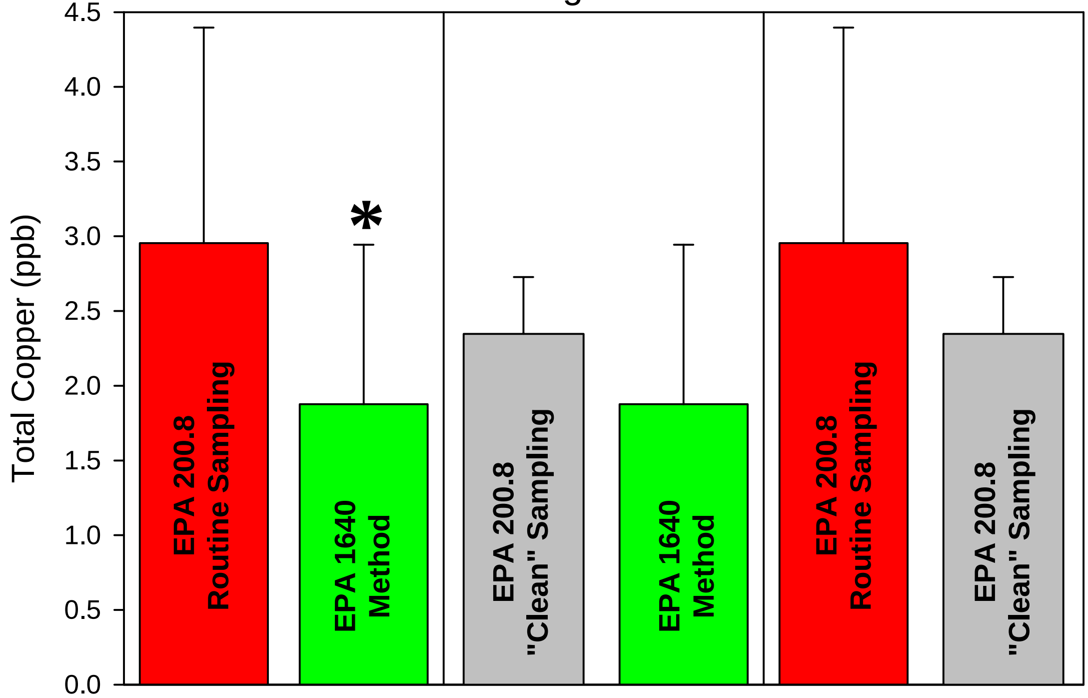
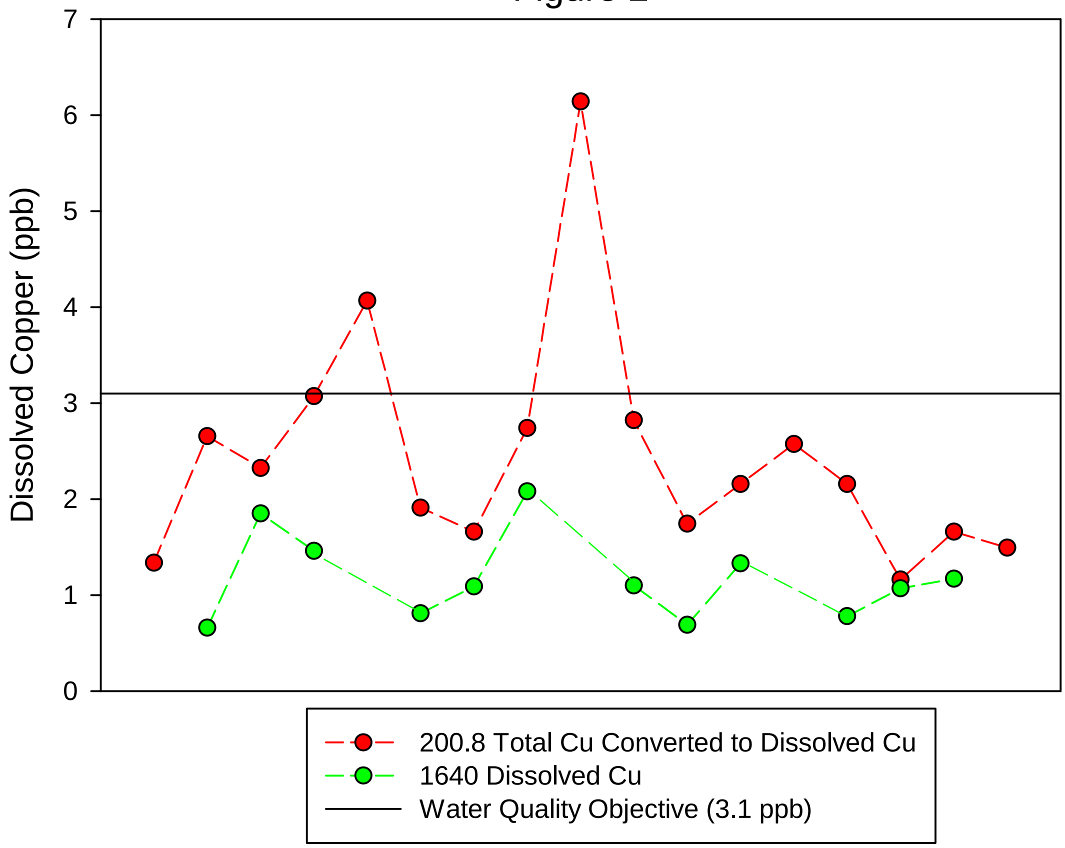
Figure 1



* - Statistically significant (t-test, P=0.035)

Figure 2



California Regional Water Quality Control Board
Los Angeles Region

Recipient of the 2001 *Environmental Leadership Award* from Keep California Beautiful

Linda S. Adams
Agency Secretary

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Arnold Schwarzenegger
Governor

August 15, 2008

Mr. Stephen R. Maguin
Chief Engineer and General Manager
Joint Outfall System
P. O. Box 4998
Whittier, CA 90607-4998

Dear Mr. Maguin:

RESPONSE TO REQUEST AMENDMENTS TO COPPER MONITORING REQUIREMENTS FOR ESTUARINE RECEIVING WATERS UNDER THE LONG BEACH WATER RECLAMATION PLANT MONITORING AND REPORTING PROGRAM – Joint Outfall System, Long Beach Water Reclamation Plant (NPDES No. CA0054119, Order No. R4-2007-0047, CI No. 5662)

We received your letter dated July 21, 2008, requesting permission to replace the total copper sampling monitoring requirement with dissolved copper monitoring using EPA Method 1640, at four estuarine receiving water locations in the San Gabriel River Estuary (RA-2, R6, R7, and R8), downstream of the Long Beach Water Reclamation Plant (Long Beach WRP).

Currently, estuarine receiving water samples are analyzed for total copper using EPA Method 200.8, because the Long Beach WRP Monitoring and Reporting Program requires the use of 40 CFR part 136-listed methods. However, your letter indicated that EPA Method 200.8 is susceptible to over-estimation of the actual copper concentration in samples with elevated salinity, like marine and estuarine waters. You also reported that recent studies conducted by your agency as well as the Los Angeles County Department of Water and Power and Southern California Edison demonstrated that the over-estimation for copper in the estuarine samples using EPA Method 200.8 is statistically significant ($p<0.01$), when compared to the measurements conducted by EPA Method 1640. In addition, you indicated that Dr. Peter Kozelka, a USEPA Region IX TMDL Liaison, recommended using EPA Method 1640 for all estuarine receiving water copper measurements.

Regional Board staff consulted with State Board staff and carefully reviewed analytical method comparison data (Method 1640 vs. Method 200.8) from the aforementioned studies and agree with your finding that using EPA Method 200.8 with collision cell technology for copper analysis of estuarine water samples may significantly overestimate the actual copper concentration. We also understand that EPA Method 1640 may have its advantages over EPA Method 200.8. However, 40 CFR part 122.45(c)(3) requires that all permit effluent limitations, standards, or prohibitions for a metal be expressed in terms of "total recoverable metal" as defined in CFR part 136, unless all approved analytical methods for the metal inherently measure only dissolved form. Even though the water quality standard for copper is specified in the California Toxics Rule (CTR) as dissolved copper, the State Implementation Policy (SIP) specifies the methodology for converting the dissolved criteria into an effluent limitation that is expressed in total recoverable form.

