FINAL

Functional Equivalent Document

Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List

SEPTEMBER 2004

DIVISION OF WATER QUALITY

STATE WATER RESOURCES CONTROL BOARD

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

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STATE WATER RESOURCES CONTROL BOARD
DIVISION OF WATER QUALITY

FINAL FUNCTIONAL EQUIVALENT DOCUMENT

WATER QUALITY CONTROL POLICY FOR DEVELOPING CALIFORNIA'S CLEAN WATER ACT SECTION 303(d) LIST

FINAL
SEPTEMBER 2004

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STATE WATER RESOURCES CONTROL BOARD
RESOLUTION NO. 2004-0063

ADOPTION OF THE WATER QUALITY CONTROL POLICY (POLICY) FOR DEVELOPING CALIFORNIA'S CLEAN WATER ACT SECTION 303(d) LIST

WHEREAS:

1. Section 303(d)(1) of the federal Clean Water Act (CWA) requires states to identify waters that do not meet applicable water quality standards with technology-based controls alone and prioritize such waters for the purposes of developing Total Maximum Daily Loads (TMDLs) [40 Code of Federal Regulations (CFR) 130.7(b)].

2. Section 13191.3(a) of the California Water Code (CWC) requires the State Water Resources Control Board (SWRCB) to prepare guidelines to be used by SWRCB and the Regional Water Quality Control Boards (RWQCBs) in listing, delisting, developing, and implementing TMDLs pursuant to section 303(d) of the federal CWA [33 United States Code (USC) section 1313(d)].

3. California Assembly Bill (AB) 982 Public Advisory Group (PAG) was established in 2000 to assist in the evaluation of SWRCB's water quality programs' structure and effectiveness as it relates to the implementation of section 303(d) of CWA [33 USC section 1313(d)] and applicable federal regulation.

4. CWC section 13191.3(b) also requires the SWRCB to consider the consensus recommendations on the guidelines adopted by PAG.

5. The 2001 Budget Act Supplemental Report required the use of a "weight of evidence" approach in developing the Policy for listing and delisting waters and to include criterion to ensure that data and information used are accurate and verifiable.

6. SWRCB, in compliance with CWC section 13147, held public hearings in Sacramento, California, on January 28, 2004 and in Torrance, California, on February 5, 2004 on the Water Quality Control Policy and carefully considered all testimony and comments received.

7. SWRCB has completed a scientific peer review by University of California scientists of the draft Functional Equivalent Document as required by section 57004 of the Health and Safety Code.

8. SWRCB has determined that the adoption of this Policy will not have a significant adverse effect on the environment.

9. The regulatory provisions of the Policy do not become effective until the regulatory provisions are approved by the Office of Administrative Law (OAL).

THEREFORE BE IT RESOLVED THAT:

The SWRCB:

1. Approves the final FED: Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List.

2. Adopts the Policy for Developing California's Clean Water Act Section 303(d) List (Attachment).

3. Authorizes the Executive Director or designee to submit the Policy to the Office of Administrative Law for approval.

4. Shall hold a public workshop after the approval of the 2004 section 303(d) list to assess implementation of the Policy.

CERTIFICATION

The undersigned, Clerk to the Board, does hereby certify that the foregoing is a full, true, and correct copy of a resolution duly and regularly adopted at a meeting of the State Water Resources Control Board held on September 30, 2004.

Debbie Irvin

Debbie Irvin
Clerk to the Board

PREFACE

Section 303(d) of the federal Clean Water Act (CWA) and accompanying federal regulations require states to regularly identify water bodies that cannot achieve applicable water quality standards after technology-based controls have been implemented. In complying, California has developed successive lists of "impaired" water bodies biennially since 1976. After 1996, public attention increasingly focused on an important consequence of "section 303(d) listing" — the development and implementation of Total Maximum Daily Loads (TMDLs). Simultaneously, public demand for regional consistency and transparency in the section 303(d) listing process intensified.

In response, the California Water Code (CWC) was modified to require the State Water Resources Control Board (SWRCB) to prepare guidelines for listing or delisting water bodies on the section 303(d) list (CWC section 13191.3(a)). SWRCB regulations (Title 23 of the California Code of Regulations [CCR] section 3777(a)) independently require that an environmental review, equivalent to a CEQA document, accompany a Policy proposed for SWRCB adoption. Such a "functionally equivalent document" (FED) must contain (a) a brief description of, (b) reasonable alternatives to, and (c) mitigation measures for the proposed activity.

This document is the final FED supporting a Policy for development of and revisions to a list of water quality limited segments, otherwise known as a section 303(d) list of water quality limited segments. This final FED explores various alternatives, provides options and recommendations, and evaluates the environmental impacts of these guidelines.

The proposed "Water Quality Control Policy for Developing California's CWA Section 303(d) List" (Policy) is intended to provide SWRCB and RWQCB staff with recommended procedures for evaluating information solicited in support of listing or delisting candidate water bodies for the section 303(d) list. The Policy does <u>not</u> develop new or revise existing water quality standards (i.e., beneficial uses, water quality objectives, or the State's Non-degradation Policy). The Policy does address scheduling of listed water bodies for eventual development and implementation of TMDLs.

The SWRCB held public hearings on January 28, 2004 and February 5, 2004 to hear public comment on the draft FED and Policy. SWRCB received testimony and written comments from 126 individuals or organizations. SWRCB staff responded to all comments received and the draft FED and Policy have been revised in response.

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LIST OF ABBREVIATIONS

AB	Assembly Bill
AGR	Agriculture water supply beneficial use category
α	Type I error rate (alpha)
APA	Administrative Procedure Act
ASTM	American Society of Testing Materials
β	Type II error rate (beta)
BCF	bioconcentration factor
BMI	benthic macroinvertebrates index
BMP	best management practice
BOD	biological oxygen demand
BPJ	best professional judgment
BPTCP	Bay Protection and Toxic Cleanup Program
BWQW	Beach Water Quality Workgroup
^oC	degrees Celsius
^oF	degrees Fahrenheit
CalEPA	California Environmental Protection Agency
CALM	Consolidated Assessment and Listing Methodology
CAMLnet	California Aquatic Bioassessment Laboratory Network
CCR	California Code of Regulations
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulations
COD	chemical oxygen demand
COMM	Commercial and recreational fisheries beneficial use category
CSBP	California Stream Bioassessment Procedures
CTR	California Toxic Rule
CWA	Clean Water Act
CWC	California Water Code
DDT	dichlorodiphenyltrichloroethane
DEP	Department of Environmental Protection
DEQ	Department of Environmental Quality
DFG	California Department of Fish and Game
DHS	California Department of Health Services
DO	dissolved oxygen
DOC	dissolved organic carbon
dw	dry weight
EDL	Elevated Data Level
EIR	Environmental Impact Report
EMAP	Environmental Monitoring and Assessment Program
EqP	equilibrium partitioning
ERL	Effects Range-Low
ERM	Effects Range-Median
FED	Functional Equivalent Document
GIS	Geographic Information System
H_a	alternate hypothesis

H_o	null hypothesis
I	Incomplete beta function
IBI	index of biological integrity
IND	Industrial process supply beneficial use category
IRIS	Integrated Risk Information System
k	number of exceedances in a sample
kdelist	maximum number of exceedances to remove a water body/pollutant combination from the list
klist	minimum number of exceedances to list
MCL	maximum contaminant level
mg/kg	milligrams per kilogram (parts per million)
mg/L	milligrams per liter (parts per million)
mm	millimeter
MSD	minimum significant difference
MTRL	Maximum Tissue Residue Level
MUN	Municipal beneficial use category
MWAT	maximum weekly average temperature
N	sample size
NAS	National Academy of Sciences
NAV	Navigational beneficial use category
NAWQA	National Water Quality Assessment Program
ng/kg	nanograms per kilogram
NMFS	National Marine Fishery Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	nonpoint source
NSSP	National Shellfish Sanitation Program
NTU	nephelometric turbidity unit
oc	organic carbon
OC	operating characteristics curve
OEHHA	Office of Environmental Health Hazard Assessment
ONRW	outstanding national resource water
P	Probability
p	Estimate of the true proportion of samples
PAG	Public Advisory Group
PAH	Polynuclear Aromatic Hydrocarbon
PCB	polychlorinated biphenyl
PEC	Probable Effects Concentration
PEL	Probable Effects Level
pH	Hydrogen ion concentration
PHG	Public Health Goal
POW	Hydropower generation beneficial use category
PP	Precautionary Principle
QA	quality assurance
QC	quality control
QAPP	quality assurance project plan
QL	quantitation limit

r	exceedance rate
REC	Recreational beneficial use category
REMAP	Regional Environmental Monitoring and Assessment Program
RIVPACS	River Invertebrate Prediction and Classification Scheme
RMP	regional monitoring program
RTAG	Regional Technical Advisory Group
RWQCB	Regional Water Quality Control Board
SB	Senate Bill
SCCWRP	Southern California Coastal Water Research Project
SFEI	San Francisco Estuary Institute
SMWP	State Mussel Watch Program
SNARL	Sierra Nevada Aquatic Research Laboratory
SNARLs	suggested no-adverse-response levels
SQG	sediment quality guideline
STRTAG	State Regional Technical Advisory Group
SWAMP	Surface Water Ambient Monitoring Program
SWMP	Storm Water Management Plan
SWRCB	State Water Resources Control Board
TDS	Total Dissolved Solids
TEL	Threshold Effects Level
TIE	Toxicity Identification Evaluation
TKP	Total Kjeldahl phosphorus
TMDL	Total Maximum Daily Load
TOC	Total Organic Carbon
TSD	Technical Support Document
TSS	Total Suspended Solids
µg/L	micrograms per liter (parts per billion)
USC	United States Code
USEPA	U.S. Environmental Protection Agency
USFDA	U.S. Food and Drug Administration
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
V*	sediment evaluation tool
WDR	waste discharge requirement
WQ	water quality
WQC	Water Quality Criteria
WQO	Water Quality Objective
ww	wet weight

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FINAL FUNCTIONAL EQUIVALENT DOCUMENT:

WATER QUALITY CONTROL POLICY
FOR DEVELOPING CALIFORNIA'S
CLEAN WATER ACT SECTION 303(d) LIST

INTRODUCTION

Section 303(d)(1) of the federal Clean Water Act (CWA) requires states to identify waters that do not meet applicable water quality standards with technology-based controls alone and prioritize such waters for the purposes of developing Total Maximum Daily Loads (TMDLs) (40 Code of Federal Regulations (CFR) 130.7(b)). Water quality limited segments are defined as "any segment [of a water body] where it is known that water quality does not meet applicable water quality standards, and/or is not expected to meet applicable water quality standards, even after application of technology-based effluent limitations required by [CWA] sections 301(b) or 306…" (40 CFR 130.2(j)). The states are required to assemble and evaluate all existing and readily available water quality-related data and information to develop the list (40 CFR 130.7(b)(5)) and to provide documentation to list or not to list a state's waters (40 CFR 130.7(b)(6)).

Section 13191.3(a) of the California Water Code (CWC) requires the State Water Resources Control Board (SWRCB), on or before July 1, 2003, to prepare guidelines to be used by the SWRCB and the RWQCBs (Regional Water Quality Control Boards) in listing, delisting, developing, and implementing TMDLs pursuant to section 303(d) of the federal CWA (33 United States Code [USC] section 1313(d)). In addition, the 2001 Budget Act Supplemental Report required the use of a "weight of evidence" approach in developing the Policy for listing and delisting waters and to include criteria that ensure the data and information used are accurate and verifiable.

CWC section 13191.3(b) also requires the SWRCB to consider the consensus recommendations on the guidelines adopted by the Public Advisory Group (PAG). California Assembly Bill (AB) 982 PAG was established in 2000 to assist in the evaluation of the SWRCB's water quality programs structure and effectiveness as it relates to the implementation of section 303(d) of the CWA (33 USC section 1313 (d)) and applicable federal regulation. The PAG has of twelve members from the regulated community and twelve members from the environmental community. Each member has an alternate representative.

Purpose

The purpose of this Functional Equivalent Document (FED) is to present alternatives and SWRCB staff recommendations for the development of a Water Quality Control Policy to guide the RWQCBs in the development of the CWA section 303 (d) list. The FED also assesses the potential adverse environmental impacts of the recommended Policy.

CEQA Compliance

The SWRCB must comply with the requirements of the California Environmental Quality Act (CEQA) and the Administrative Procedure Act (APA) when adopting a plan, policy or guideline. CEQA provides that a program of a State regulatory agency is exempt from the requirements of preparing Environmental Impact Reports (EIRs), Negative Declarations, and Initial Studies if certain conditions are met. The process the SWRCB is using to develop the Policy has received certification from the Resources Agency to be "functionally equivalent" to the CEQA process (Title 14 CCR section 15251(g)). Therefore, this FED fulfills the requirements of CEQA for preparation of an environmental document.

As part of a certified regulatory program, the proposed Policy is exempt from Chapter 3 of CEQA that requires state agencies to prepare EIRs and Negative Declarations (Resources Code section 21080.5). Agencies qualifying for this exemption must comply with CEQA's goals and policies, evaluate environmental impacts, consider cumulative impacts, consult with other agencies with jurisdiction, provide public notice and allow public review, respond to comments on the draft environmental document, adopt CEQA findings, and provide for monitoring of mitigation measures. SWRCB regulations (CCR Title 23, Chapter 27, section 3777) require that a document prepared under its certified regulatory programs must include:

1. a brief description of the proposed activity;

2. reasonable alternatives to the proposed activity; and

3. mitigation measures to minimize any significant adverse environmental impacts of the proposed activity.

A certified regulatory program is exempt from the requirement to prepare an EIR or Negative Declaration but must comply with other CEQA requirements. The SWRCB will, therefore, prepare the FED following CEQA guidelines. The environmental impacts that may occur as a result of the Policy are summarized in an Environmental Checklist and analyzed in the Environmental Effects section of the FED.

Background

The listing of water bodies pursuant to CWA section 303(d) has evolved over time. The first section 303(d) list was assembled in 1976. This initial list identified less than 20 water bodies in the section 305(b) report as “Water Quality Limited Segments”. The “Water Quality Limited Segments” list remained virtually the same until 1988, when the number of water quality limited segments increased to 75 water bodies. In 1990, the list grew to approximately 250 water quality limited segments due in part to an increase in water quality assessment activity resulting from amendment of the CWA. CWA section 304 required lists of impaired waters and sources to be submitted to U.S. Environmental Protection Agency (USEPA) as a "one time" effort. The list included waters (1) not achieving numeric water quality standards for priority pollutants after implementation of technology-based controls, (2) not meeting the fishable/swimmable goals of the Act, and (3) not meeting applicable standards after technology-based controls were met due primarily to point source discharge of toxic pollutants.

In 1997, the SWRCB and RWQCB staff prepared informal guidance for the water quality assessment update. That guidance outlined procedures for the RWQCBs assessment process. The assessment methodology recommended: (1) reevaluation of the listed water bodies on the 1996 section 303(d) list, (2) reviewing new monitoring information, (3) consistent procedures for the information soliciting process, and (4) measures to increase public participation. The RWQCBs staff used these guidelines to establish public noticing procedures, list or delist water bodies, and prioritize and schedule TMDLs.

In 1998, 509 water bodies were listed with 1,471 water body/pollutant combinations. This 1998 section 303(d) list served as the basis for the 2002 list. The State and USEPA-approved 2002 section 303(d) list has a total of 685 water quality limited segments and 1,883 segment-pollutant combinations (SWRCB, 2003a; USEPA, 2003d).