Furthermore, USEPA does not allow the use of a dissolved metal procedure as noted under 40 CFR part 136.6 (b)(3) and 40 CFR part 136.3 note 4 to Table I-B. For these reasons, the Regional Board cannot grant your request to use EPA Method 1640 instead of EPA Method 200.8, for copper monitoring in the San Gabriel River Estuary at four monitoring stations (RA-2, R6, R7, and R8) downstream of the Long Beach WRP.

We recommend that you seek USEPA approval for an alternative test procedure (ATP), by submitting an ATP application to USEPA for use of EPA Method 1640. You may contact Ms. Roseanne Sakamoto of USEPA by phone at (415) 972-3813, or via email at sakamoto.roseanne@epa.gov, to obtain additional information about applying for an ATP.

If you have any question regarding this issue, please contact Jau Ren Chen at (213) 576-6656.

Sincerely,

Tracy J. Egoscue
Executive Officer

cc Mr. Bill Ray, State Water Resources Control Board, Office of Information Management Analysis
Ms. Roseanne Sakamoto, Environmental Protection Agency, Region 9

Bioassessment tools in novel habitats: An evaluation of indices and sampling methods in low-gradient streams in California

Raphael D. Mazor, Kenneth C. Schiff, Kerry J. Ritter, Andy Rehn[1] and Peter Ode[1]

ABSTRACT

Biomonitoring programs are often required to assess streams for which assessment tools have not been developed. For example, low-gradient streams (slope ≤1%) comprise 20 to 30% of all stream miles in California and are of particular interest to watershed managers, yet most sampling methods and bioassessment indices in the State were developed in high-gradient systems. This study evaluated the performance of three sampling methods: targeted riffle composite (TRC), reachwide benthos (RWB), and the margin-center-margin modification of RWB (MCM); and two indices: the Southern California Index of Biotic Integrity (SCIBI) and the ratio of observed to expected taxa (O/E) in low-gradient streams in California for application in this habitat type. Performance was evaluated in terms of efficacy (i.e., ability to collect enough individuals for index calculation), comparability (i.e., similarity of assemblages and index scores), sensitivity (i.e., responsiveness to disturbance), and precision (i.e., ability to detect small differences in index scores). The sampling methods varied in the degree to which they targeted macroinvertebrate-rich microhabitats, such as riffles and vegetated margins, which may be naturally scarce in low-gradient streams. The RWB method failed to collect sufficient individuals (i.e., ≥450) to calculate the SCIBI in 28 of 45 samples, and often collected fewer than 100 individuals, suggesting it is inappropriate for low-gradient streams in California. Failures for the other methods were less common (TRC:16 samples; MCM:11 samples). Within-site precision, measured as the minimum detectable difference (MDD), was poor but similar across methods for the SCIBI (ranging from 19 to 22). RWB had the lowest MDD for O/E scores (0.20 vs. 0.24 and 0.28 for MCM and TRC, respectively). Mantel correlations showed that assemblages were more similar within sites among methods than within methods among sites, suggesting that the sampling methods were collecting similar assemblages of organisms. Statistically significant disagreements among methods were not detected, although O/E scores were higher for RWB samples than TRC. Index scores suggested impairment at all sites in the study. Although index scores did not respond strongly to several measurements of disturbance in the watershed, % agriculture showed a significant, negative relationship with O/E scores.

INTRODUCTION

Large-scale biomonitoring programs are often confronted with the need to assess habitat types for which assessment tools have not been developed. This problem is severe in large heterogeneous regions like California (Carter and Resh 2005). Developing and maintaining unique assessment tools for multiple habitat types may be prohibitively expensive and may impede comparison of data from different regions. Therefore, assessing the applicability of tools in diverse habitat types is a critical need for large biomonitoring programs.

In southern California, biomonitoring programs use tools like the SCIBI (Ode *et al.* 2005), which were developed using reference sites that were predominantly in high-gradient (i.e., >1% slope) streams. However, low-gradient streams are a major feature in alluvial plains of this region (Carter and

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Resh 2005). According to the National Hydrography Dataset Plus (NHD+; USEPA and USGS 2005) approximately 20 to 30% of all stream miles in California have slopes below 1%. Because these habitats are subject to numerous impacts and alterations (SMCBWG 2007), several biomonitoring efforts in California specifically target low-gradient streams, even though the applicability of assessment tools created and validated in high-gradient streams has not been tested.

Low-gradient streams differ from high-gradient streams in many respects (Montgomery and Buffington 1997). For example, bed substrate is typically composed of fines and sands, rather than cobbles, boulders, or bedrock. In California and other semiarid climates, low-gradient channels are often complex, with ambiguous and dynamic bank structure. Frequent floods create new channels and cause streams to abandon old ones (Carter and Resh 2005). For bioassessment programs, an important distinction between high- and low-gradient streams is the scarcity of riffles and other microhabitats that are typically targeted by macroinvertebrate sampling protocols (e.g., Harrington 1999).

In this study, application of three sampling methods and two bioassessment indices for use in low-gradient streams in California were evaluated. Sampling methods were assessed for efficacy (i.e., the ability to collect sufficient numbers of benthic macroinvertebrates), comparability (i.e., community similarity and agreement among assessment indices), sensitivity (i.e., responsiveness of the indices to watershed disturbance), and precision of the assessment indices (i.e., power of assessments to detect differences among sites).

METHODS

Study Areas

Twenty-one low-gradient sites were sampled in several regions across California (Table 1; Figure 1). Most sites were in heavily altered rivers, although a few were in protected watersheds. Slopes were estimated from the NHD+ (USEPA and USGS 2005), or from digital elevation models (at Jack Slough, Wadsworth Canal, and the Santa Ana River, which lacked associated data in the NHD+). All sites were on reaches defined in the NHD+ as having slopes below 1%.

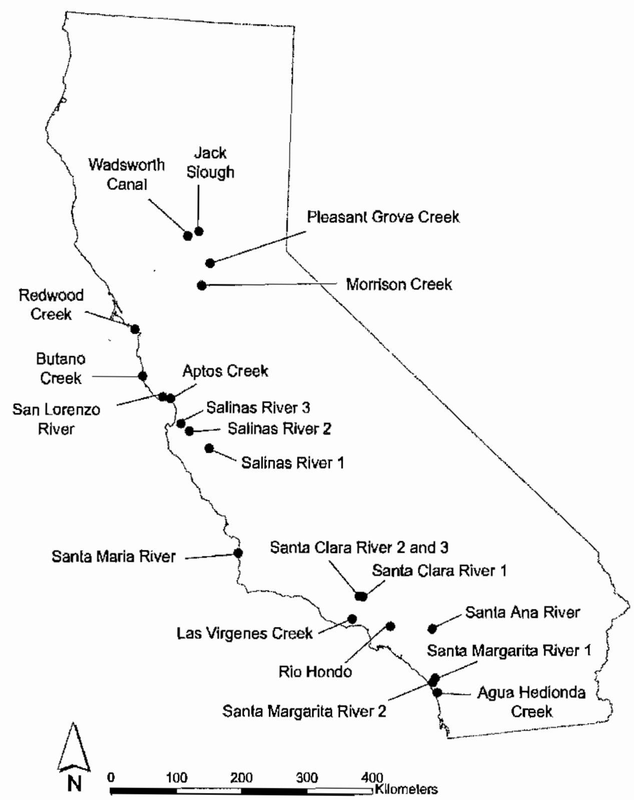


Figure 1. Location of study sites.

Sampling

At each site, TRC, RWB, and MCM sampling methods were used to collect benthic macroinvertebrates. The three sampling methods differ in the degree to which they target the richest microhabitats (e.g., riffles or vegetated margins). TRC and RWB are similar to methods used in the nationwide Environmental Monitoring and Assessment Program (EMAP; Peck *et al.* 2006), and both methods are currently used in California's bioassessment programs (Ode 2007). MCM is intended to capture marginal habitats not sampled by RWB, and has been adopted for use in low-gradient streams in California (Ode and van Buuren 2008). Samples were displaced upstream or downstream by 1 m when necessary to avoid interference among different methods. At 12 sites, triplicate samples were collected for each method (Table 1).

For the TRC method, 11 equidistant transects were established along the 150-m reach, and 3 1-ft^2 areas of streambed were sampled at three randomly selected transects. At each transect, field crews targeted the richest microhabitats and sampled a total of 9 ft^2 of streambed in three riffles. This method is

Table 1. Low-gradient sites included in the study. S = assessed using Southern California Index of Biotic Integrity; X = not assessed using an index of biotic integrity; WS = watershed; Local = within 500 m of sampling point; Ndel = ambiguous watersheds which could not be delineated; Ndet = ambiguous stream network for which stream order could not be determined; and * = triplicate samples collected.