During the development of the section 303(d) list in 2002, the RWQCBs assembled and evaluated all new available water quality data and information and provided recommendations for each water body-pollutant combination. The RWQCBs prepared staff reports, fact sheets, and summaries of the additions, deletions and changes to the 1998 section 303(d) list in order to create the 2002 list. The SWRCB staff reviewed the RWQCBs staff recommendations and either concurred or identified the reasons for not concurring with the RWQCB recommendations.

In preparing the 2002 section 303(d) list, the SWRCB set *Priorities and Schedules for Completing TMDLs* as required by federal law for listed water bodies to help guide TMDL planning (40 CFR 130.7(b)(4)). Federal regulations also require the state to identify waters targeted for TMDL development in the next two years.

In addition to the section 303(d) list the following related lists were compiled in 2002:

TMDL Completed List. This list included water bodies where a number of TMDLs have been completed to show progress in developing TMDLs. The TMDLs Completed List contained those water quality limited segments that already had TMDLs with approved implementation plans.

Enforceable Programs List. This list included water bodies where an alternate regulatory program was already in place to address the water quality problem. Regulatory programs included the Consolidated Toxic Hot Spots Cleanup Plan and enforcement of existing permits or other legally required authorities. The programs and requirements were specifically applicable to the identified water quality problem.

Monitoring List. Many water bodies identified had minimal, contradictory, or anecdotal information that suggested standards were not met but the available data or information was inadequate to draw a conclusion. In many cases, the data or information were not of adequate quality and/or quantity to support a listing. In these cases, a finding was made that more information must be collected to resolve whether water quality objectives and beneficial uses were attained. Waters on this list were considered high priority for monitoring before the completion of the next section 303(d) list.

The TMDLs Completed List, the Enforceable Programs List, and the Monitoring List were not considered part of the section 303(d) list. However, these lists including the section 303(d) list were submitted to the USEPA.

Developing the Scope of the Policy

CWC section 13191.3(b) requires SWRCB to consider the consensus recommendations of the PAG. In developing the proposed Policy, SWRCB staff consulted with the PAG and other groups several times. Six scoping meetings were held between December 2001 and January 2002 with members from the environmental and regulated caucuses. Based on the feedback received at these meetings, SWRCB staff developed a concept paper discussing important policy issues. This concept paper was discussed at the PAG's February 2002, April 2002, July 2002, and October 2002 meetings (AB 982 PAG, 2002). A pre-draft version of the Policy was reviewed by the PAG during its July 2003 meeting (AB 982 PAG, 2003). At each step in this review the PAG caucuses provided verbal and written comments (e.g., Johns, 2002, 2003; Sheehan, 2002, 2003), but only in February 2002 did the PAG provided consensus recommendations.

Consensus Recommendations of the PAG

In February 2002, the AB 982 PAG developed the following consensus recommendations:

- The listing process should be transparent.
- The public participation process should be transparent; in addition it should be (a) specific and (b) well advertised with active outreach to diverse geographic areas and those with environmental justice concerns.
- To the greatest extent possible, there should be a consistent standardized set of tools and principles used across the Regions to evaluate data. Additionally, site-specific information should be taken into consideration.

Scope of FED

The FED has been developed with consideration of existing state statute, regulations, and policies; the current approaches of the SWRCB and the RWQCBs; approaches used by other states; USEPA guidance; and the consensus recommendations of the PAG.

The FED contains six major sections: Introduction, Environmental Setting, Issue Analysis, Environmental Effects of the Proposed Policy, Environmental Checklist, and References. The Proposed Policy in included in Appendix A and the responses to all comments received before the close of the hearing record on February 18, 2004 and comments received before or at the September 8, 2004 workshop are included in Appendix B. Comments discussed at the September SWRCB workshop were focused on a draft final version of the FED (SWRCB, 2004b).

Statement of Goals

The SWRCB's goals for this Policy are to provide:

- consistent and transparent approaches for the identification of water quality limited segments using a standardized set of tools and principles to be used by the RWQCBs to evaluate data;
- scientifically defensible approaches to address the identification and listing of water bodies on the section 303(d) list; and
- a transparent public participation process.

Proposed Action

The proposed action is SWRCB adoption of the proposed Policy outlined above and as presented in Appendix A.

ENVIRONMENTAL SETTING

California encompasses a variety of environmental conditions ranging from the Sierra Nevada to deserts (with a huge variation in between these two extremes) to the Pacific Ocean.

For water quality management, section 13200 of the Porter-Cologne Water Quality Control Act (Porter-Cologne) divides the State into nine different hydrologic regions. Brief descriptions of the Regions and the water bodies, including water bodies on the 2002 section 303(d) list (Table 1) are presented below. The information descriptive of the Regions provided in this section comes from the Basin Plans.

North Coast Region (Region 1)

The North Coast Region comprises all regional basins, including Lower Klamath Lake and Lost River Basins, draining into the Pacific Ocean from the California-Oregon state line southern boundary and includes the watershed of the Estero de San Antonio and Stemple Creek in Marin and Sonoma Counties (Figure 1). Two natural drainage basins, the Klamath River Basin and the North Coastal Basin divide the Region. The Region covers all of Del Norte, Humboldt, Trinity, and Mendocino Counties, major portions of Siskiyou and Sonoma Counties, and small portions of Glenn, Lake, and Marin Counties. It encompasses a total area of approximately 19,390 square miles, including 340 miles of coastline and remote wilderness areas, as well as urbanized and agricultural areas.

Beginning at the Smith River in northern Del Norte County and heading south to the Estero de San Antonio in northern Marin County, the Region encompasses a large number of major river estuaries. Other north coast streams and rivers with significant estuaries include the Klamath River, Redwood Creek, Little River, Mad River, Eel River, Noyo River, Navarro River, Elk Creek, Gualala River, Russian River and Salmon Creek (this creek mouth also forms a lagoon). Northern Humboldt County coastal lagoons include Big Lagoon and Stone Lagoon. The two largest enclosed bays in the North Coast Region are Humboldt Bay and Arcata Bay (both in Humboldt County). Another enclosed bay, Bodega Bay, is located in Sonoma County near the southern border of the Region.

Listings on the 2002 section 303(d) list for the North Coast Region included seven water bodies affecting an estimated 49,374 acres (bays, estuaries, lakes, and wetlands) and 48 water bodies affecting 20,493 miles of rivers and shoreline. The major pollutants affecting these water bodies included nutrients, metals, pathogens, sediment, and temperature among others (SWRCB, 2003a).

TABLE 1: TOTAL WATER BODIES BY REGION, WATER BODY TYPE AND ESTIMATED SIZE AFFECTED ON THE 2002 SECTION 303(D) LIST

Region	Water Body Type	Pollutant Category	Pollutant Category Totals*	Total Estimated Size Affected
1	Bays and Harbors	Other Organics	1	16,075 Acres
1	Estuaries	Nutrients	1	199 Acres
1	Estuaries	Sediment	2	247 Acres
1	Lakes/Reservoirs	Metals/Metalloids	3	6,054 Acres
1	Lakes/Reservoirs	Miscellaneous**	1	26,998 Acres
1	Rivers/Streams	Miscellaneous**	36	17,148 Miles
1	Rivers/Streams	Nutrients	12	5,849 Miles
1	Rivers/Streams	Pathogens	2	282 Miles
1	Rivers/Streams	Sediment	37	14,647 Miles
2	Bays and Harbors	Metals/Metalloids	11	279,415.73 Acres
2	Bays and Harbors	Miscellaneous**	10	270,870.73 Acres
2	Bays and Harbors	Nutrients	1	8,545 Acres
2	Bays and Harbors	Other Organics	10	270,870.73 Acres
2	Bays and Harbors	Pathogens	2	10,984 Acres
2	Bays and Harbors	Pesticides	10	270,870.73 Acres
2	Bays and Harbors	Sediment	1	8,545 Acres
2	Coastal Shoreline	Pathogens	5	3.1 Miles
2	Estuaries	Metals/Metalloids	4	47,472.5 Acres
2	Estuaries	Miscellaneous**	2	47,393 Acres
2	Estuaries	Nutrients	2	54.5 Acres
2	Estuaries	Other Inorganics	2	54.5 Acres
2	Estuaries	Other Organics	5	47,518.5 Acres
2	Estuaries	Pathogens	1	169 Acres
2	Estuaries	Pesticides	6	48,642.5 Acres
2	Lakes/Reservoirs	Metals/Metalloids	4	1,289 Acres
2	Lakes/Reservoirs	Miscellaneous**	1	299 Acres
2	Lakes/Reservoirs	Nutrients	2	441 Acres
2	Lakes/Reservoirs	Trash	1	142 Acres
2	Rivers/Streams	Metals/Metalloids	5	50.3 Miles
2	Rivers/Streams	Nutrients	6	151.1 Miles
2	Rivers/Streams	Pathogens	9	159.4 Miles
2	Rivers/Streams	Pesticides	37	523.3 Miles
2	Rivers/Streams	Sediment	9	202.6 Miles
2	Wetlands, Tidal	Metals/Metalloids	1	66,339 Acres
2	Wetlands, Tidal	Nutrients	1	66,339 Acres

Region	Water Body Type	Pollutant Category	Pollutant Category Totals*	Total Estimated Size Affected
2	Wetlands, Tidal	Salinity	1	66,339 Acres
3	Bays and Harbors	Metals/Metalloids	2	1,998 Acres
3	Bays and Harbors	Pathogens	2	2,001 Acres
3	Bays and Harbors	Pesticides	1	79 Acres
3	Bays and Harbors	Sediment	2	2,001 Acres
3	Bays and Harbors	Toxicity	1	76 Acres
3	Coastal Shoreline	Metals/Metalloids	1	12 Miles
3	Coastal Shoreline	Pathogens	11	7.23 Miles
3	Coastal Shoreline	Pesticides	1	12 Miles
3	Estuaries	Metals/Metalloids	1	196 Acres
3	Estuaries	Nutrients	6	552.2 Acres
3	Estuaries	Other Organics	2	384 Acres
3	Estuaries	Pathogens	5	2,371.2 Acres
3	Estuaries	Pesticides	5	2,397 Acres
3	Estuaries	Salinity	1	30 Acres
3	Estuaries	Sediment	6	2,678.2 Acres
3	Lakes/Reservoirs	Metals/Metalloids	2	6,362 Acres
3	Lakes/Reservoirs	Nutrients	2	79 Acres
3	Lakes/Reservoirs	Pathogens	1	23 Acres
3	Rivers/Streams	Metals/Metalloids	8	102.9 Miles
3	Rivers/Streams	Miscellaneous**	1	16 Miles
3	Rivers/Streams	Nutrients	24	311 Miles
3	Rivers/Streams	Other Organics	3	17 Miles
3	Rivers/Streams	Pathogens	40	520.82 Miles
3	Rivers/Streams	Pesticides	7	136.6 Miles
3	Rivers/Streams	Salinity	5	215 Miles
3	Rivers/Streams	Sediment	27	438.6 Miles
3	Rivers/Streams	Toxicity	1	8.6 Miles
4	Bays and Harbors	Metals/Metalloids	5	6,673 Acres
4	Bays and Harbors	Miscellaneous**	4	148,148 Acres
4	Bays and Harbors	Other Organics	10	154,421 Acres
4	Bays and Harbors	Pathogens	3	849 Acres
4	Bays and Harbors	Pesticides	10	154,421 Acres
4	Bays and Harbors	Toxicity	7	154,248 Acres
4	Bays and Harbors	Trash	1	146,645 Acres
4	Coastal Shoreline	Other Organics	31	32.77 Miles
4	Coastal Shoreline	Pathogens	56	62.83 Miles
4	Coastal Shoreline	Pesticides	33	33.78 Miles
4	Estuaries	Metals/Metalloids	2	605 Acres

Region	Water Body Type	Pollutant Category	Pollutant Category Totals*	Total Estimated Size Affected
4	Estuaries	Miscellaneous**	1	15 Acres
4	Estuaries	Nutrients	2	359 Acres
4	Estuaries	Other Organics	2	605 Acres
4	Estuaries	Pathogens	2	64 Acres
4	Estuaries	Pesticides	3	654 Acres
4	Estuaries	Sediment	1	344 Acres
4	Estuaries	Toxicity	1	344 Acres
4	Lakes/Reservoirs	Hydromodification	1	121 Acres
4	Lakes/Reservoirs	Metals/Metalloids	9	696.8 Acres
4	Lakes/Reservoirs	Miscellaneous**	7	255 Acres
4	Lakes/Reservoirs	Nuisance	8	243.8 Acres
4	Lakes/Reservoirs	Nutrients	16	949.1 Acres
4	Lakes/Reservoirs	Other Organics	4	321 Acres
4	Lakes/Reservoirs	Pathogens	1	20 Acres
4	Lakes/Reservoirs	Pesticides	5	429 Acres
4	Lakes/Reservoirs	Salinity	1	15 Acres
4	Lakes/Reservoirs	Toxicity	1	20 Acres
4	Lakes/Reservoirs	Trash	6	235.6 Acres
4	Rivers/Streams	Hydromodification	5	48.43 Miles
4	Rivers/Streams	Metals/Metalloids	35	236.09 Miles
4	Rivers/Streams	Miscellaneous**	12	194.4 Miles
4	Rivers/Streams	Nuisance	11	99.9 Miles
4	Rivers/Streams	Nutrients	53	393.19 Miles
4	Rivers/Streams	Other Inorganics	14	124.2 Miles
4	Rivers/Streams	Other Organics	11	58.2 Miles
4	Rivers/Streams	Pathogens	51	350.69 Miles
4	Rivers/Streams	Pesticides	17	124.6 Miles
4	Rivers/Streams	Salinity	19	236.3 Miles
4	Rivers/Streams	Sediment	14	101 Miles
4	Rivers/Streams	Toxicity	17	122.3 Miles
4	Rivers/Streams	Trash	17	104.7 Miles
4	Wetlands, Tidal	Hydromodification	1	289 Acres
4	Wetlands, Tidal	Metals/Metalloids	2	44 Acres
4	Wetlands, Tidal	Miscellaneous**	1	289 Acres
4	Wetlands, Tidal	Nutrients	1	31 Acres
4	Wetlands, Tidal	Other Organics	1	13 Acres
4	Wetlands, Tidal	Pathogens	1	31 Acres
4	Wetlands, Tidal	Pesticides	2	44 Acres
4	Wetlands, Tidal	Toxicity	1	13 Acres
4	Wetlands, Tidal	Trash	1	289 Acres