Site	Watershed	County	Watershed Size (km^2)	Stream Order	% Developed		% Agricultural		% Open space	
					WS	Local	WS	Local	WS	Local
Within Central and Southern California										
Central Coast										
S	Aptos Creek*	Santa Cruz	200	3	18	92	0	0	82	8
S	Salinas River 1	Monterey	10940	6	14	71	0	1	86	28
S	Salinas River 2*	Monterey	10666	7	5	28	7	61	88	11
S	Salinas River 3	Monterey	9141	7	5	13	4	27	90	60
S	San Lorenzo River	Santa Cruz	378	4	5	7	6	56	88	37
S	Santa Maria River*	Santa Barbara	1844	6	4	4	6	0	91	96
South Coast										
S	Agua Hedionda Creek*	San Diego	80	3	76	77	0	0	24	23
S	Las Virgenes Creek*	Los Angeles	63	3	19	29	0	0	81	71
S	Rio Hondo*	Los Angeles	325	3	70	83	0	0	30	17
S	Santa Ana River	Riverside	1965	6	25	78	1	0	74	22
S	Santa Clara River 1	Los Angeles	817	4	14	68	0	0	86	32
S	Santa Clara River 2	Los Angeles	1107	5	16	76	0	1	84	23
S	Santa Clara River 3	Los Angeles	1107	5	16	75	0	5	84	20
S	Santa Margarita River 1*	San Diego	1856	6	13	48	3	0	84	52
S	Santa Margarita River 2*	San Diego	1888	6	14	24	3	0	83	76
Outside Central and Southern California										
Bay Area										
X	Butano Creek	San Mateo	234	3	11	34	0	0	89	66
X	Redwood Creek*	Marin	44	2	4	10	2	24	94	67
Central Valley										
X	Jack Slough	Yuba	Ndel	3		7		91		2
X	Morrison Creek*	Sacramento	114	3	40	100	4	0	56	0
X	Pleasant Grove Creek	Placer	40	3	69	34	3	16	28	50
X	Wadsworth Canal	Sutter	Ndel	Ndet		12		87		1

similar to the targeted riffle composite method used by EMAP, which sampled a total of 8 ft^2 of streambed from four to eight riffles (Peck *et al.* 2006). A second difference was the fixed reach length of 150 m, in contrast to EMAP, which had a variable reach length set at 40 times the wetted width.

In contrast to TRC, which allowed the field crew to sample the richest microhabitats within transects, the RWB method used systematically distributed sampling locations. For RWB, eleven equidistant transects were established along the 150-m reach, and one sample was collected with a D-frame kick-net along each transect at 25, 50, or 75% of the stream width (with the position changing at each transect). A total of 11 ft^2 of streambed was sampled. This method is similar to the Reach-Wide Benthos method used by EMAP, except that EMAP used variable reach length set to 40 times the wetted width (Peck *et al.* 2006).

The MCM method was identical to RWB with minor modification. Instead of collecting samples at 25, 50 and 75% of stream width, samples were collected at 0, 50, and 100%. Unlike RWB, MCM samples were collected from the margins, which in low-gradient streams often contain the richest, most stable microhabitats (e.g., vegetated margins). As with RWB, 11 ft^2 of streambed were sampled.

Benthic macroinvertebrates were sorted and identified to the Standard Taxonomic Effort Level 1 (i.e., most taxa to genus, with Chironomidae left at family) established by the Southwestern Association of Freshwater Invertebrate Taxonomists (Richards and Rogers 2006). When possible, at least 500 individuals were identified in each sample.

Data Analysis

For each sample, bioassessment metrics and indices were calculated and analyzed to evaluate the efficacy, comparability, sensitivity, and precision of the three sampling methods.

Calculation of indices and metrics

The SCIBI was calculated for 15 sites located on coastal drainages from Santa Cruz to San Diego Counties. No IBIs were calculated for the two sites in the San Francisco Bay Area and the four sites in the Central Valley because IBIs for these regions were not available at the time of the study. Furthermore, small sample sizes in these regions and unknown comparability of IBIs for different regions would limit the utility of including these sites. In order to calculate the SCIBI, benthic macroinvertebrate data were processed according to the index requirements. For example, samples containing more than 500 individuals were randomly subsampled with replacement to obtain 500 individuals per sample.

Calculation of O/E scores

Observed-over-expected scores were calculated for all sites using a predictive model developed for the state of California (Charles P. Hawkins pers. com.; Western Center for Monitoring and Assessment. Accessed online March 30, 2007: http://129.123.10.240/wmcportal/DesktopDefault.aspx). These scores are the ratio of observed to expected taxa, and are based on only those taxa with a probability of occurrence ≥50%. The original identifications were converted to operational taxonomic unit (OTU) names used in the models, and ambiguous taxa (i.e., those that could not be assigned to an OTU and those that could not be adequately identified, such as early instars), as well as all Chironomidae larvae, were eliminated. The resulting sample counts were reduced to 300, if more than 300 individuals remained after removal of ambiguous taxa. Sites were assigned to the appropriate submodel based on climate (i.e., low mean annual precipitation, and high mean monthly temperature), which were used to predict expected taxa occurrence (E) using longitude, percent sedimentary geology in the watershed, and log mean annual precipitation. Climatic data were obtained from the Oregon Climate Center (accessed online March 30, 2007: http://www.ocs.orst.edu/prism), and geologic data were obtained from a generalized geological map of the United States (accessed online March 30, 2007: http://pubs.usgs.gov/atlas/geologic). Details of these predictive models can be found in Ode *et al.* 2008.

The two Central Valley sites were located in streams with ambiguous watersheds, and therefore required that percent sedimentary geology be estimated, rather than calculated by geographic information systems (GIS). For this study, percent sedimentary geology was estimated at 100%. Using different percent sedimentary geology values (i.e., 0, 20, 40, 60, and 80%) had negligible effect on O/E scores; coefficient of variation for scores within each sample at the two Central Valley sites was <2%, (data not shown), perhaps as a result of the low numbers of observed taxa at these sites.

Evaluation of sampling methods and indices

Efficacy

To assess the efficacy of the sampling methods, the percentage of samples was calculated for each method that collected at least 450 individuals (within 10% of the minimum number for calculating the SCIBI) or at least 270 individuals (within 10% of the minimum number for calculating O/E, counting only unambiguous taxa). In bioassessment applications, smaller samples would be rejected and represent wasted resources. In order to minimize the effects of pseudoreplication, the percentage of samples containing an adequate number of individuals was calculated for each site; then, this percentage was averaged across all 21 sites. This rate estimated the likelihood of collecting adequate samples from the population of sites in the study. McNemar's test was used to test differences between methods (paired within sites) for statistical significance (Zar 1999, Stokes *et al.* 2000). Because McNemar's test requires binary data, within-site rates were rounded to 1 or 0 at replicated sites. A Bonferroni correction was used to account for multiple tests across methods (i.e., $\alpha = 0.05/3 = 0.017$).

Comparability

To see if the different sampling methods collected similar types of organisms, community structure between sampling methods was compared using a Mantel test (Mantel 1967). Mantel tests provide a measure of correlation (Mantel's R) between two sampling methods. Sorensen distance was used as a dissimilarity measure. For sites where multiple samples were collected, mean distances were used; that is, matrices comprised mean or observed distances between pairs of sites, not samples. All samples were included in this analysis, regardless of the number of individuals collected. Significance was tested against correlation values for 999 runs with randomized data.

A Bonferroni correction was used to account for multiple tests across methods (i.e., $\alpha = 0.05/3 = 0.017$). PC-ORD [Version 5.12] was used to run Mantel tests (MJM Software Design, Glendeden Beach, OR).

To determine the relative influence of sampling method on assessment indices, a variance components analysis was used to determine how much of the variability was explained by differences among sites, sampling methods, and their interaction. Restricted maximum likelihood (REML) was used to calculate variance components because of the unbalanced design. SAS was used for all calculations (using PROC VARCOMP method=REML, SAS Institute Inc. 2004). Unlike the mean square method of estimating variance components, REML ensures that all components are greater than or equal to zero (Larsen *et al.* 2001). Because sites were a fixed factor and not a random factor, the variance component attributable to site must be considered a finite, or pseudo variance (Courbois and Urquhart 2004). Only sites where all three sampling methods were represented (after excluding samples containing inadequate numbers of organisms) were used in this analysis.

To assess agreement among the sampling methods, mean SCIBI and O/E values were calculated and regressed for each pair of methods. Slopes were tested against 1 and intercepts to 0 ($\alpha = 0.05$); Theil's test for consistency and agreement, which is based on differences between sampling methods, was used as an additional test of comparability (Theil 1958). Pairwise differences between mean SCIBI and O/E scores were regressed against log watershed area and stream order to see if these gradients contributed to the observed disagreements. A Bonferroni correction was not used for either analysis in order to increase the ability to detect disagreements. Bias was not explicitly assessed because none of the methods could be assumed to represent a true value. Only samples with adequate numbers of individuals were used in this analysis.

Sensitivity

The sensitivity of the assessment indices to watershed alteration was assessed by correlating mean SCIBI and O/E scores against land cover metrics, including percent open, developed, and agricultural land within the watershed for all sites with unambiguous watersheds (Table 1). This analysis assumed that the biology of the streams respond to these watershed alterations. Open water was excluded from all calculations. Land cover data was obtained from the National Land Cover Database (USGS 2003). Relationships were assessed by calculating the Spearman rank correlation, which is robust to non-normal distributions and extreme values in land cover metrics (Zar 1999). Only samples with the minimum number of individuals for each index were used in this analysis. Data from each sampling method were analyzed independently. A Bonferonni correction was used to account for multiple comparisons ($\alpha = 0.05/6 = 0.008$) across two indices and three land cover classes within each method.

Precision

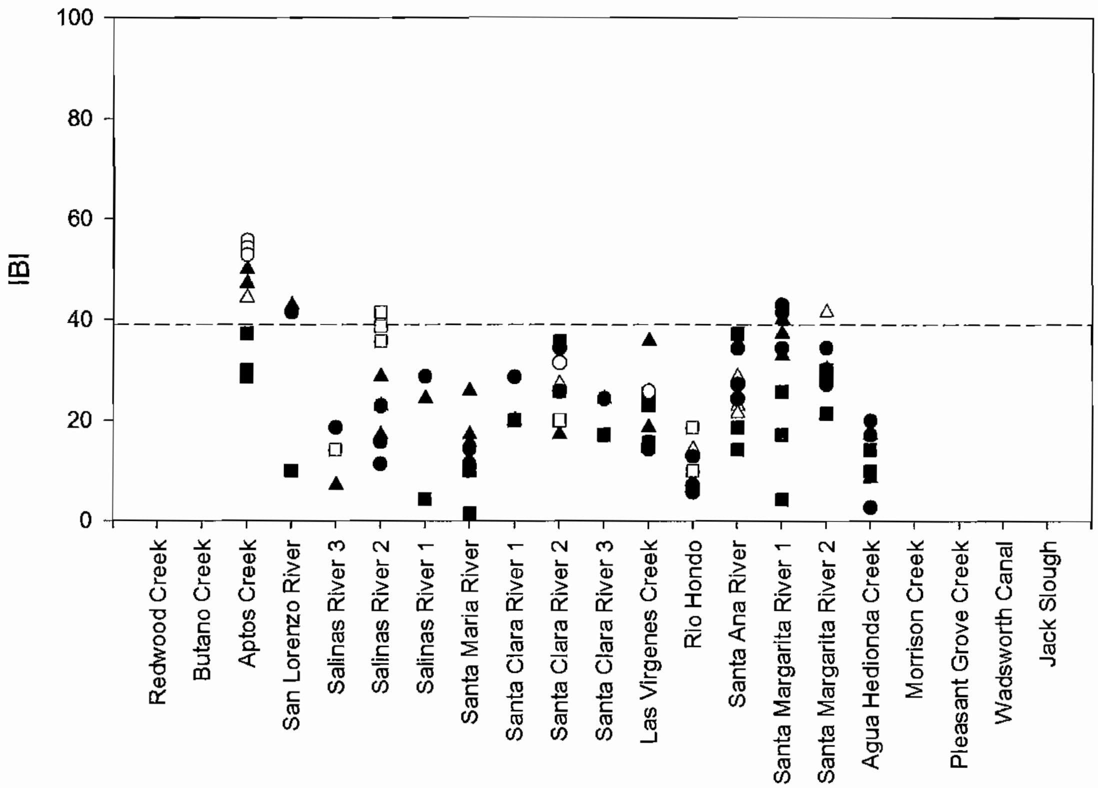
Precision was evaluated by calculating the MDD of each sampling method for SCIBI and O/E scores (Zar 1999, Fore *et al.* 2001). The MDD was calculated using the mean squared error from a nested ANOVA (replicates within site) as an estimate for average within-site variance. Only data from site and method combinations with replication (after exclusion of samples lacking adequate numbers of individuals) were used to estimate variability. These estimated variabilities were applied to a two-sample *t*-test ($\alpha = 0.05$, $\beta = 0.10$) with three replicates in each sample. Additionally, the coefficient of variation (CV) of the indices for each method, averaged across sites, was calculated.

RESULTS

One hundred thirty-five samples were collected at 21 sites throughout the state; 15 of these sites were located along the southern and central California coast. All three methods were used at each site, and 196 taxa were identified. For all sampling methods, SCIBI and O/E scores were low at most sites (Figure 2). For example, mean SCIBI scores were well under 39 (the impairment threshold) at all but one site (Aptos Creek). Observed-over-expected scores indicated impairment in nearly every sample, as scores were below the impairment threshold of 0.66 in all but three samples.

Efficacy

Efficacy was low for all methods, and many samples contained fewer than the required number of individuals. Ideally, each sample should have contained at least 500 individuals. However, only 46 of 135 samples met this target; 34 of the remaining 89 samples had at least 450 individuals, the minimum required for calculation of the SCIBI. For the 55 samples with fewer than 450 individuals, IBIs may a)



b)

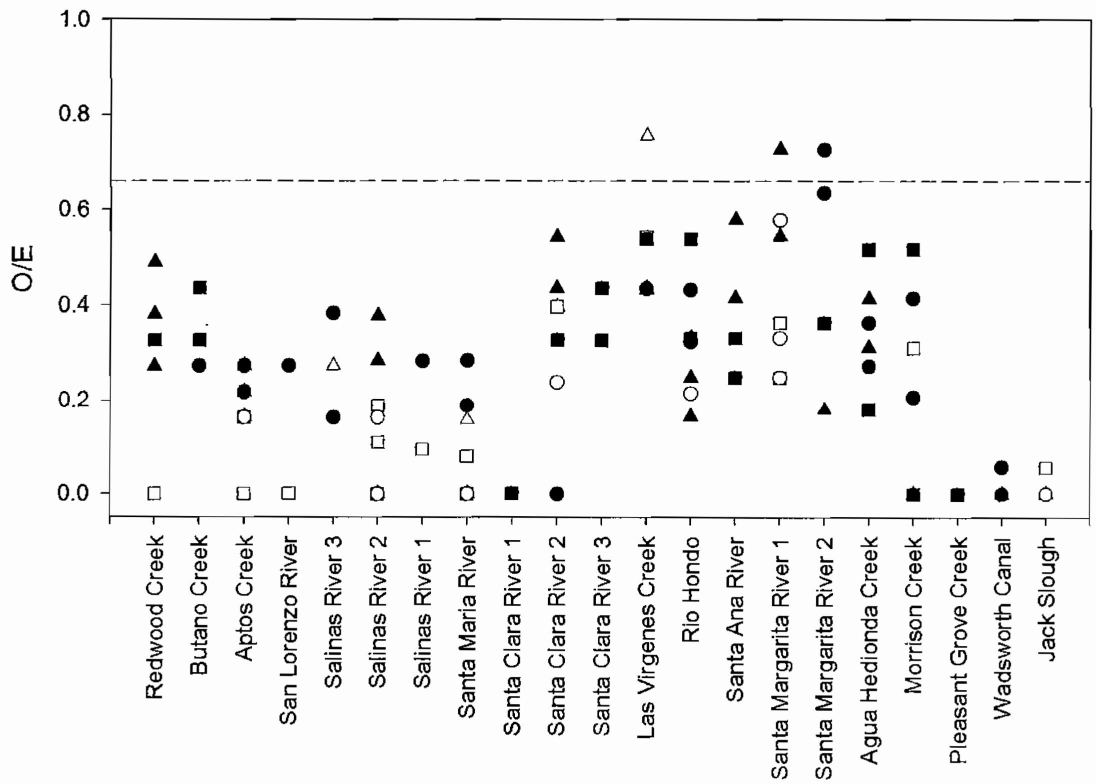


Figure 2. Southern California Index of Biotic Integrity (SCIBI; a) and Observed/Expected (O/E; b) scores by site and method. Each point represents an individual sample. Triangles represent MCM samples. Squares represent RWB samples. Circles represent TRC samples. Black symbols are samples containing sufficient individuals for index calculation, and white symbols are samples containing insufficient individuals for index calculation. Dashed lines represent the threshold for identifying impairment with each index (i.e., 39 for the SCIBI, and 0.66 for the O/E).

not be valid. Furthermore, 55 samples had fewer than 270 unambiguously identified individuals, meaning that O/E scores may not be valid for these samples.