Region	Water Body Type	Pollutant Category	Pollutant Category Totals*	Total Estimated Size Affected
5	Estuaries	Metals/Metalloids	3	43,991 Acres
5	Estuaries	Nutrients	1	952 Acres
5	Estuaries	Pesticides	3	43,991 Acres
5	Estuaries	Salinity	1	22,904 Acres
5	Estuaries	Toxicity	3	43,991 Acres
5	Lakes/Reservoirs	Metals/Metalloids	14	87,196 Acres
5	Lakes/Reservoirs	Nutrients	1	40,070 Acres
5	Lakes/Reservoirs	Pathogens	1	98 Acres
5	Rivers/Streams	Metals/Metalloids	38	636.75 Miles
5	Rivers/Streams	Miscellaneous**	2	127.3 Miles
5	Rivers/Streams	Nutrients	12	199.43 Miles
5	Rivers/Streams	Other Organics	3	18.8 Miles
5	Rivers/Streams	Pathogens	15	81.93 Miles
5	Rivers/Streams	Pesticides	35	647.3 Miles
5	Rivers/Streams	Salinity	9	218 Miles
5	Rivers/Streams	Sediment	3	28.8 Miles
5	Rivers/Streams	Toxicity	18	630 Miles
5	Wetlands, Freshwater	Metals/Metalloids	1	3,045 Acres
5	Wetlands, Freshwater	Salinity	1	7,962 Acres
6	Lakes/Reservoirs	Metals/Metalloids	2	2,687 Acres
6	Lakes/Reservoirs	Nutrients	7	113,832 Acres
6	Lakes/Reservoirs	Other Organics	1	819 Acres
6	Lakes/Reservoirs	Sediment	4	88,937 Acres
6	Rivers/Streams	Hydromodification	4	30.8 Miles
6	Rivers/Streams	Metals/Metalloids	13	83.31 Miles
6	Rivers/Streams	Miscellaneous**	9	218.1 Miles
6	Rivers/Streams	Nutrients	12	92.58 Miles
6	Rivers/Streams	Other Inorganics	1	4 Miles
6	Rivers/Streams	Other Organics	1	3.8 Miles
6	Rivers/Streams	Pathogens	14	104.98 Miles
6	Rivers/Streams	Salinity	5	29 Miles
6	Rivers/Streams	Sediment	16	220 Miles
6	Rivers/Streams	Toxicity	1	58 Miles
6	Saline Lakes	Hydromodification	1	665 Acres
6	Saline Lakes	Metals/Metalloids	2	58,421 Acres
6	Saline Lakes	Salinity	2	58,421 Acres
6	Wetlands, Freshwater	Metals/Metalloids	1	62,590 Acres
6	Wetlands, Freshwater	Nutrients	1	1 Acre
6	Wetlands, Freshwater	Salinity	1	1 Acre

Region	Water Body Type	Pollutant Category	Pollutant Category Totals*	Total Estimated Size Affected
7	Rivers/Streams	Metals/Metalloids	2	1,279 Miles
7	Rivers/Streams	Nutrients	1	66 Miles
7	Rivers/Streams	Other Organics	1	66 Miles
7	Rivers/Streams	Pathogens	2	76.4 Miles
7	Rivers/Streams	Pesticides	3	1,345 Miles
7	Rivers/Streams	Sediment	2	1,288 Miles
7	Rivers/Streams	Trash	1	66 Miles
7	Saline Lakes	Metals/Metalloids	1	233,340 Acres
7	Saline Lakes	Nutrients	1	233,340 Acres
7	Saline Lakes	Salinity	1	233,340 Acres
8	Bays and Harbors	Metals/Metalloids	3	1,390 Acres
8	Bays and Harbors	Other Organics	3	1,390 Acres
8	Bays and Harbors	Pathogens	1	221 Acres
8	Bays and Harbors	Pesticides	3	1,390 Acres
8	Coastal Shoreline	Metals/Metalloids	1	2.6 Miles
8	Coastal Shoreline	Pathogens	2	6.33 Miles
8	Estuaries	Metals/Metalloids	1	653 Acres
8	Estuaries	Pesticides	1	653 Acres
8	Lakes/Reservoirs	Metals/Metalloids	1	2,865 Acres
8	Lakes/Reservoirs	Miscellaneous**	1	2,865 Acres
8	Lakes/Reservoirs	Nutrients	4	5,839 Acres
8	Lakes/Reservoirs	Pathogens	3	547.2 Acres
8	Lakes/Reservoirs	Sediment	2	5,296 Acres
8	Lakes/Reservoirs	Toxicity	1	2,431 Acres
8	Rivers/Streams	Metals/Metalloids	3	11.8 Miles
8	Rivers/Streams	Nutrients	5	19.1 Miles
8	Rivers/Streams	Pathogens	16	156.59 Miles
8	Rivers/Streams	Pesticides	1	7.8 Miles
8	Rivers/Streams	Salinity	2	20.8 Miles
8	Rivers/Streams	Sediment	2	6.3 Miles
8	Rivers/Streams	Toxicity	1	6.3 Miles
9	Bays and Harbors	Metals/Metalloids	3	2240 Acres
9	Bays and Harbors	Miscellaneous**	8	206.8 Acres
9	Bays and Harbors	Nutrients	1	2032 Acres
9	Bays and Harbors	Other Organics	2	60.5 Acres
9	Bays and Harbors	Pathogens	3	2,160.9 Acres
9	Bays and Harbors	Pesticides	1	5.5 Acres
9	Bays and Harbors	Toxicity	8	206.8 Acres
9	Coastal Shoreline	Pathogens	20	23.86 Miles

Region	Water Body Type	Pollutant Category	Pollutant Category Totals*	Total Estimated Size Affected
9	Estuaries	Metals/Metalloids	1	1319 Acres
9	Estuaries	Nutrients	6	2,155.2 Acres
9	Estuaries	Pathogens	7	2,108.59 Acres
9	Estuaries	Pesticides	1	1,319 Acres
9	Estuaries	Sediment	4	1,243.8 Acres
9	Estuaries	Trash	1	1,319 Acres
9	Lakes/Reservoirs	Nuisance	2	1,665 Acres
9	Lakes/Reservoirs	Nutrients	2	1,137 Acres
9	Lakes/Reservoirs	Salinity	1	1,104 Acres
9	Rivers/Streams	Metals/Metalloids	3	13.6 Miles
9	Rivers/Streams	Miscellaneous**	1	6.4 Miles
9	Rivers/Streams	Nutrients	9	75.12 Miles
9	Rivers/Streams	Other Inorganics	1	1.2 Miles
9	Rivers/Streams	Other Organics	1	5.8 Miles
9	Rivers/Streams	Pathogens	8	54.9 Miles
9	Rivers/Streams	Pesticides	2	7 Miles
9	Rivers/Streams	Salinity	8	49.01 Miles
9	Rivers/Streams	Sediment	2	2.12 Miles
9	Rivers/Streams	Toxicity	2	25.6 Miles
9	Rivers/Streams	Trash	1	5.8 Miles

* The pollutant category totals are derived from counting the number of pollutant-water segment combinations for the pollutant category. For a more detailed listing of water body/pollutant combinations, please refer to SWRCB (2003a).

** Miscellaneous pollutants include abnormal fish histology, pH, pH(high), temperature, habitat alterations, noxious aquatic plants, exotic species, exotic vegetation, fish consumption advisory, shellfish harvesting advisory, benthic community effects, and fish kills (SWRCB, 2003a).

Distinct temperature zones characterize the North Coast Region. Along the coast, the climate is moderate and foggy with limited temperature variation. Inland, however, seasonal temperature ranges in excess of 100°F (Fahrenheit) have been recorded. Precipitation is greater than for any other part of California, and damaging floods are a fairly frequent hazard. Particularly devastating floods occurred in the North Coast area in December 1955, December 1964, and February 1986. Ample precipitation in combination with the mild climate found over most of the North Coast Region has provided a wealth of fish, wildlife, and scenic resources. The mountainous nature of the Region, with its dense coniferous forests interspersed with grassy or chaparral covered slopes, provides shelter and food for deer, elk, bear, mountain lion, fur bearers, and many upland bird and mammal species. The numerous streams and rivers of the Region contain anadromous fish, and the reservoirs, although few in number, support both cold water and warm water fish.

Tidelands and marshes are extremely important to many species of waterfowl and shore birds, both for feeding and nesting. Cultivated land and pasturelands also provide supplemental food for many birds, including small pheasant populations. Tideland areas along the north coast provide important habitat for marine invertebrates and nursery areas for forage fish, game fish, and crustaceans. Offshore coastal rocks are used by many species of seabirds as nesting areas.

Major components of the economy are tourism and recreation, logging and timber milling, aggregate mining, commercial and sport fisheries, sheep, beef and dairy production, and vineyards and wineries. In all, the North Coast Region offers a beautiful natural environment with opportunities for scientific study and research, recreation, sport and commerce.

Approximately two percent of California’s total population resides in the North Coast Region. The largest urban centers are Eureka in Humboldt County, and Santa Rosa in Sonoma County.

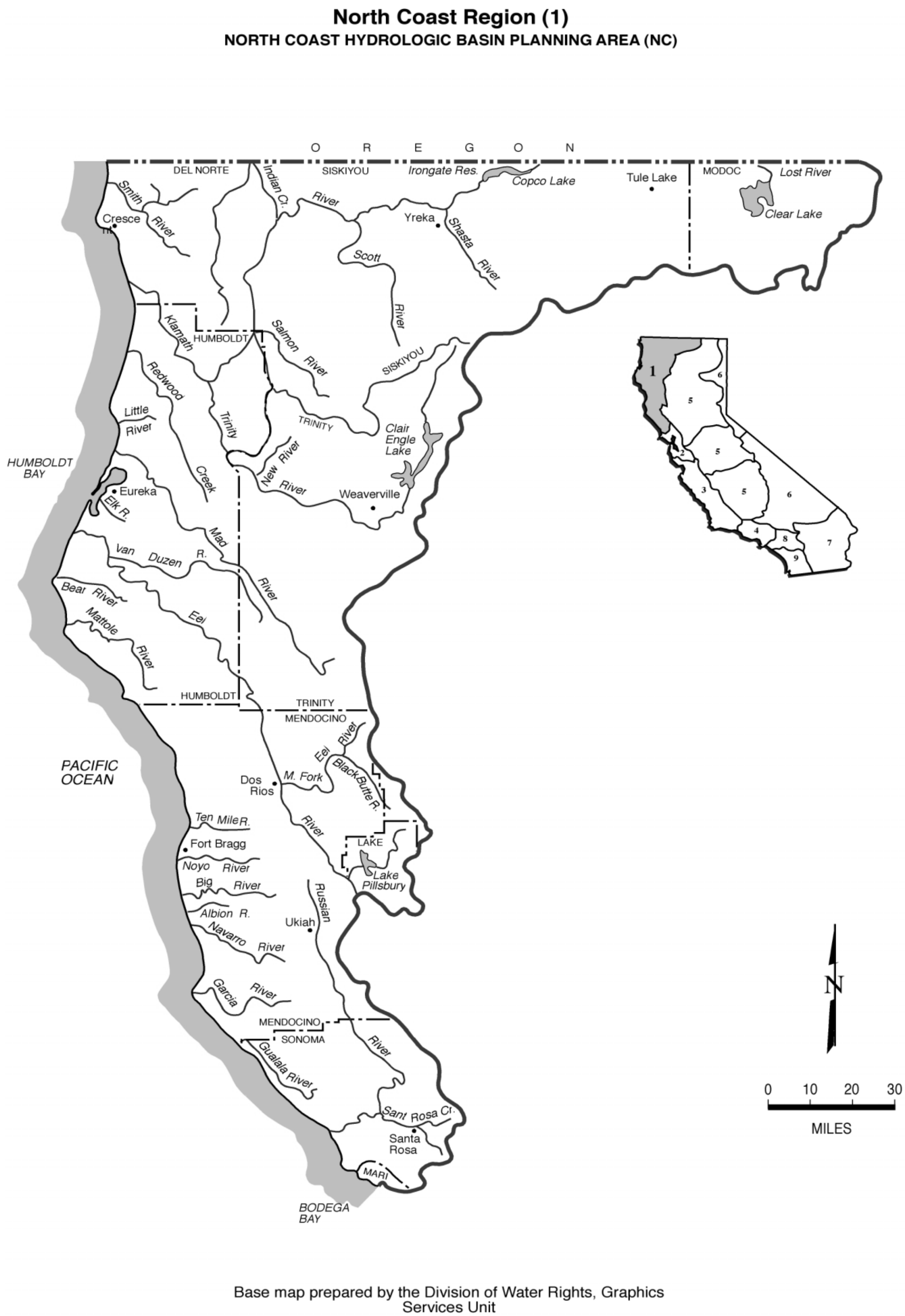


FIGURE 1: NORTH COAST REGION HYDROLOGIC BASIN

San Francisco Region (Region 2)

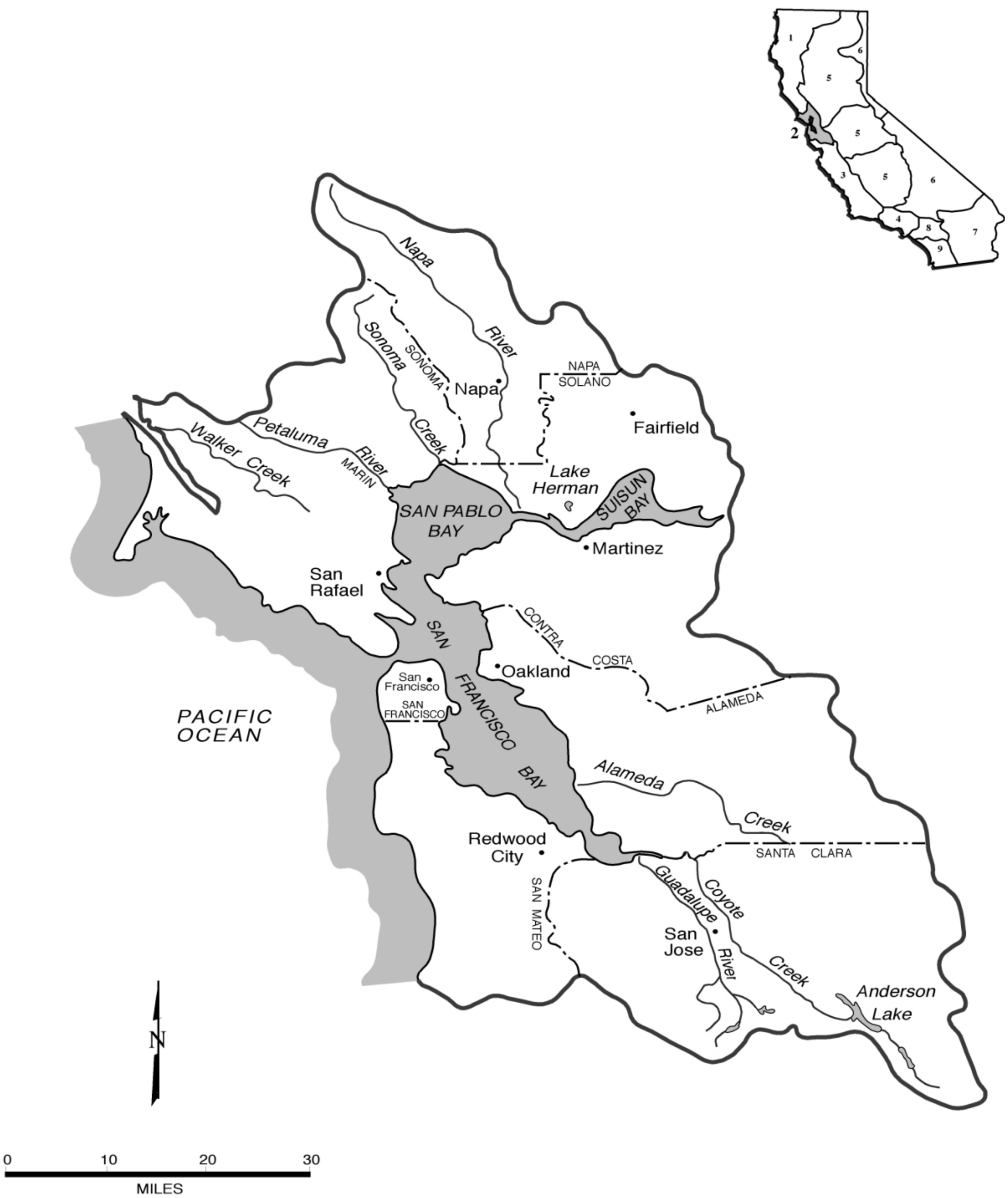
The San Francisco Bay Region comprises San Francisco Bay, Suisun Bay beginning at the Sacramento River, and San Joaquin River westerly, from a line which passes between Collinsville and Montezuma Island (Figure 2). The Region's boundary follows the borders common to Sacramento and Solano counties and Sacramento and Contra Costa counties west of the Markely Canyon watershed in Contra Costa County. All basins west of the boundary, described above, and all basins draining into the Pacific Ocean between the southern boundary of the North Coast Region and the southern boundary of the watershed of Pescadero Creek in San Mateo and Santa Cruz counties are included in the Region.

The Region comprises most of the San Francisco Estuary to the mouth of the Sacramento-San Joaquin Delta. The San Francisco Estuary conveys the waters of the Sacramento and San Joaquin Rivers to the Pacific Ocean. Located on the central coast of California, the Bay system functions as the only drainage outlet for waters of the Central Valley. It also marks a natural topographic separation between the northern and southern coastal mountain ranges. The Region's waterways, wetlands, and bays form the centerpiece of the fourth largest metropolitan area in the United States, including all or major portions of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma counties.

The San Francisco Bay RWQCB has jurisdiction over the part of the San Francisco Estuary, which includes all of the San Francisco Bay segments extending east to the Delta (Winter Island near Pittsburg). The San Francisco Estuary sustains a highly dynamic and complex environment. Within each section of the Bay system lie deepwater areas that are adjacent to large expanses of very shallow water. Salinity levels range from hypersaline to fresh water and water temperature varies widely. The Bay system's deepwater channels, tidelands, marshlands, fresh water streams and rivers provide a wide variety of habitats within the Region. Coastal embayments including Tomales Bay and Bolinas Lagoon are also located in this Region. The Central Valley RWQCB has jurisdiction over the Delta and rivers extending further eastward.

The Sacramento and San Joaquin Rivers enter the Bay system through the Delta at the eastern end of Suisun Bay and contribute almost all of the fresh water inflow into the Bay. Many smaller rivers and streams also convey fresh water to the Bay system. The rate and timing of these fresh water flows are among the most important factors influencing physical, chemical and biological conditions in the Estuary. Flows in the region are highly seasonal, with more than 90 percent of the annual runoff occurring during the winter rainy season between November and April.

San Francisco Bay Region (2)
SAN FRANCISCO BAY HYDROLOGIC BASIN PLANNING AREA (SF)



Base map prepared by the Division of Water Rights, Graphics Services Unit

FIGURE 2: SAN FRANCISCO BAY REGION HYDROLOGIC BASIN

The San Francisco Estuary is made up of many different types of aquatic habitats that support a great diversity of organisms. Suisun Marsh in Suisun Bay is the largest brackish-water marsh in the United States. San Pablo Bay is a shallow embayment strongly influenced by runoff from the Sacramento and San Joaquin Rivers.

The Central Bay is the portion of the Bay most influenced by oceanic conditions. The South Bay, with less freshwater inflow than the other portions of the Bay, acts more like a tidal lagoon. Together these areas sustain rich communities of aquatic life and serve as important wintering sites for migrating waterfowl and spawning areas for anadromous fish.

The 2002 section 303(d) list for the San Francisco Region included 25 water bodies affecting an estimated 396,296 acres (bays, estuaries, lakes, and wetlands) and 54 water bodies affecting 724 miles of rivers and shoreline. The major pollutants affecting these water bodies included nutrients, metals, pathogens, pesticides, and sediment among others (SWRCB, 2003a).

Central Coast Region (Region 3)

The Central Coast Region comprises all basins (including Carrizo Plain in San Luis Obispo and Kern Counties) draining into the Pacific Ocean from the southern boundary of the Pescadero Creek watershed in San Mateo and Santa Cruz Counties; to the southeastern boundary of the Rincon Creek watershed, located in western Ventura County (Figure 3). The Region extends over a 300-mile long by 40-mile wide section of the State's central coast. Its geographic area encompasses all of Santa Cruz, San Benito, Monterey, San Luis Obispo, and Santa Barbara Counties as well as the southern one-third of Santa Clara County, and small portions of San Mateo, Kern, and Ventura Counties. Included in the region are urban areas such as the Monterey Peninsula and the Santa Barbara coastal plain; prime agricultural lands such as the Salinas, Santa Maria, and Lompoc Valleys; National Forest lands; extremely wet areas such as the Santa Cruz mountains; and arid areas such as the Carrizo Plain.

Water bodies in the Central Coast Region are varied. Enclosed bays and harbors in the Region include Morro Bay, Elkhorn Slough, Tembladero Slough, Santa Cruz Harbor, Moss Landing Harbor, San Luis Harbor, and Santa Barbara Harbor. Several small estuaries also characterize the Region, including the Santa Maria River Estuary, San Lorenzo River Estuary, Big Sur River Estuary, and many others. Major rivers, streams, and lakes include San Lorenzo River, Santa Cruz River, San Benito River, Pajaro River, Salinas River, Santa Maria River, Cuyama River, Estrella

River and Santa Ynez River, San Antonio Reservoir, Nacimiento Reservoir, Twitchel Reservoir, and Cuchuma Reservoir.

The economic and cultural activities in the basin have been primarily agrarian. Livestock grazing persists, but has been combined with hay cultivation in the valleys. Irrigation, with pumped local groundwater, is very significant in intermountain valleys throughout the basin. Mild winters result in long growing seasons and continuous cultivation of many vegetable crops in parts of the basin.

While agriculture and related food processing activities are major industries in the Region, oil production, tourism, and manufacturing contribute heavily to its economy. The northern part of the Region has experienced a significant influx of electronic manufacturing; while offshore oil exploration and production have heavily influenced the southern part. Total population of the Region is estimated at 1.22 million people.

Water quality problems frequently encountered in the Central Coastal Region include excessive salinity or hardness of local groundwaters. Increasing nitrate concentration is a growing problem in a number of areas, in both groundwater and surface water. Surface waters suffer from bacterial contamination, nutrient enrichment, and siltation in a number of watersheds. Pesticides are a concern in agricultural areas and associated downstream water bodies.

Listings on the 2002 section 303(d) list for the Central Coast Region included 16 water bodies affecting an estimated 11,366 acres (bays, estuaries, lakes, and wetlands) and 77 water bodies affecting 842 miles of rivers and shoreline. The major pollutants affecting these water bodies included nutrients, metals, pathogens, pesticides, and sediment among others (SWRCB, 2003a).

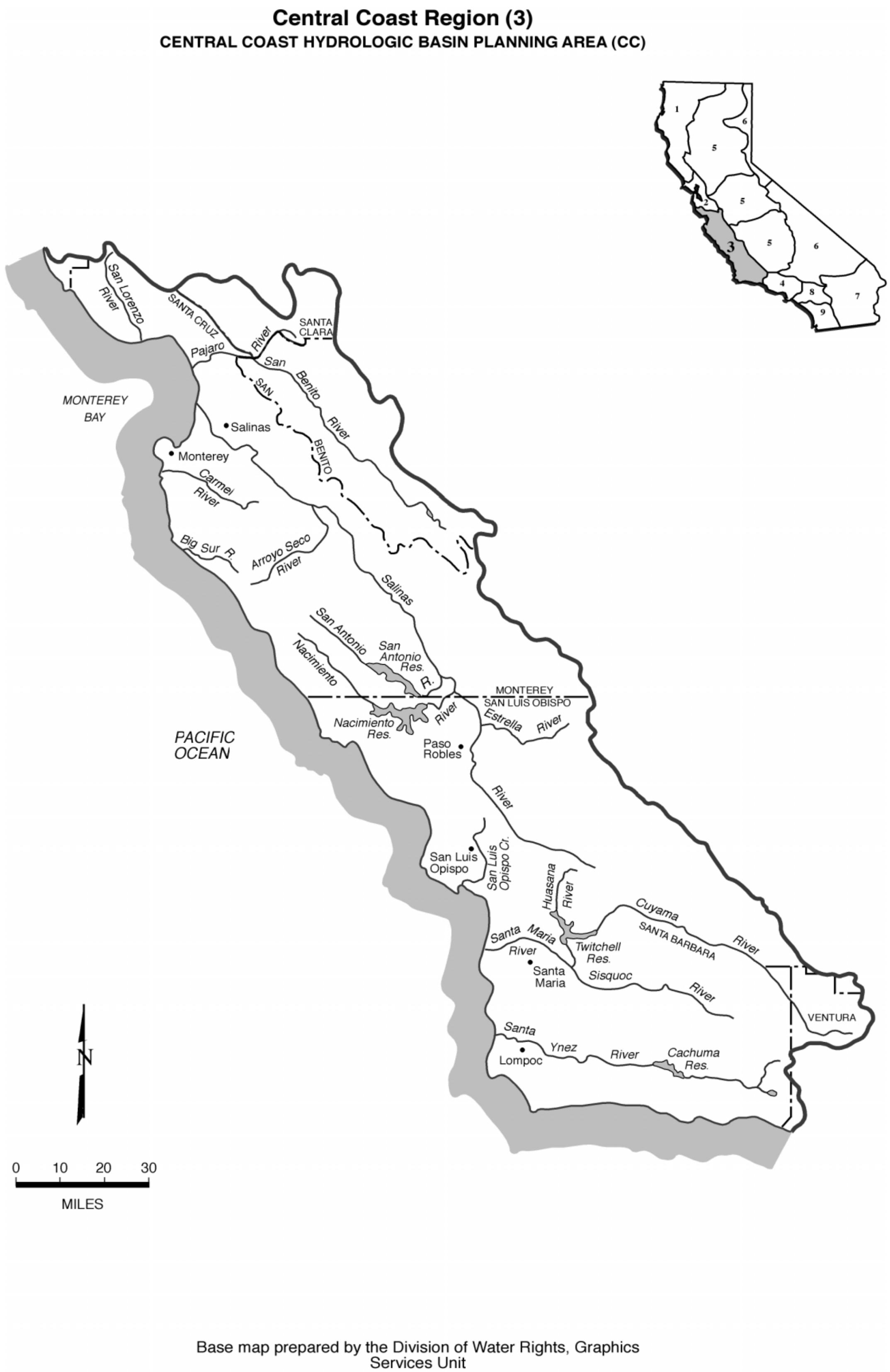


FIGURE 3: CENTRAL COAST REGION HYDROLOGIC BASIN

Los Angeles Region (Region 4)

The Los Angeles Region comprises all basins draining into the Pacific Ocean between the southeastern boundary of the watershed of Rincon Creek, located in western Ventura County, and a line which coincides with the southeastern boundary of Los Angeles County, from the Pacific Ocean to San Antonio Peak, and follows the divide, between the San Gabriel River and Lytle Creek drainages to the divide between Sheep Creek and San Gabriel River drainages (Figure 4).

The Region encompasses all coastal drainages flowing into the Pacific Ocean between Rincon Point (on the coast of western Ventura County) and the eastern Los Angeles County line, as well as the drainages of five coastal islands (Anacapa, San Nicolas, Santa Barbara, Santa Catalina and San Clemente). In addition, the Region includes all coastal waters within three miles of the continental and island coastlines Two large deepwater harbors (Los Angeles and Long Beach Harbors) and one smaller deepwater harbor (Port Hueneme) are contained in the Region. There are small craft marinas within the harbors, as well as tank farms, naval facilities, fish processing plants, boatyards, and container terminals. Several small-craft marinas also exist along the coast (Marina del Rey, King Harbor, Ventura Harbor); these contain boatyards, other small businesses and dense residential development.

Several large, primarily concrete-lined rivers (Los Angeles River, San Gabriel River) lead to unlined tidal prisms which are influenced by marine waters. Salinity may be greatly reduced following rains since these rivers drain large urban areas composed of mostly impermeable surfaces. Some of these tidal prisms receive a considerable amount of freshwater throughout the year from publicly owned treatment works discharging tertiary-treated effluent. Lagoons are located at the mouths of other rivers draining relatively undeveloped areas (Mugu Lagoon, Malibu Lagoon, Ventura River Estuary, and Santa Clara River Estuary). There are also a few isolated coastal brackish water bodies receiving runoff from agricultural or residential areas.

Santa Monica Bay, which includes the Palos Verdes Shelf, dominates a large portion of the open coastal water bodies in the Region. The Region's coastal water bodies also include the areas along the shoreline of Ventura County and the waters surrounding the five offshore islands in the region.

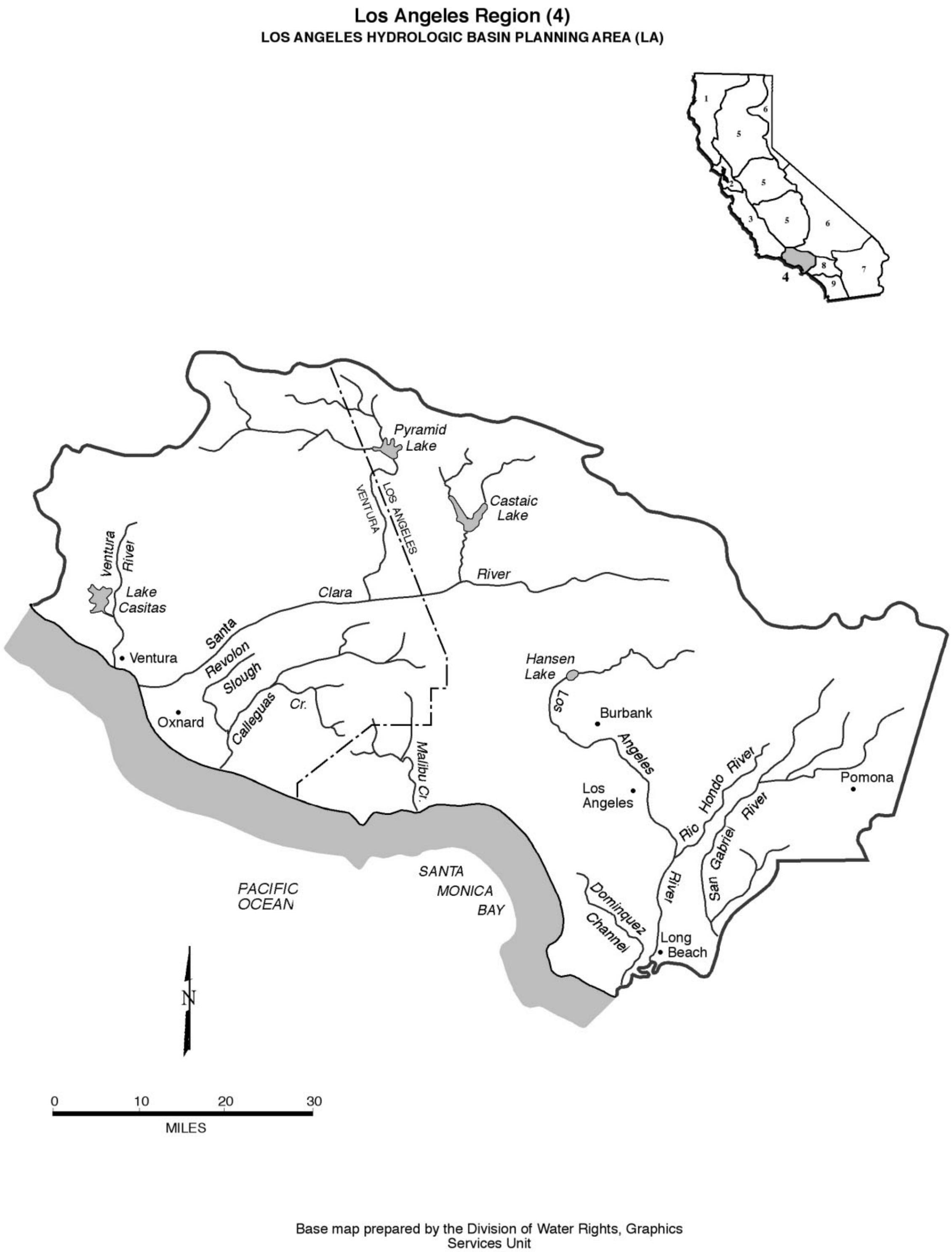


FIGURE 4: LOS ANGELES REGION HYDROLOGIC BASIN

Waters on the 2002 section 303(d) list for the Los Angeles Region included 38 water bodies affecting an estimated 156,921 acres (bays, estuaries, lakes, and wetlands) and 142 water bodies affecting 802 miles of rivers and shoreline. The major pollutants affecting these water bodies included nutrients, metals, pathogens, pesticides, and sediment among others (SWRCB, 2003a).