Several samples had extremely low counts (e.g., four individuals; Table 2). Most of these samples were collected by the RWB sampling method. Nearly half (21 out of 45) of RWB samples had fewer than 450 individuals. In contrast, only 2 MCM samples and 6 TRC samples had fewer than 450 individuals. The adjusted efficacy rate, a site-adjusted estimate of sampling efficacy, for the MCM method (54%) was twice that of RWB (27%). The adjusted efficacy rate for TRC (46%) was nearly as high as that of the MCM method. However, these differences fell short of statistical significance after Bonferroni corrections were applied (i.e., p >0.017). The rates were slightly higher for samples with at least 270 individuals at 67, 32, and 67% for MCM, RWB, and TRC, respectively, and these differences were statistically significant (McNemar's test p = 0.0039).

Comparability

Sampling methods comparability was good in terms of both multivariate community structure and index scores. Mantel's test showed significant correlations among benthic macroinvertebrate communities collected by all three sampling methods (Table 3). However, the RWB method had weaker correlations with both TRC (0.40) and MCM (0.45), compared to the higher correlation observed between TRC and MCM (0.69). In all cases, the correlations were significant (p <0.002).

Variance components analysis showed that the methods were highly comparable and that site accounted for nearly all of the explained variance in both indices. The analysis of SCIBI scores included 7 sites and 26 samples; the analysis of O/E scores included 10 sites and 52 samples. Site accounted for

Table 3. Mantel correlations between sampling methods. Asterisk denotes statistical significance (p <0.017).

Method 1	Method 2	Mantel's R	P
RWB	MCM	0.45	0.001*
RWB	TRC	0.40	0.002*
MCM	TRC	0.69	0.001*

100% of the explained variance in SCIBI scores and 95% in O/E scores. Method and interaction between site and method explained none or negligible components of the variance in these indices (0 to 5%).

Significant disagreements between pairs of sampling methods were not observed for either index (Table 4; Figure 3). Slopes for all three comparisons were not significantly different from 1, and no intercepts were significantly different from 0. Consistency among SCIBI scores was best (i.e., slope closest to 1) between the MCM and TRC methods (slope = 0.96) and worst for the MCM and RWB methods (slope = 0.62). In contrast, consistency among O/E scores was best between the MCM and RWB methods (slope = 0.97) and worst for the RWB and TRC methods (slope = 0.72). Theil's test confirmed the lack of significant disagreements among IBI and O/E scores between pairs of methods. No differences between sampling methods were significantly related to log watershed area or stream order (regression slope and intercept p >0.05).

Sensitivity

Sensitivity of both indices to gradients in land cover was poor, although to some extent the relationships were affected by sampling method, specific cover type, and geographic scale (Table 5; Figure 4). For example, O/E scores were strongly and negatively correlated with agricultural land cover in the

Table 2. Samples, sites, and efficacy by method. Adjusted Rate = site-adjusted estimate of efficacy rate.

Method	Total		≥ 450 Organisms			≥ 270 Organisms		
	Samples	Sites	Samples		Adjusted Rate	Samples		Adjusted Rate
MCM	45	21	34	76%	54%	32	71%	67%
RWB	45	21	17	38%	27%	14	31%	32%
TRC	45	21	29	64%	46%	30	67%	67%

Table 4. Regressions of mean IBI and O/E scores for each method. Slopes were tested against 1 and intercepts were tested against 0. Methods 1 and 2 plotted on x and y axis, respectively, in Figure 3. SE = Standard error.

Index	Method 1 (x)	Method 2 (y)	n	r^2	Slope	SE	p	Intercept	SE	p
SCIBI	MCM	TRC	14	0.77	0.96	0.15	0.803	2.52	3.96	0.537
	MCM	RWB	7	0.45	0.62	0.25	0.194	6.31	5.53	0.305
	MH	TRC	7	0.74	1.18	0.28	0.540	-0.30	5.63	0.959
O/E	MCM	TRC	14	0.78	0.86	0.13	0.284	0.02	0.04	0.633
	MCM	RWB	8	0.90	0.97	0.13	0.816	0.02	0.04	0.653
	RWB	TRC	8	0.71	0.72	0.19	0.185	0.06	0.06	0.401

watershed (Spearman's ρ ranged from -0.46 to -0.89 across sampling methods). However, most relationships between index scores and land cover metrics were not statistically significant (i.e., $p < 0.008$). Only the relationship between O/E scores from RWB samples were significantly correlated with agricultural land use in the watershed ($\rho = -0.89$, $p = 0.003$). Although the direction of correlation often met expectations (e.g., % open space in the watershed vs. SCIBI; Figure 4c), a few showed no clear relationship (e.g., % developed land in the watershed vs. O/E; Figure 4d).

Precision

Sampling method affected the precision of both the SCIBI and O/E scores (Table 6). For example, the RWB sampling method had the largest MDD for the SCIBI: 22 vs. 19 for the other two methods. However, RWB had the lowest MDD when O/E

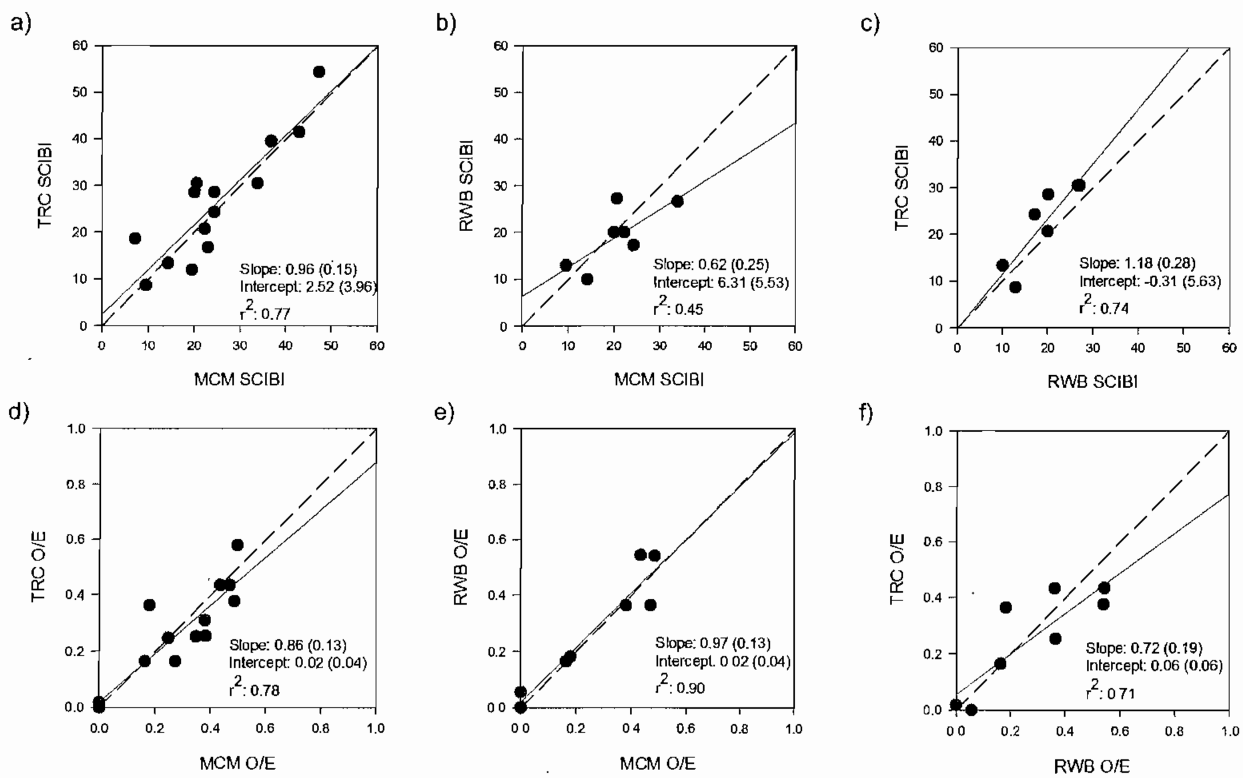


Figure 3. Agreement between the sampling methods for Southern California Index of Biotic Integrity (SCIBI; a – c) and Observed/Expected (O/E; d – f) scores Each point represents the mean index score at a site. Solid lines represent linear regressions, and dashed lines represent perfect 1:1 relationships. Numbers in parentheses are standard errors. Slopes were tested against 1, and intercepts were tested against 0.

Table 5. Spearman rank correlations (ρ) between bioassessment indices and landscape metrics. * = statistical significance ($p < 0.008$).

Index	Land Cover	Method	Watershed			1 km radius		
			n	ρ	p	n	ρ	P
SCIBI	% Developed	MCM	15	-0.08	0.783	15	0.11	0.685
		RWB	7	-0.75	0.054	7	-0.59	0.159
		TRC	14	-0.32	0.914	14	0.20	0.487
	% Open	MCM	15	-0.04	0.892	15	0.09	0.742
		RWB	7	0.62	0.139	7	0.67	0.102
		TRC	14	-0.04	0.890	14	-0.08	0.782
	% Agricultural	MCM	15	0.06	0.842	15	-0.11	0.689
		RWB	7	0.12	0.799	7	0.22	0.628
		TRC	14	0.00	0.991	14	-0.02	0.954
O/E	% Developed	MCM	15	0.14	0.640	15	0.35	0.202
		RWB	8	-0.28	0.509	8	-0.07	0.866
		TRC	17	0.23	0.370	17	0.31	0.222
	% Open	MCM	15	-0.05	0.857	15	0.01	0.980
		RWB	8	0.40	0.333	8	0.17	0.693
		TRC	17	-0.24	0.355	17	0.02	0.948
	% Agricultural	MCM	15	-0.67	0.009	15	-0.24	0.388
		RWB	8	-0.89	0.003*	8	-0.15	0.719
		TRC	17	-0.46	0.064	17	-0.31	0.220

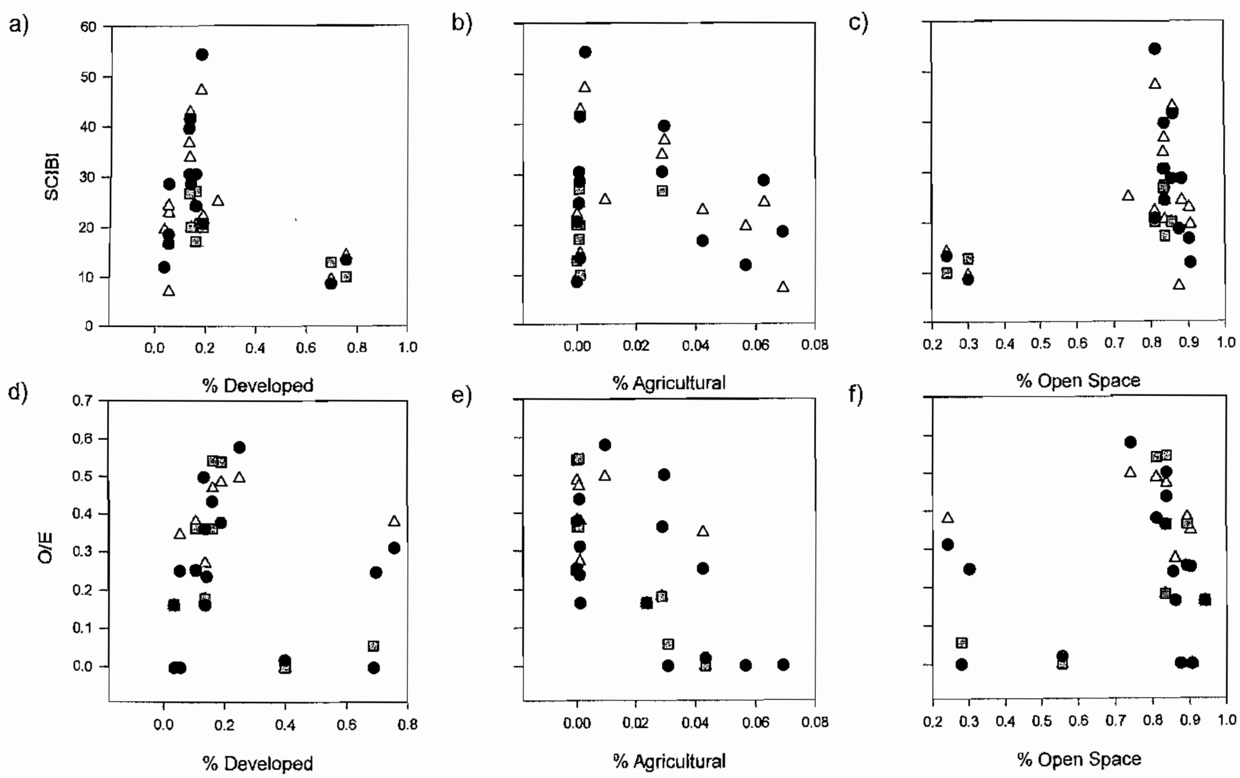


Figure 4. Index scores versus land cover metrics. Each point represents the mean of all samples collected by one method at each site. White triangles represent MCM samples. Gray squares represent RWB samples. Black circles represent TRC samples.

Table 6. Within-site variability (expressed as mean square error, MSE) and minimum detectable difference (from a two-sample, 2-tailed t-test with n = 30, α = 0.05, and β = 0.1) for each of the sampling methods. d.f.: degrees of freedom. SS: sum of squares. MSE: mean square error. MDD: mean detectable difference.

Index	Method		d.f.	SS	MSE	F	p	MDD
SCIBI	TRC	Sites	7	2507	358	12.5	>0.0001	19
		Residuals	15	430	29			
	RWB	Sites	3	403	134	3.7	0.0701	22
		Residuals	7	254	36			
	MCM	Sites	8	1745	218	8.0	0.0002	19
		Residuals	16	437	27			
O/E	TRC	Sites	8	0.625	0.078	12.7	>0.0001	0.28
		Residuals	13	0.074	0.006			
	RWB	Sites	3	0.115	0.038	14.5	0.0037	0.20
		Residuals	6	0.016	0.003			
	MCM	Sites	9	0.860	0.096	20.9	>0.0001	0.24
		Residuals	17	0.078	0.005			

scores were used: 0.20 vs. 0.28 for TRC and 0.24 for MCM. Coefficients of variation showed similar trends in variability among methods when SCIBI scores were used, (ranging from 22 to 27%), and lower CVs for RWB when O/E scores were used: 12 vs. 20% for MCM and 45% for TRC.

The low number of samples containing adequate numbers of individuals meant that estimates of within-site variance were sometimes based on very small samples. For example, only four sites in the region using the SCIBI had multiple samples with sufficient numbers of organisms collected by the RWB method. This problem was less severe for estimates based on O/E scores because fewer individuals per sample are required for index calculation, and because sites in the Central Valley and San Francisco Bay area could be included in the estimates.

Discussion

Low-gradient streams are distinct from other streams in many aspects, such as substrate material, bed morphology, and the distribution of microhabitats (Montgomery and Buffington 1997). As a consequence of these differences, traditional bioassessment approaches in California that were developed in high-gradient streams with diverse microhabitats have limited applications in low-gradient reaches. The sampling methods evaluated in this study differed in the extent to which they targeted the richest microhabitats (such as riffles, or vegetated margins). For example, the TRC method allows field crews to select the richest microhabitats specifically. In contrast, the RWB method may systematically undersample or miss these habitats entirely, as the richest areas in low-gradient streams are typically found at the margins (Montgomery and Buffington 1997). The MCM method, a modification of the RWB method, was designed so that these margins could be targeted.

Caution should be used when applying sampling methods or assessment tools that were calibrated for specific habitat types (e.g., high-gradient streams) to new habitats (e.g., low-gradient streams). The present study's evaluation of assessment tools unveiled a number of shortcomings that weaken application of these tools in low-gradient streams, including the inability to collect adequate numbers of organisms, poor sensitivity of assessments, and low precision of the sampling methods. Significant disagreements among the methods were not detected, although power was low because of the low number of samples. The inability of the RWB sampling method to collect an adequate number of individuals in nearly half of all samples makes it unsuitable for low-gradient streams, even though this method is widely used by bioassessment programs in California (Ode 2007) and across the USA (Peck *et al.* 2006). Although biomonitoring programs must assess a diverse range of habitat types with available tools, the present study indicates that these programs may be well served by evaluating tools in novel habitats where monitoring activities occur.