Central Valley Region (Region 5)

The Central Valley Region includes approximately 40 percent of the land in California stretching from the Oregon border to the Kern County/ Los Angeles county line. The Region is divided into three basins. For planning purposes, the Sacramento River Basin and the San Joaquin River basin are covered under one Basin Plan and the Tulare Lake Basin is covered under a separate distinct one.

The Sacramento River Basin covers 27,210 square miles and includes the entire area drained by the Sacramento River (Figure 5). The principal streams are the Sacramento River and its larger tributaries: the Pitt, Feather, Yuba, Bear, and American Rivers to the East; and Cottonwood, Stony, Cache, and Putah Creek to the west. Major reservoirs and lakes include Shasta, Oroville, Folsom, Clear Lake, and Lake Berryessa.

The San Joaquin River Basin covers 15,880 square miles and includes the entire area drained by the San Joaquin River (Figure 6). Principal streams in the basin are the San Joaquin River and its larger tributaries: the Consumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, Chowchilla, and Fresno Rivers. Major reservoirs and lakes include Pardee, New Hogan, Millerton, McClure, Don Pedro, and New Melones.

The Tulare Lake Basin covers approximately 16,406 square miles and comprises the drainage area of the San Joaquin Valley south of the San Joaquin River (Figure 7). The planning boundary between the San Joaquin River Basin and the Tulare Lake Basin is defined by the northern boundary of Little Pinoche Creek basin eastward along the channel of the San Joaquin River to Millerton Lake in the Sierra Nevada foothills, and then along the southern boundary of the San Joaquin River drainage basin. Main rivers within the basin include the King, Kaweah, Tule, and Kern Rivers, which drains the west face of the Sierra Nevada Mountains. Imported surface water supplies enter the basin through the San Luis Drain- California Aqueduct System, Friant- Kern Channel and the Delta Mendota Canal.

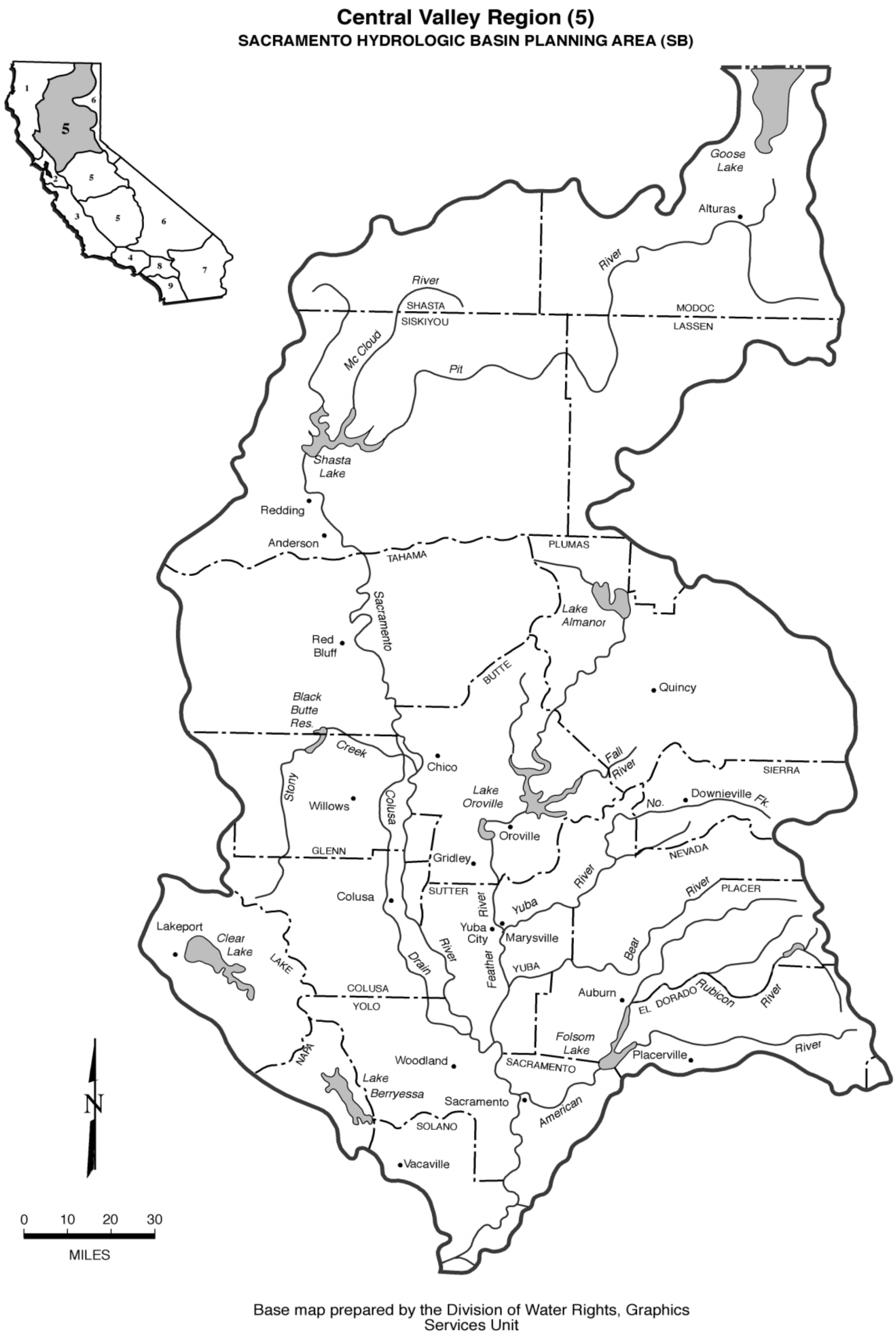
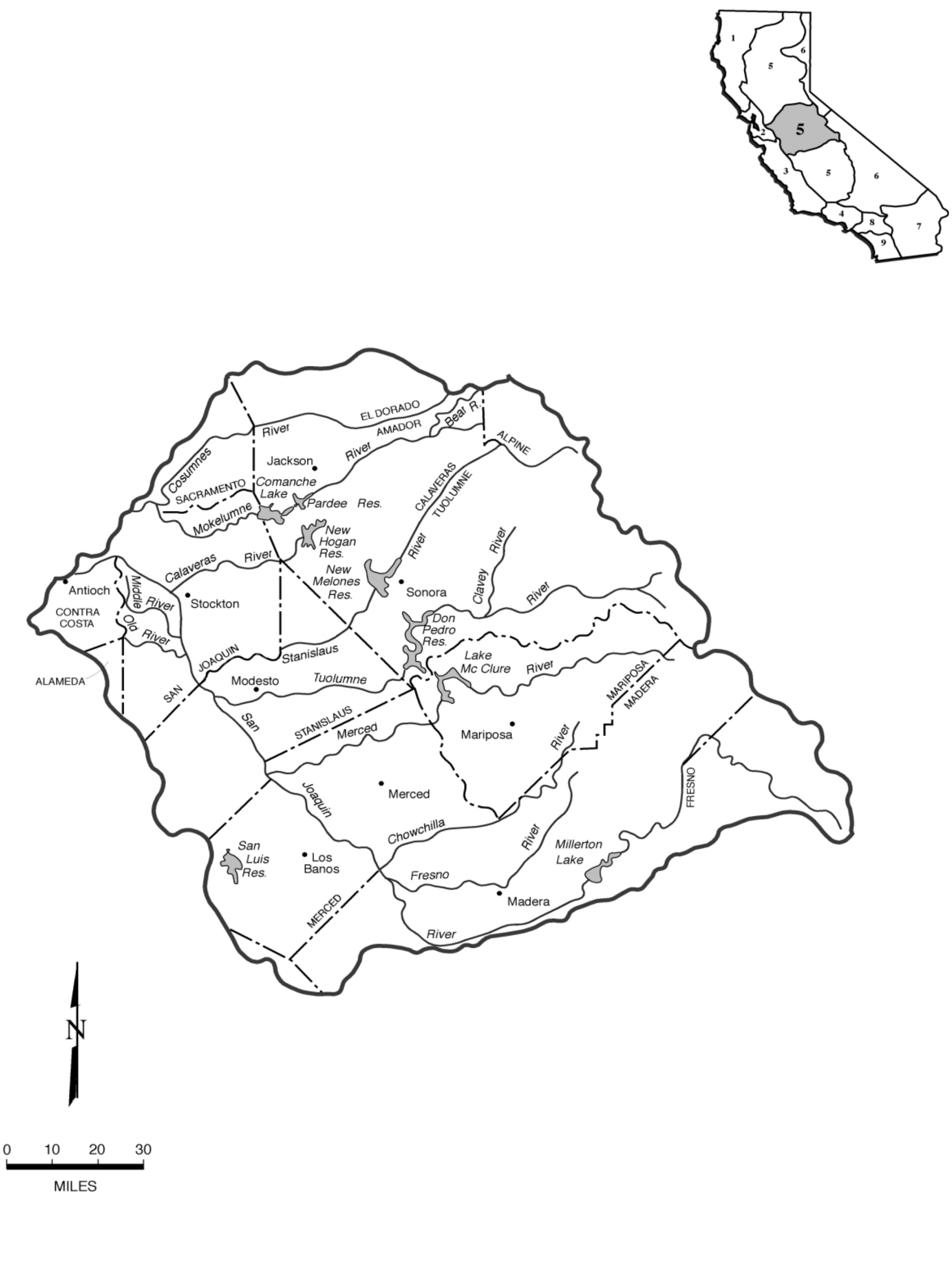


FIGURE 5: CENTRAL VALLEY REGION, SACRAMENTO REGION HYDROLOGIC BASIN

Central Valley Region (5)

SAN JOAQUIN HYDROLOGIC BASIN PLANNING AREA (SJ)



Base map prepared by the Division of Water Rights, Graphics Services Unit

FIGURE 6: CENTRAL VALLEY REGION, SAN JOAQUIN HYDROLOGIC BASIN

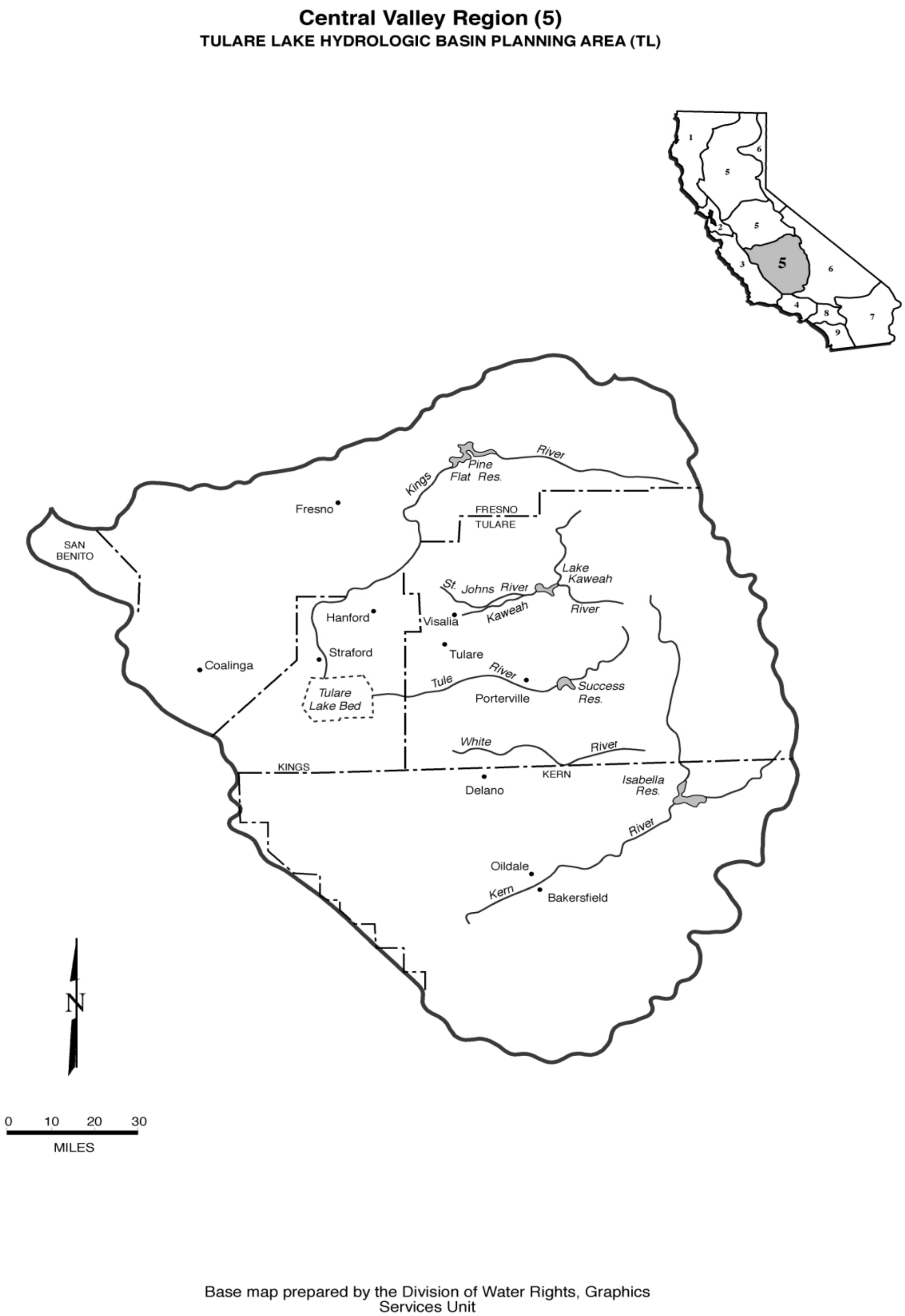


FIGURE 7: CENTRAL VALLEY REGION, TULARE LAKE HYDROLOGIC BASIN

The two northern most basins are bound by the crests of the Sierra Nevada on the east and the Coast Range and Klamath Mountains on the west. They extend about 400 miles from the California-Oregon border southward to the headwaters of the San Joaquin River. These two river basins cover about one fourth of the total area of the State and over 30 percent of the State's irrigable land. The Sacramento and San Joaquin Rivers furnish roughly 50 percent of the State's water supply. Surface water from the two drainage basins meet and form the Delta, which ultimately drains into the San Francisco Bay.