Variance components analysis of assessment indices showed that differences among sites explained more of the variance in index scores than differences among sampling methods, suggesting that similar types of benthic macroinvertebrates are collected by the different methods. However, analysis of disagreements among the methods indicated that some samples collected by RWB were distinct from those collected by TRC, and samples collected by MCM were intermediate between the other two. For example, samples collected by TRC had lower O/E scores than samples collected by MCM, which in turn were lower than those collected by RWB. However, differences among these methods did not reach statistical significance.

Other studies comparing single, targeted habitat sampling methods (e.g., TRC) to multi-habitat sampling methods (e.g., RWB) have shown similar results. For example, MDDs reported in other studies (or calculated from reported variabilities) were comparable to those reported here, although generally larger (Rehn *et al.* 2007, Blocksom *et al.* 2008). However, these studies found that multi-habitat sampling reduced variability in multimetric indices, whereas the present study found that variability was lower for the single habitat method (i.e., TRC; Table 7). As in Rehn *et al.* (2007), the present study found that TRC samples had higher O/E scores than RWB samples, but that the strength of disagreement was inconsistent in the largest watersheds.

The generally weak response of the indices to land cover metrics suggests that the SCIBI and O/E may not be sensitive to variability in watershed-scale disturbance in low-gradient streams. This conclusion is tempered by small sample sizes that limited power, and sensitivity to reach-scale degradation was not explored in this study for lack of data. Several studies have shown the strong impact of reach-scale factors on benthic macroinvertebrates, which may exceed the influence of watershed-scale stressors (e.g., Hickey and Doran 2004, Sandin and Johnson 2004). Furthermore, most of the watersheds in the study were highly altered, particularly those in the region of the SCIBI, and portions of the disturbance gradient to which these indices are more sensitive may not have been adequately sampled. Several studies have found that biota responds to disturbance gradients ≤10% development in a watershed, but responses above this gradient are muted (e.g., Hatt *et al.* 2004, Walsh *et al.* 2007). Agricultural land cover, which was low in most watersheds (<10%), showed strong responses with the indices, suggesting that the study was able to capture portions of this gradient to which both the SCIBI and O/E were sensitive.

The low numbers of organisms collected from the low-gradient streams in the study may reflect the naturally low population densities of benthic macroinvertebrates in these reaches. The River Continuum Concept hypothesizes that higher order streams with larger watersheds have a lower energy base because of reduced allochthonous input and depressed autochthonous productivity (Vannote *et al.* 1980). This lower energy base would be expected to support reduced biomass. However, observation of the sites in this study suggests that the lack of stable microhabitats (e.g., riffles and vegetated margins) may account for the reduced numbers of macroinvertebrates, as few species are adapted to the shifting sandy substrate found in most low-gradient streams in California. A well known, but extreme, example of the impact of shifting sandy substrates on maintaining low densities of benthic macroinvertebrates are the migrating submerged dunes in the lower

Table 7. Minimum detectable differences in multimetric indices. Southern California Index of Biotic Integrity (SCIBI); Northern California Index of Biotic Integrity (NICIBI); Virginia Stream Condition Index (VSCI); Macroinvertebrate Biotic Integrity Index (MBII); California O/E Index (O/E); and NT = not tested.

Index type	Method	Present study	Rehn *et al.* 2007	Blocksom *et al.* 2008	
Multimetric index	Single-habitat	19.2 (SCIBI)	19.7 (SCIBI + NCIBI)	19.88 (VSCI)	29.79 (MBII)
	Multi-habitat	22.6 (SCIBI)	15.5 (SCIBI + NCIBI)	17.37 (VSCI)	17.91 (MBII)
Predictive model	Single-habitat	0.28 (O/E)	0.22 (O/E)	NT	NT
	Multi-habitat	0.20 (O/E)	0 19 (O/E)	NT	NT

Amazon River (Sioli 1975, Lewis, Jr. *et al.* 2006). Although very high productivity of Chironomidae and other benthic macroinvertebrates has been observed in low-gradient sandy rivers of the southeastern United States, this productivity was attributed to snags and other stable microhabitats, more than to the shifting sandy substrate (Benke 1998). Thus, the vast majority of the macroinvertebrate activity in a large reach of river was found in small areas containing snags (Wallace and Benke 1984). Snag microhabitats are arguably less common in streams of the arid Southwest, which lack dense riparian forests to contribute snag-forming woody debris and may be less likely to be sampled using a systematic sampling method like RWB.

Bioassessment programs are often required to make do with available tools to fulfill regulatory mandates, yet they lack resources to evaluate the tools for applications in all habitats of concern. Although all sampling methods in this study suffered from poor efficiency in collecting organisms, the MCM method greatly improved efficacy and reduced the frequency of rejected samples. Furthermore, the lack of significant disagreements and inconsistencies suggests that the MCM method produced results that were comparable to the other methods already in use in California, which may facilitate integration of historical data sets (Cao *et al.* 2005, Rehn *et al.* 2007). Therefore, the present study supports the use of MCM in low-gradient streams in California as a substitute for the currently preferred RWB method. Overall, bioassessment programs can improve data quality and avoid unnecessary expenses by explicitly evaluating assessment tools when assessing novel habitat types.

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Inc., and California Regional Water Quality Control Boards for field sampling; and Chuck Hawkins for assistance with predictive models. This project was partially supported by the Stormwater Monitoring Coalition of Southern California.

ATACHMENT D Certified 7004 1160 0000 6970 9190

WATER RECLAMATION
SOLID WASTE MANAGEMENT

COUNTY SANITATION DISTRICTS
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STEPHEN R. MAGUIN
Chief Engineer and General Manager

July 13, 2009

Ms. Tracy Egoscue
California Regional Water Quality Control Board
Los Angeles Region
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Dear Ms. Egoscue:

Request for Postponement of Hearing and
Opportunity for Submission of Written Comments on revised July 2009 303(d) List

The purpose of this letter is to request postponement of the California Regional Water Quality Control Board, Los Angeles Region's (Regional Water Board) public hearing regarding the 2008 Los Angeles Region Clean Water Act Section 303(d) List of Impaired Waters (303(d) List) which is scheduled for consideration on Thursday, July 16, 2009. We also request an opportunity to submit written comments on the revised 303(d) List labeled July 2009 that was only made readily available today. This version includes major substantive changes from the previously published version that would likely have significant impacts on the Sanitation Districts' discharge standards and receiving water objectives. We respectively request that adequate time to perform detailed technical review and submit written comments be provided before the Regional Water Board takes action. Due to these considerations, the Sanitation Districts request that the hearing scheduled for this Thursday be postponed to a later Regional Water Board meeting. Thank you for your consideration of this request.

Very truly yours,

Stephen R. Maguin

Stephen R. Maguin

SRM:ATH:lmb

cc: LB Nye, Regional Water Board
Man Voong, Regional Water Board

DOCS 1312924

ATACHMENT D

From: PostMaster
Sent: Monday, July 13, 2009 3:31 PM
To: Burgess, Lilian
Subject: Delivery Status Notification (Relay)

This is an automatically generated Delivery Status Notification.

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ATACHMENT D

Written Comments on Revised July 2009 303(d) List, DOC #1312924From: Burgess, Lilian
Sent: Monday, July 13, 2009 3:30 PM
To: tegoscue@waterboards.ca.gov
Subject: Written Comments on Revised July 2009 303(d) List, DOC #1312924

From the office of Ray Tremblay

<<1312924.pdf>>

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STEPHEN R. MAGUIN
Chief Engineer and General Manager

July 16, 2009
File No. 31-370-40.4A

Ms. Tracy Egoscue
California Regional Water Quality Control Board
Los Angeles Region
320 West 4th Street, Suite 200
Los Angeles, CA 90013

Dear Ms. Egoscue:

Comments on the July 2009 Version of the Proposed Los Angeles Region
Clean Water Act Section 303(d) List of Impaired Waters

On July 13, 2009, the Sanitation Districts of Los Angeles County (Sanitation Districts) submitted a letter requesting postponement of the California Regional Water Quality Control Board, Los Angeles Region's (Regional Water Board's) public hearing regarding the proposed 2008 Los Angeles Region Clean Water Act Section 303(d) List of Impaired Waters (303(d) List). The letter also requested an opportunity to submit written comments on the revised 303(d) List labeled July 2009. Based on the change sheet issued by Regional Water staff on July 14, 2009, the Sanitation Districts withdraw their request for postponement of the public hearing. We strongly support the change sheet. However, the Sanitation Districts still believe that the July 2009 version of the 303(d) contains significant changes from the previous version, and that an opportunity to provide written comments is warranted. Therefore, we respectfully request the Regional Water Board accept this letter as part of the record on this matter. Because of the extremely limited time available (less than three business days) to prepare written comments, these comments are preliminary in nature. The Sanitation Districts would appreciate an opportunity to submit more detailed comments on the July 2009 303(d) List at a later date.