The Delta is a maze of river channels and diked islands covering roughly 1,150 square miles, including 78 square miles of water area. Two major water projects located in the South Delta, the Federal Central Valley Project and the State Water Project, deliver water from the Delta to Southern California, the San Joaquin Valley, Tulare Lake Basin, the San Francisco Bay Area, as well as within the Delta boundaries. The legal boundary of the Delta is described in CWC section 12220.

The 2002 section 303(d) list for the Central Valley Region included 20 water bodies affecting an estimated 142,292 acres (bays, estuaries, lakes, and wetlands) and 83 water bodies affecting 1344 miles of rivers. The major pollutants affecting these water bodies included nutrients, metals, pathogens, and pesticides among others (SWRCB, 2003a).

Lahontan Region (Region 6)

The Lahontan Region has historically been divided into North and South Lahontan Basins at the boundary between the Mono Lake and East Walker River watersheds (Figure 8 and 9). It is about 570 miles long and has a total area of 33,131 square miles. The Lahontan Region includes the highest (Mount Whitney) and lowest (Death Valley) points in the contiguous United States. The topography of the remainder of the Region is diverse. The Region includes the eastern slopes of the Warner, Sierra Nevada, San Bernardino, Tehachapi and San Gabriel Mountains, and all or part of other ranges including the White, Providence, and Granite Mountains. Topographic depressions include the Madeline Plains, Surprise, Honey Lake, Bridgeport, Owens, Antelope, and Victor Valleys.

The Region is generally in a rain shadow; however, annual precipitation amounts can be high (up to 70 inches) at higher elevations. Most precipitation in the mountainous areas falls as snow. Desert areas receive relatively little annual precipitation (less than 2 inches in some locations) but this can be concentrated and lead to flash flooding. Temperature extremes recorded in the Lahontan Region range from –45^{o}F at Boca (Truckee River watershed) to 134 ^{o}F in Death Valley. The varied topography, soils, and microclimates of the Lahontan Region support a

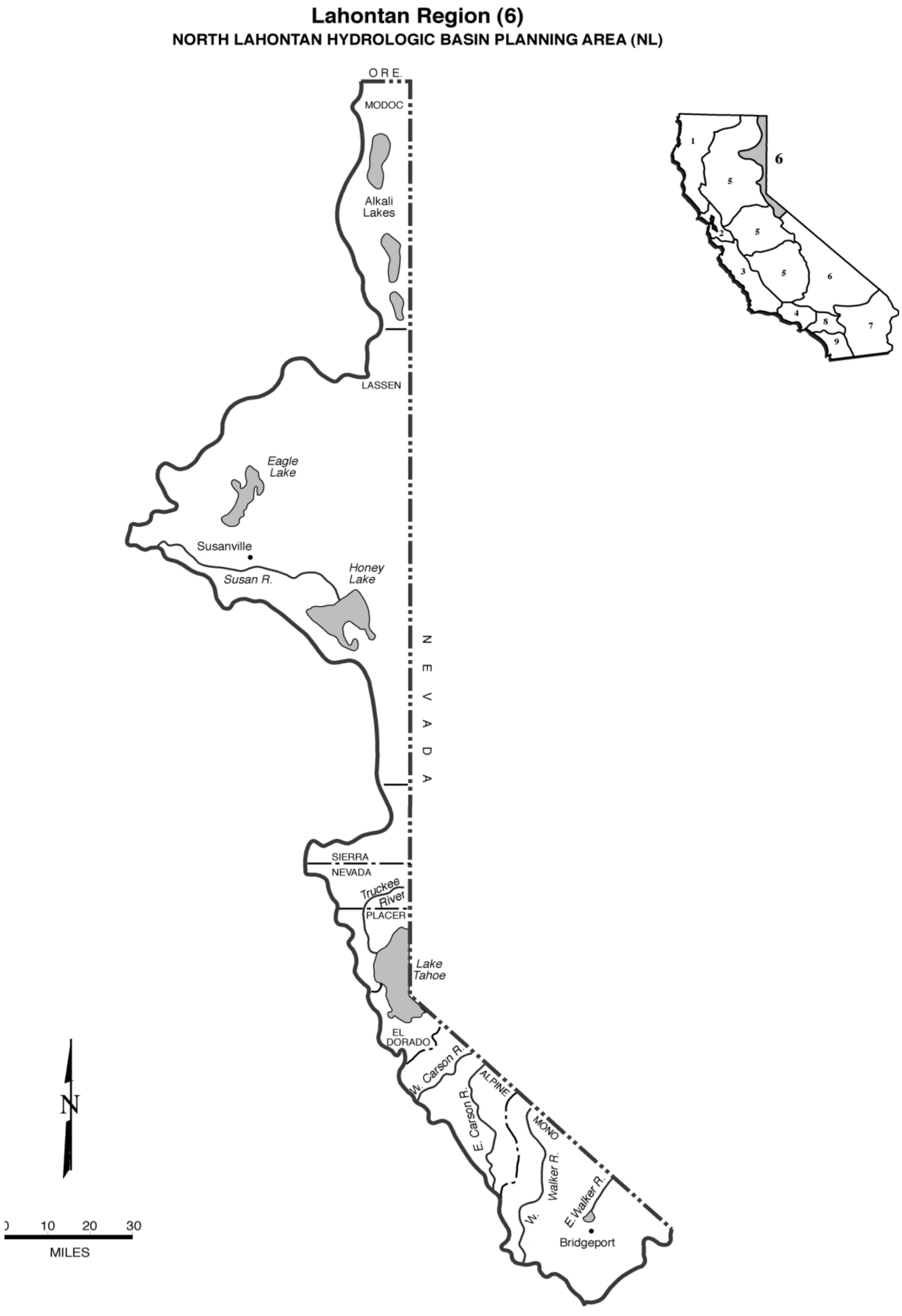


FIGURE 8: LAHONTAN REGION, NORTH LAHONTAN HYDROLOGIC BASIN

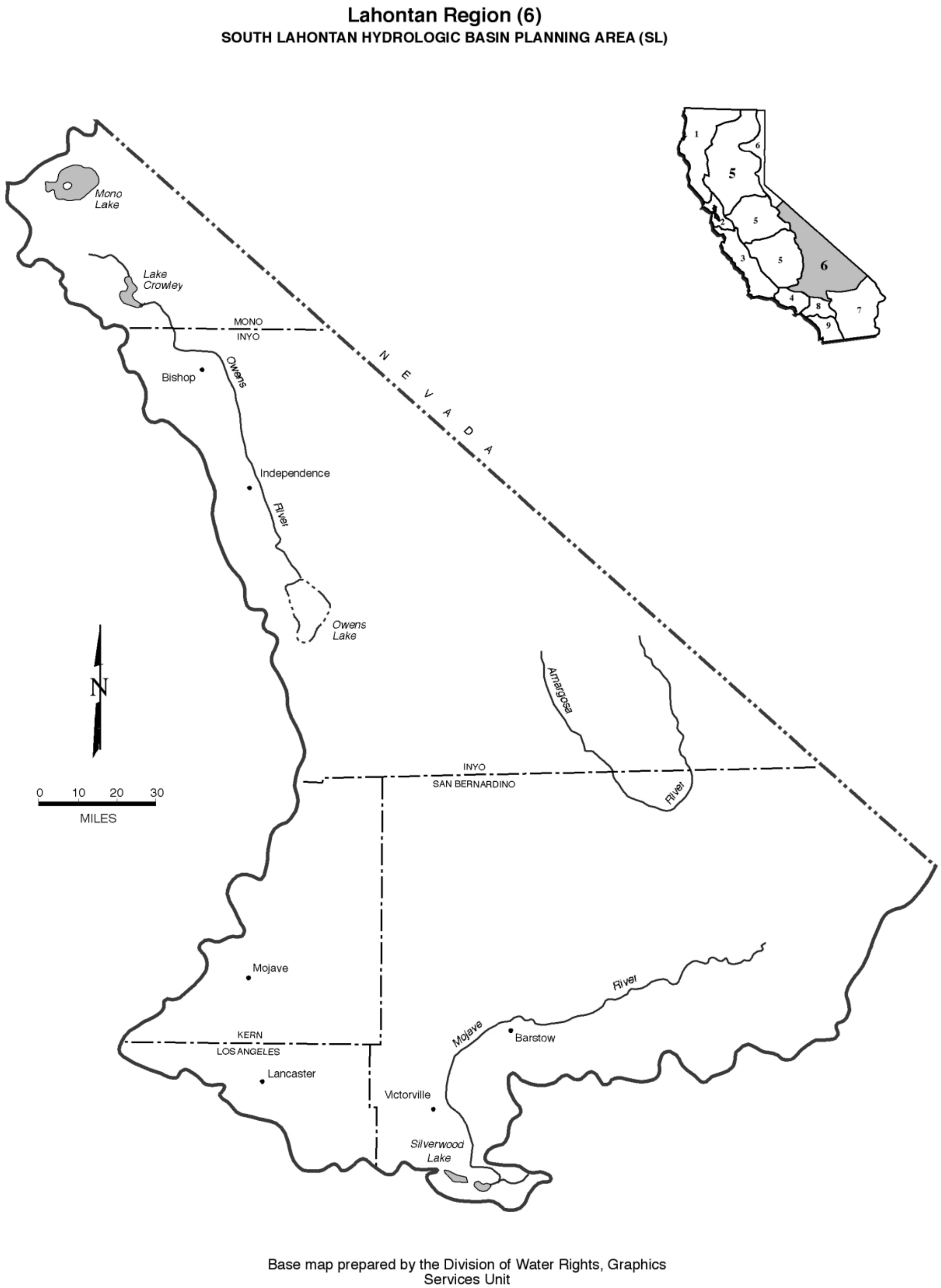


FIGURE 9: LAHONTAN REGION, SOUTH LAHONTAN HYDROLOGIC BASIN

corresponding variety of plant and animal communities. Vegetation ranges from sagebrush and creosote bush scrub in the desert areas to pinyon-juniper and mixed conifer forest at higher elevations. Subalpine and alpine communities occur on the highest peaks. Wetland and riparian plant communities, including marshes, meadows, “sphagnum” bogs, riparian deciduous forest, and desert washes, are particularly important for wildlife, given the general scarcity of water in the Region.

The Lahontan Region is rich in cultural resources (archaeological and historic sites), ranging from remnants of Native American irrigation systems to Comstock mining era ghost towns, such as Bodie, and 1920s resort homes at Lake Tahoe and Death Valley (Scotty's Castle).

Much of the Lahontan Region is in public ownership, with land use controlled by agencies, such as the U.S. Forest Service (USFS), National Park Service, Bureau of Land Management, various branches of the military, the California State Department of Parks and Recreation, and the City of Los Angeles Department of Water and Power. While the permanent resident population (about 500,000 in 1990) of the Region is low, most of it is concentrated in high density communities in the South Lahontan Basin. In addition, millions of visitors use the Lahontan Region for recreation each year. Rapid population growth has occurred in the Victor and Antelope Valleys and within commuting distance of Reno, Nevada. Principal communities of the North Lahontan Basin include Susanville, Truckee, Tahoe City, South Lake Tahoe, Markleeville, and Bridgeport. The South Lahontan Basin includes the communities of Mammoth Lakes, Bishop, Ridgecrest, Mojave, Adelanto, Palmdale, Lancaster, Victorville, and Barstow. Recreational and scenic attractions of the Lahontan Region include Eagle Lake, Lake Tahoe, Mono Lake, Mammoth Lakes, Death Valley, and portions of many wilderness areas. Segments of the East Fork Carson and West Walker Rivers are included in the State Wild and Scenic River system. Both developed (e.g., camping, skiing, day use) and undeveloped (e.g., hiking, fishing) recreation are important components of the Region's economy. In addition to tourism, other major sectors of the economy are resource extraction (mining, energy production, and silviculture), agriculture (mostly livestock grazing), and defense-related activities. There is relatively little manufacturing industry in the Region, in comparison to major urban areas of the state. Economically valuable minerals, including gold, silver, copper, sulfur, tungsten, borax, and rare earth metals have been or are being mined at various locations within the Lahontan Region.

The Lahontan Region includes over 700 lakes, 3,170 miles of streams and 1,581 square miles of groundwater basins. There are twelve major watersheds (called “hydrologic units” under the Department of Water

Resources' mapping system) in the North Lahontan Basin. Among these are the Eagle Lake, Susan River/Honey Lake, Truckee, Carson, and Walker River watersheds. The South Lahontan Basin includes three major surface water systems (the Mono Lake, Owens River, and Mojave River watersheds) and a number of separate closed groundwater basins. Water quality problems in the Lahontan Region are largely related to nonpoint sources (including erosion from construction, timber harvesting, and livestock grazing), storm water, acid drainage from inactive mines, and individual wastewater disposal systems.

Listings on the 2002 section 303(d) list for the Lahontan Region included 16 water bodies affecting an estimated 239,309 acres (lakes and wetlands) and 54 water bodies affecting 699 miles of rivers and shoreline. The major pollutants affecting these water bodies included nutrients, metals, pathogens, and pesticides among others (SWRCB, 2003a).

Colorado River Basin Region (Region 7)

The Colorado River Basin Region covers approximately 13 million acres (20,000 square miles) in the southeastern portion of California (Figure 10).

It includes all of Imperial County and portions of San Bernardino, Riverside, and San Diego Counties. It shares a boundary for 40 miles on the northeast with the State of Nevada, on the north by the New York, Providence, Granite, Old Dad, Bristol, Rodman, and Ord Mountain ranges, on the west by the San Bernardino, San Jacinto, and Laguna Mountain ranges, on the south by the Republic of Mexico, and on the east by the Colorado River and State of Arizona. Geographically the Region represents only a small portion of the total Colorado River drainage area which includes portions of Arizona, Nevada, Utah, Wyoming, Colorado, New Mexico, and Mexico. A significant geographical feature of the Region is the Salton Trough, which contains the Salton Sea and the Coachella and Imperial Valleys. The two valleys are separated by the Salton Sea, which covers the lowest area of the depression. The trough is a geologic structural extension of the Gulf of California.

Much of the agricultural economy and industry of the Region is located in the Salton Trough. There are also industries associated with agriculture, such as sugar refining as well as increasing development of geothermal industries. In the future, agriculture is expected to experience little growth in the Salton Trough, but there will likely be increased development of other industries (such as construction, manufacturing, and services). The present Salton Sea, located on the site of a prehistoric lake, was formed between 1905 and 1907 by overflow of the Colorado River. The Salton Sea serves as a drainage reservoir for irrigation return water and storm

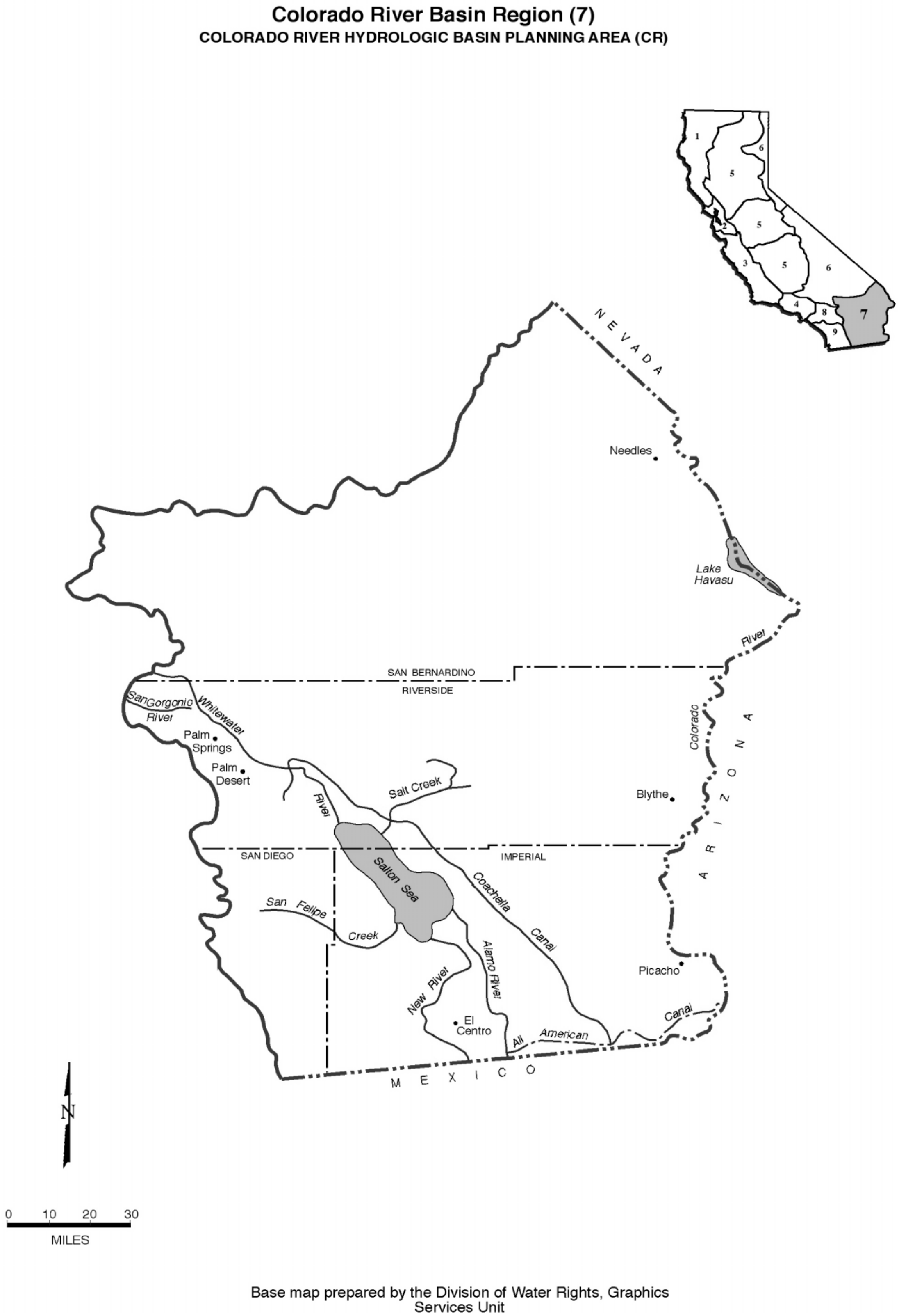


FIGURE 10: COLORADO RIVER REGION HYDROLOGIC BASIN

water from the Coachella Valley, Imperial Valley, and Borrego Valley, and also receives drainage water from the Mexicali Valley in Mexico. The Salton Sea is California's largest inland body of water and provides a very important wildlife habitat and sportfishery. Development along California's 230 mile reach of the Colorado River, which flows along the eastern boundary of the Region, include agricultural areas in Palo Verde Valley and Bard Valley, urban centers at Needles, Blythe, and Winterhaven, several transcontinental gas compressor stations, and numerous small recreational communities. Some mining operations are located in the surrounding mountains. Also the Fort Mojave, Chemehuevi, Colorado River, and Yuma Indian Reservations are located along the River.

Waters on the 2002 section 303(d) list for the Colorado River Basin Region included one water body affecting an estimated 233,340 acres (lakes and wetlands) and five water bodies affecting 1,421 miles of rivers. The major pollutants affecting these water bodies included nutrients, metals, pathogens, pesticides, and sediments among others (SWRCB, 2003a).

The Region has the driest climate in California. The winters are mild and summers are hot. Temperatures range from below freezing to over 120°F. In the Colorado River valleys and the Salton Trough, frost is a rare occurrence and crops are grown year round. Snow falls in the Region's higher elevations, with mean seasonal precipitation ranging from 30 to 40 inches in the upper San Jacinto and San Bernardino Mountains. The lower elevations receive relatively little rainfall. An average four inches of precipitation occurs along the Colorado River, with much of this coming from late summer thunderstorms moving north from Mexico. Typical mean seasonal precipitation in the desert valleys is 3.6 inches at Indio and 3.2 inches at El Centro. Precipitation over the entire area occurs mostly from November through April, and August through September, but its distribution and intensity are often sporadic. Local thunderstorms may contribute all the average seasonal precipitation at one time, or only a trace of precipitation may be recorded at any locale for the entire season.

The Region provides habitat for a variety of native and introduced species of wildlife. Increased human population and its associated development have adversely affected the habitat for some species, while enhancing it for others. Large areas within the Region are inhabited by animals tolerant of arid conditions, including small rodents, coyotes, foxes, birds, and a variety of reptiles. Along the Colorado River and in the higher elevations of the San Bernardino and San Jacinto Mountains where water is more abundant, deer, bighorn sheep, and a diversity of small animals exist.

Practically all of the fishes inhabiting the Region are introduced species. The most abundant species in the Colorado River and irrigation canals include largemouth bass, smallmouth bass, flathead and channel catfish, yellow bullhead, bluegill, redear sunfish, black crappie, carp, striped bass, threadfin shad, red shiner, and, in the colder water above Lake Havasu, rainbow trout. Grass carp have been introduced into sections of the All American Canal system for aquatic weed control. Fish inhabiting agricultural drains in the Region generally include mosquito fish, mollies, red shiners, carp, and tilapia, although locally significant populations of catfish, bass, and sunfish occur in some drains. A considerable sportfishery exists in the Salton Sea, with orangemouth corvina, gulf croaker, sargo, and tilapia predominating. The Salton Sea National Wildlife Refuge and state waterfowl management areas are located in or near the Salton Sea. The refuge supports large numbers of waterfowl in addition to other types of birds. Located along the Colorado River are the Havasu, Cibola and Imperial National Wildlife Refuges. The Region provides habitat for certain endangered/threatened species of wildlife including desert pupfish, razorback sucker, Yuma clapper rail, black rail, least Bell's vireo, yellow billed cuckoo, desert tortoise, and peninsular bighorn sheep.

Santa Ana Region (Region 8)

The Santa Ana Region comprises all basins draining into the Pacific Ocean between the southern boundary of the Los Angeles Region and the drainage divide between Muddy and Moro Canyons, from the ocean to the summit of San Joaquin Hills; along the divide between lands draining into Newport Bay and Laguna Canyon to Niguel Road; along Niguel Road and Los Aliso Avenue to the divide between Newport Bay and Aliso Creek drainages; and along the divide and the southeastern boundary of the Santa Ana River drainage to the divide between Baldwin Lake and Mojave Desert drainages; to the divide between the Pacific Ocean and Mojave Desert drainages (Figure 11). The Santa Ana Region is the smallest of the nine regions in the state (2,800 square miles) and is located in southern California, roughly between Los Angeles and San Diego. Although small geographically, the region’s four-plus million residents (1993 estimate) make it one of the most densely populated regions. The climate of the Santa Ana Region is classified as Mediterranean: generally dry in the summer with mild, wet winters. The average annual rainfall in the region is about fifteen inches, most of it occurring between November and March. The enclosed bays in the Region include Newport Bay, Bolsa Bay (including Bolsa Chica Marsh), and Anaheim Bay. Principal Rivers include Santa Ana, San Jacinto and San Diego. Lakes and reservoirs include Big Bear, Hemet, Mathews, Canyon Lake, Lake Elsinore, Santiago Reservoir, and Perris Reservoir.

The section 2002 303(d) list for the Santa Ana Region included nine water bodies affecting an estimated 7,886 acres (bays, estuaries, lakes, and wetlands) and 24 water bodies affecting 191 miles of rivers and shoreline. The major pollutants affecting these water bodies included nutrients, metals, pathogens, pesticides, and sediments among others (SWRCB 2003a).

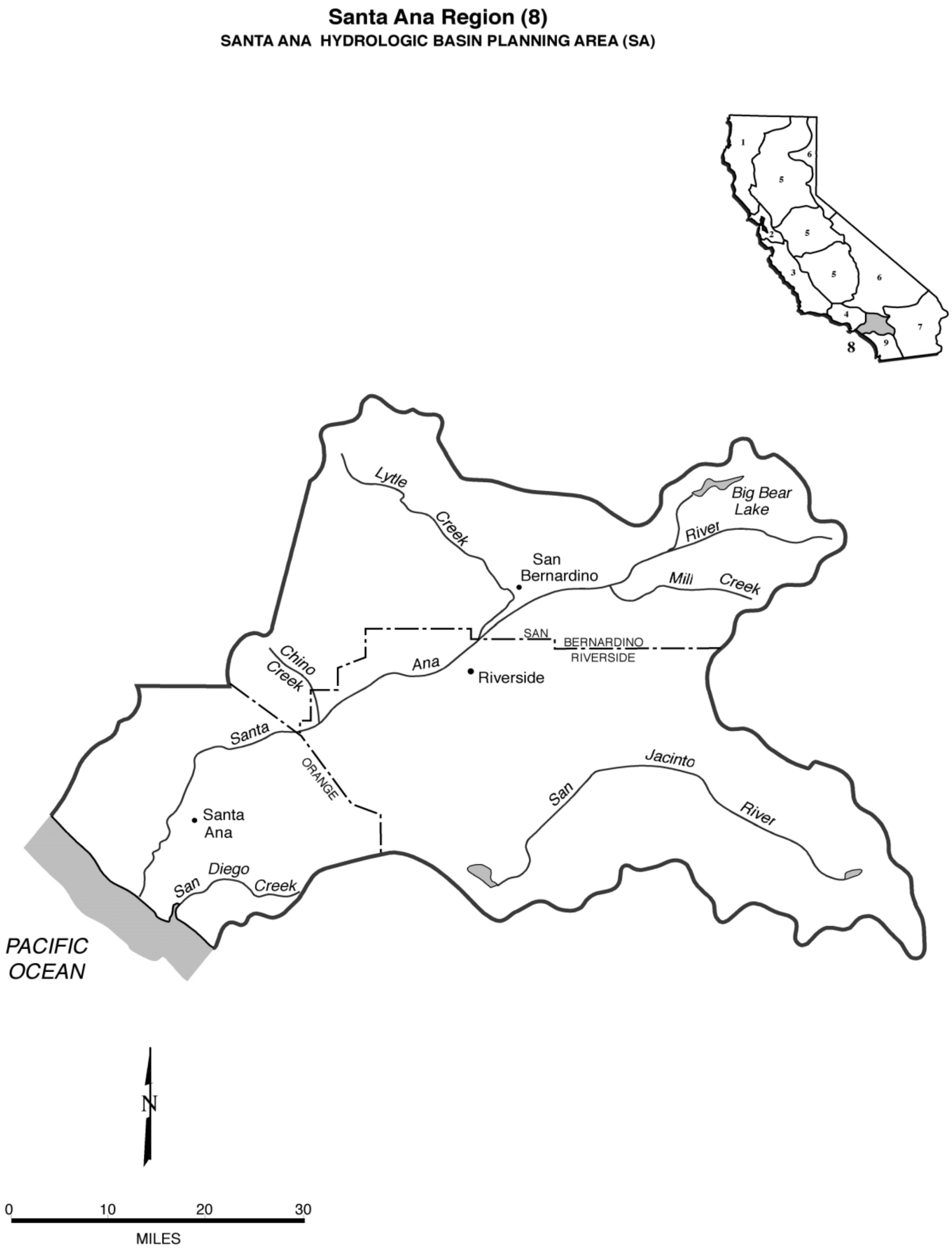
San Diego Region (Region 9)

The San Diego Region comprises all basins draining into the Pacific Ocean between the southern boundary of the Santa Ana Region and the California-Mexico boundary (Figure 12). The San Diego Region is located along the coast of the Pacific Ocean from the Mexican border to north of Laguna Beach. The Region is rectangular in shape and extends approximately 80 miles along the coastline and 40 miles east to the crest of the mountains. The Region includes portions of San Diego, Orange, and Riverside Counties. The population of the Region is heavily concentrated along the coastal strip. Six deepwater sewage outfalls and one across the beach discharge from the new border plant at the Tijuana River empty into the ocean. Two harbors, Mission Bay and San Diego Bay, support major recreational and commercial boat traffic. Coastal lagoons are found along the San Diego County coast at the mouths of creeks and rivers.

The 2002 section 303(d) list for the San Diego Region included 26 water bodies affecting an estimated 6,907 acres (bays, estuaries, lakes, and wetlands) and 40 water bodies affecting 148 miles of rivers and shoreline. The major pollutants affecting these water bodies included nutrients, metals, pathogens, pesticides, and sediments among others (SWRCB, 2003a).

Weather patterns are Mediterranean in nature with an average rainfall of approximately ten inches per year occurring along the coast. Almost all the rainfall occurs during wet cool winters. The Pacific Ocean generally has cool water temperatures due to upwelling. This nutrient-rich water supports coastal beds of giant kelp. The cities of San Diego, National City, Chula Vista, Coronado, and Imperial Beach surround San Diego Bay in the southern portion of the Region.

San Diego Bay is long and narrow, 15 miles in length and approximately one mile across. A deep-water harbor, San Diego Bay has experienced waste discharge from former sewage outfalls, industries, and urban runoff. Up to 9,000 vessels may be moored there. San Diego Bay also hosts four major U.S. Navy bases with approximately 80 surface ships and submarines. Coastal waters include bays, harbors, estuaries, beaches, and open ocean.