Impairment Listings for "Benthic-Macroinvertebrate Bioassessments"

The July 2009 version of the 303(d) List as amended July 14, 2009 contains a number of newly proposed listings for "Benthic-Macroinvertebrate Bioassessments" that were not included in the April 2009 version. The proposed listings are based on application of the Southern California Coastal Index of Biological Integrity (SoCal IBI), and include listings for San Jose Creek Reach 1 and Santa Clara River Reach 6. The Sanitation Districts believe these proposed listings should be removed, for the reasons listed below.

- Listing Based on SoCal IBI Is Inconsistent With State Policy. The Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List (Listing Policy) indicates that water bodies should only be listed for degradation of biological populations if they have significant degradation **relative to reference sites**. While the scientists that developed the SoCal IBI attempted to incorporate reference conditions into the index itself, the reference conditions used to develop the index did not include any low elevation locations in Los Angeles County similar to the San Jose Creek and the Santa Clara River reaches of concern.[1] Similar low elevation and low gradient streams representative of those in the Los Angeles Region from areas outside the county were significantly under-represented in the study. Therefore, the use of the SoCal IBI for listing purposes is not appropriate for these waterbodies.

- <u>A low SoCal IBI Score Does Not Necessarily Indicate Impairment.</u> Regarding reference conditions, the SoCal IBI is calculated by comparing bioassessment results from a receiving water location to a reference index. A lower score indicates that the receiving water location was different from the reference index but does not necessarily indicate "impairment" unless the stream characteristics (elevation, gradient, habitat structure etc) of the reference locations are similar to those in the sampled location. In other words, different types of streams would be expected to support different types of invertebrate communities. Low-gradient streams differ in many respects from high-gradient streams. In low-gradient streams, bed substrate is typically composed of fines and sand, rather than the cobbles, boulders, or bedrock typically found in high-gradient streams. In high-gradient streams, sediments and leaf litter are typically removed with the increased flow velocities resulting in larger open spaces between rocks and cobble that provide different habitats for different types of invertebrates utilizing different feeding strategies (more predators and fewer detritus feeders). In the low-gradient streams, the sediment and leaf litter/detritus loads are naturally deposited in the channel filling up the available spaces between rocks. These habitats support a much different population of invertebrates (more detritus feeders and fewer predators), not necessarily an "impaired" population. Therefore, adequate consideration of reference sites is an essential component in application of the SoCal IBI.
- <u>The SoCal IBI Has Not Been Validated For Low-Gradient Streams.</u> The scientific community acknowledges that existing assessment tools such as the SoCal IBI have not been validated for low-gradient streams. In a recent study that examined low gradient streams in California, including sites within Reach 6 of the Santa Clara River, Raphael D. Mazor of the Southern California Water Research Program (SCCWRP) stated, "Several biomonitoring efforts in California specifically target low-gradient streams, as these habitats are subject to numerous impacts and alterations, … even though the applicability of assessment tools created and validated in high-gradient streams have not been tested."[2] The study found that, "As a consequence of these differences [substrate material, bed morphology, and distribution of microhabitats], traditional bioassessment approaches in California that were developed in high-gradient streams with diverse microhabitats have limited applications in low-gradient reaches,"[3] and, "Caution should be used when applying sampling methods for assessment tools that were calibrated for specific habitat types (e.g., high gradient streams) to new habitats (e.g., low gradient streams)."[4] They study also concluded, "….observation of the sites in this study suggests that the lack of stable microhabitats (e.g., riffles and vegetated

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[1] Ode, P.R., A.C. Rehn, J.T. May. 2005. A Quantitative Tool for Assessing the Integrity of Southern Coastal California Streams. Environmental Management Vol. 35, No 4, pp. 493-504.
[2] Mazor, Raphael D.; Schiff, Kenneth; Ritter, Kerry; Rehn, Andy; and Ode, Peter; Bioassessment Tools in Novel Habitats: An Evaluation of Indices and Sampling Methods in Low-Gradient Streams in California, Enviorn. Monit. Assess., DOI 10.1007/s10661-009-1033-3.
[3] Id.
[4] Id.

margins) may account for the reduced number of macroinvertebrates, as few species are adapted to the shifting sandy substrate found in most low gradient streams in California."[5]

- The SoCal IBI Not Appropriate For Modified Channels. The sites where bioassessments were conducted in San Jose Creek Reach 1 were highly modified from natural conditions. The San Jose Creek Reach 1 bioassessment sampling locations are in a channel with concrete-lined sides. The appropriate IBI reference index for such locations has not yet been defined.[6]
- The San Jose Creek Reach 1 Bioassessment Data Fails Data Quality Objectives. The San Jose Creek Reach 1 sites where data was collected in support of the proposed listing are not suitable site for application of the SoCal IBI. The SoCal IBI was developed solely for wadeable streams, and this location is not wadeable. When bioassessments were conducted at these sites, specified sampling protocols had to modified because these locations are not wadeable (i.e., all samples were collected from one edge of the creek instead of at various locations on both sides and the middle of the creek). Therefore, the data collected is not of a sufficient high quality to make determinations of water quality standards attainment, and should be discarded per Section 6.1.4 of the Listing Policy. In a letter to the Sanitation Districts dated June 30, 2008, the Regional Water Board concurred that only wadeable sites should be used for bioassessments and the modified procedure employed by the Sanitation Districts is not representative. The letter states, "... consultations with Dr. Pete Ode, the Surface Water Ambient Monitoring Program's Bioassessment Coordinator, suggest that such **monitoring with modified methods is inappropriate and will not allow comparisons with data collected via the standard method**." [Emphasis added.] Note that Dr. Pete Ode is the scientist responsible for development of the SoCal IBI.
- Other State Agencies Recognize Limitations associated with SoCal IBI. The State Water Resources Control Board (State Water Board), Surface Water Ambient Monitoring Program, Department of Fish and Game, and others recognize the limitations of the SoCal IBI regarding reference sites. They have identified application of Tiered Aquatic Life Uses (TALU) and the selection of more representative/appropriate regional reference locations as being necessary components to the state's bioassessment program.[7]

The Sanitation Districts believe that it is premature at this time to make impairment decisions using the SoCal IBI. Substantive issues remain regarding application of the index, particularly with regard to identification of appropriate reference sites and with regard to whether use of the index is appropriate for highly modified channels. The Sanitation Districts therefore strongly recommend that the Regional Water Board delay making decisions regarding benthic macroinvertebrate community impairments in this listing cycle. Instead, the Regional Water Board should work with stakeholders and scientists to resolve these outstanding issues, and consider impairments of benthic macroinvertebrate communities in the next listing cycle.

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[5] Id.

[6] Ken Schiff, Deputy Director of the Southern California Coastal Water Research Program. Personal communication. 7/14/2009.

[7] Ode, P.R., K. Schiff. Technical Report 581. Recommendations for the Development and Maintenance of a Reference Condition Management Program, Report to the Surface Water Ambient Monitoring Program. Southern California Coastal Water Research Project.
C.O. Yoder and R. Plotnikoff. 2009. Evaluation of the California State Water Resources Control Board's Bioassessment Program, Final Report to U.S. EPA-OST and Region IX.

In conclusion, the Sanitation Districts request that the Regional Water Board make changes to the proposed 303(d) list as outlined in this letter, and would welcome the chance to work with the Regional Board on developing guidance regarding the use of bioassessments for making impairment decisions. If you have any questions regarding this letter, please contact Ann Heil at (562) 908-4288, extension 2803, aheil@lacsd.org.

Very truly yours,
Stephen R. Maguin

Raymond Tremblay
Assistant Departmental Engineer
Technical Services Department

RT:ATH:lmb

Cc: Renee Purdy, Regional Water Board
LB Nye, Regional Water Board
Man Voong, Regional Water Board