Base map prepared by the Division of Water Rights, Graphics Services Unit

FIGURE 11: SANTA ANA REGION HYDROLOGIC BASIN

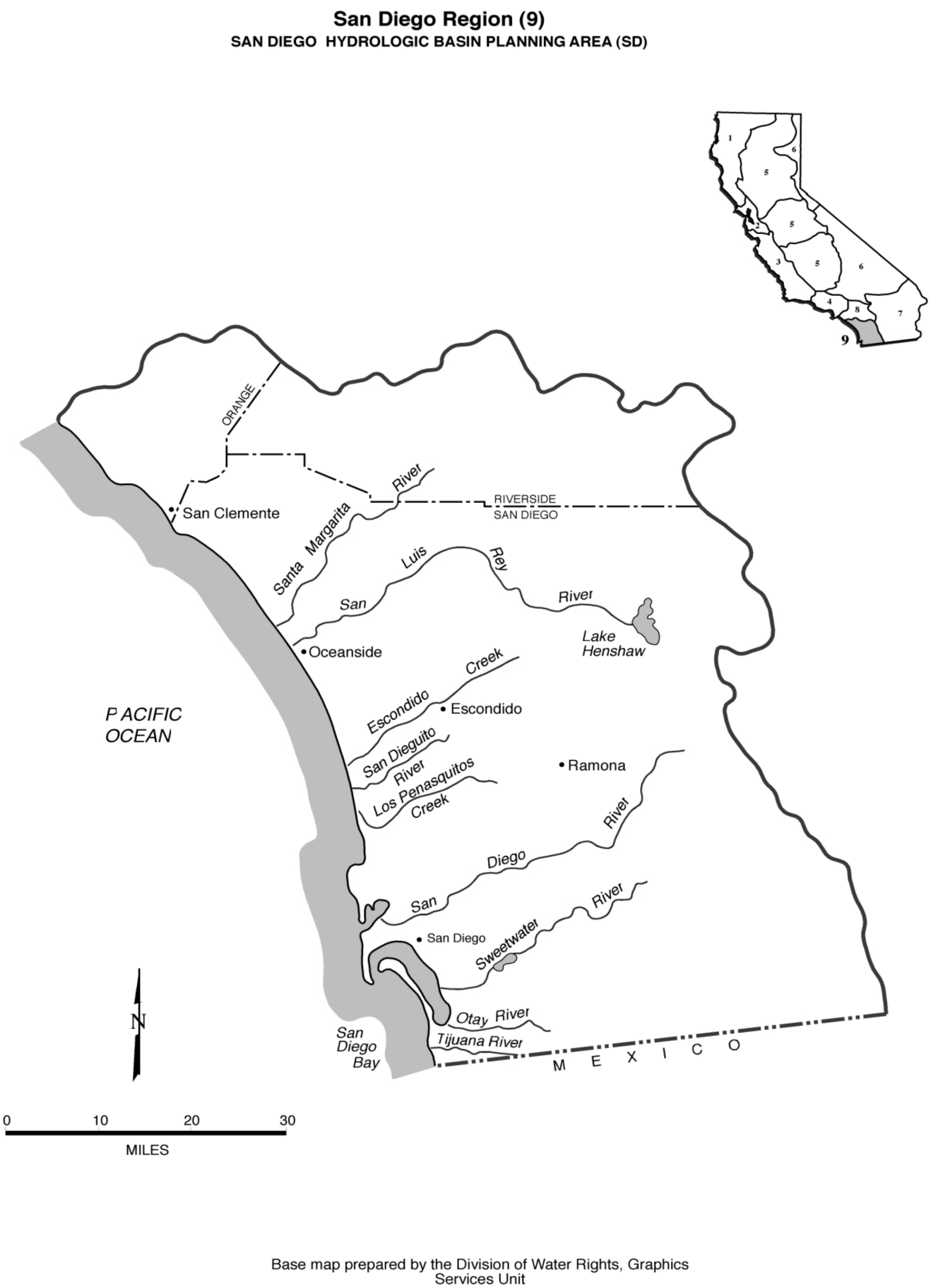


FIGURE 12: SAN DIEGO REGION HYDROLOGIC BASIN

Deep draft commercial harbors include San Diego Bay and Oceanside Harbor and shallower harbors include Mission Bay and Dana Point Harbor. Tijuana Estuary, Sweetwater Marsh, San Diego River Flood Control Channel, Kendal-Frost Wildlife Reserve, San Dieguito River Estuary, San Elijo Lagoon, Batiquitos Lagoon, Agua Hedionda Lagoon, Buena Vista Lagoon, San Luis Rey Estuary, and Santa Margarita River Estuary are the important estuaries of the Region.

There are thirteen principal stream systems in the Region originating in the western highlands and flowing to the Pacific Ocean. From north to south these are Aliso Creek, San Juan Creek, San Mateo Creek, San Onofre Creek, Santa Margarita River, San Luis Ray River, San Marcos Creek, Escondido Creek, San Dieguito River, San Diego River, Sweetwater River, Otay River, and the Tijuana River. Most of these streams are interrupted in character having both perennial and ephemeral components due to the rainfall pattern in the region. Surface water impoundments capture flow from almost all the major streams.

ISSUE ANALYSIS

The staff analysis of each issue addressed during the development of the Policy is formatted consistently to provide the SWRCB with a summary of the topic or issue as well as alternatives for their action. All comments received and the responses are presented in Appendix B. Many of the issue analyses were revised in response to the comments received.

Each issue analysis contains the following sections:

Issue: A brief question framing the issue or topic.

Issue Description: A description of the issue or topic plus (if appropriate) any additional background information, list of limitations and assumptions, descriptions of related programs or other information.

Baseline: A description of how the SWRCB or RWQCBs addressed the issue or topic during the development of the 2002 section 303(d) list and, if necessary, prior to 2002.

Alternatives: For each issue or topic, at least two alternatives are provided for SWRCB consideration.

Recommendation: In this section, a suggestion is made for which alternative (or combination of alternatives) should be adopted by the SWRCB. The reader is also referred to the section(s) of the proposed Policy relevant to the issue.

Issue 1: Scope of the Listing/Delisting Policy

Issue: What factors should be addressed by the Listing/Delisting Policy?

Issue Description: To develop guidance on listing and delisting factors, the SWRCB held scoping meetings for the Policy with members of the AB 982 PAG as well as other constituencies interested in the development of this Policy. Some of these constituencies urged the SWRCB to consider revision of beneficial uses before any listing decisions were made. Comments have also been received suggesting that the Policy be limited to creation of the section 303(d) list since other programs focus on standards revision (e.g., triennial review of the Basin Plans). Additionally, during development of the 2002 section 303(d) list, several comments addressed the appropriateness or applicability of many of the water quality standards and beneficial use designations (SWRCB, 2003a).

CWC section 13191.3(a) requires the SWRCB to develop guidelines for listing and delisting of waters on the section 303(d) list. The development of a section 303(d) list relies on the interpretation of existing water quality standards.

Baseline: SWRCB is required to submit to USEPA a new section 303(d) list every two years. In 2002, SWRCB did not modify any water quality standards during the development of the section 303(d) list.

Alternatives:

1. Incorporate guidance on listing/delisting factors only. CWA section 303(d) requires the state to create a list of waters that do not currently meet existing water quality standards and where TMDLs are still required. This alternative is focused narrowly on developing guidance for completion of the section 303(d) list.

   Focusing the Policy on the listing/delisting factors for the section 303(d) list provide the following advantages: (1) deadlines are more likely to be met for completion of the section 303(d) list; (2) the established triennial review process for the Basin Plans and Statewide Plans would not have to conform to the 2-year time frame for development of the section 303(d) list; and (3) the process would be manageable with existing staff resources.

   The major disadvantage to this approach is that existing standards may not represent actual water body conditions and the problem identified during the listing process may no longer represent a real water quality problem.

   Another disadvantage is that, if not narrowly focused, the potential to broadly apply the Policy requirements is greater. For example, the Policy could potentially be used to determine compliance with permit limitations or translate narrative objectives for the regulation of point sources. To avoid these problems and others, the Policy should clearly state that it is not to be used to: (1) develop or revise water quality objectives or beneficial uses (2) determine compliance with waste discharge requirements (WDRs) or National Pollutant Discharge Elimination System (NPDES) requirements, or (3) interpret narrative water quality standards for the purposes of regulating point sources. The purpose of the Policy should be clearly articulated.

Of the two alternatives considered, this is the preferred alternative because a standardized approach for developing California's section 303(d) list would be established that focuses only on development of the list.

2. <u>Incorporate guidance on beneficial use designation/de-designation and water quality standards revision or development, as well as guidance on interpretation of water quality standards</u>. A National Academy of Sciences (NAS) committee (2001) has recommended that beneficial uses and water quality standards be reviewed as a first step in developing the section 303(d) list. The NAS committee wrote:

> "States should develop appropriate use designations for water bodies in advance of assessment and refine these use designations prior to TMDL development."
>
> "CWA goals of fishable and swimmable waters are too broad to be operational as statements of designated uses. Thus, there should be greater stratification of designated uses at the state level (such as primary and secondary contact recreation). The appropriate designated use may not be the use that would be realized in the water's predisturbed condition. Sufficient science and examples exist for all states to inject this level of detail into their water quality standards."

The purpose of the section 303(d) list is to provide information about water bodies relative to existing standards. Preparation of the list does not require states to reexamine whether those standards are appropriate.

There are disadvantages of taking an approach that combines the section 303(d) process with standards review and revision. Any attempt to revise water quality standards before or during the listing process would almost certainly prevent timely fulfillment of section 303(d)-required tasks. The process for revising beneficial uses or water quality objectives is lengthy and it would be unlikely that the SWRCB and RWQCBs would be able to complete these revisions within the mandated 3-year time frame.

The process for examining and assessing water quality standards is distinct and by necessity separate from the section 303(d) listing process. Federal law requires the states to review water quality standards "at least once every three years" (40 CFR 131.20). During a triennial review, the:

> "State shall . . . hold public hearings for the purpose of reviewing applicable water quality standards, and, as appropriate, modifying or adopting standards. Any water body segment with water quality standards that do not include the uses specified in section 101(a)(2) of the Act shall be re-examined every three years to determine if any new information has become available."

The often lengthy and labor-intensive process to review and change water quality standards is best handled through the established Basin Plan Triennial Review process.

The advantage of combining the triennial review process and the development of the section 303(d) list is that the SWRCB would be more likely to identify real water quality problems.

Recommendation: Alternative 1. See Policy section 1.

Issue 2: Structure of the Section 303(d) List

Issue: Should the State integrate the federal CWA requirements for assessing water quality? What structure should be used?

Issue Description: USEPA has issued guidance (USEPA, 2003b) that recommends states integrate the report requirements of sections 303(d) and 305(b). Section 305(b) of the CWA requires that states and other jurisdictions receiving CWA grant funding submit a water quality report to USEPA every two years that evaluates the quality of the state's waters. The section 305(b) report contains summary information about water quality conditions in rivers, lakes, estuaries, bays, harbors, wetlands, and coastal waters.

The SWRCB and RWQCBs prepare both the section 303(d) list and the section 305(b) report. A key portion of the listing process is deciding how to address water bodies and sites identified as not meeting water quality standards.

Baseline: In 2002, the SWRCB submitted four lists to the USEPA:

Section 303(d) List of Water Quality Limited Segments. Waters on this list did not meet water quality standards due to pollutants. It is required that USEPA approve this list.

Enforceable Program List. Water quality standards were not met but the problem is being addressed by another enforceable program.

TMDL Completed List. Water quality standards were not met; a TMDL and implementation plan has been approved for the water body-pollutant combination.

Monitoring List. Insufficient data and information were available to place the water body on the section 303(d) list.

In the past, California has developed the section 303(d) list independently of the CWA section 305(b) Report. After the section 303(d) list is developed it is typically incorporated into the section 305(b) report.

Alternatives:

1. Develop an all-inclusive list of impaired waters. This list would become the section 303(d) list. The State could develop a list of impaired waters that includes all waters that may not meet water quality standards without regard to whether the problem is best resolved by the implementation of a TMDL (i.e., due to a pollutant). The appropriate management action would then be determined in an analysis separate from, and subsequent to, the determination of whether standards are being met.

   This alternative would provide consistency in the assessment approaches used by all RWQCBs while allowing the flexibility necessary to address regional differences and site-specific concerns. The maintenance of a single "Impaired Waters List" and database would allow the state to respond to potential changes in USEPA regulations for section 303(d) implementation. Future federal regulations could require state submission of a subset of this list of impaired waters. Should federal regulations change in this regard, the structure of California's impaired waters list would be easily amenable to sorting the waters to accommodate any such requirements.

   Creating an "impaired waters" list goes beyond the requirements of state law in developing the listing and delisting Policy. CWC section 13191.3(a) (Senate Bill [SB] 469) requires the SWRCB to prepare guidelines for the listing and delisting of waters and developing and implementing the TMDL program and TMDLs pursuant to section 303(d) of the federal CWA. Since all waters that do not meet water quality standards would be placed on the section 303(d) list, the identified problems would extend beyond the scope of the TMDL program.

   This alternative is very similar to the structure of the section 303(d) list as adopted in 1998. The 1998 list included all waters that were identified as not meeting water quality standards. The expectation was that the RWQCBs would develop TMDLs for all waters on the 1998 section 303(d) list. Many of the water bodies listed were not amenable to TMDL development for a variety of reasons including standards exceedance was not due to a pollutant, additional research and monitoring was needed to identify pollutants causing adverse conditions, etc.

2. Place all waters that do not meet water quality standards on the section 303(d) list and, for those waters with inadequate monitoring data, use a watch list or preliminary list. A committee of the NAS (2001) recommended that before waters are placed on the section 303(d) list, all waters should go through an initial screening assessment. This preliminary assessment would involve comparing available, and often limited, data on water quality conditions with the existing applicable water quality standards. If, based on this initial assessment, the water body is considered to exceed standards, it is advanced to a "preliminary" list for further

consideration. The NAS committee recommended that placement on the preliminary list should be relatively easy, the consequences of which would include additional investigation to determine the nature and reality of a suspected problem. The term “preliminary” indicates that water bodies on this list may later be placed on the section 303(d) list for action. Such a preliminary list has been employed in some states (e.g., Florida).

Those water bodies placed on the preliminary list would be the focus of additional monitoring and assessment of new data and information. This additional assessment would lead to a better understanding of the impacts to beneficial uses and water quality standards exceedances. If, as a result of the more complete assessment, there were sufficient evidence to indicate that water quality standards are indeed exceeded, the water segment on the preliminary list would be moved to the section 303(d) list.

The NAS Committee has stated that this process would improve the accuracy of the listing process. Placement of a water body on the preliminary list serves as an indication to stakeholders that action should be taken soon to achieve water quality standards and avoid the costs associated with TMDL development. However, because of the consequences of movement to the section 303(d) list, there may be an incentive to keep waters on the preliminary list indefinitely. This incentive can be eliminated by requiring that a water body be automatically placed on the section 303(d) list at the end of the next rotating basin monitoring cycle if additional analyses have not been undertaken. Such a requirement may also provide an incentive for point and nonpoint pollutant sources to contribute to the monitoring program in order to avoid the consequences of placement on the section 303(d) list.

3. <u>Use the Integrated Water Quality Report Guidance to develop the section 303(d) list and integrate it with the section 305(b) report</u>. In 2003, USEPA issued guidance on the integration of the CWA section 305(b) requirements with the section 303(d) list (USEPA, 2003b). This guidance implemented many of the recommendations of the NAS (2001). Instead of providing a single “preliminary list,” USEPA recommended the use of multiple lists depending on the type of water quality problem, availability of data and information, and actions that are being implemented in water bodies. Implementation of the USEPA guidance (2003b) would require the development of five major lists or categories of waters as follows:

    Category 1: Attaining the water quality standard and no use is threatened. Water bodies would be listed in this category if there are data and information that meet the requirements of the state’s assessment and listing methodology and support a determination that the water quality standard is attained and no use is threatened. RWQCBs would consider scheduling these water bodies for future monitoring to determine if the water quality standard continues to be attained.

Category 2: Attaining some of the designated uses; no use is threatened; and insufficient or no data and information is available to determine if the remaining uses are attained or threatened. Water bodies would be listed in this category if there were data and information which meet the requirements of the state's assessment and listing methodology to support a determination that some, but not all, uses are attained and none are threatened. Attainment status of the remaining uses is unknown because there is insufficient or no data or information. Monitoring would be scheduled for these water bodies to determine if the previously attained uses remain in attainment, and to determine the attainment status of those uses for which data and information was previously insufficient to make a determination.

Category 3: Insufficient or no data and information to determine if any designated use is attained. Water bodies would be listed in this category when the data or information to support an attainment determination for any use is not available, consistent with the requirements of the state's assessment and listing methodology. To assess the attainment status of these water bodies, the state should obtain supplementary data and information, or schedule monitoring as needed.

Category 4: Impaired or threatened for one or more designated uses but does not require the development of a TMDL.

Category 4A: TMDL has been completed. Water bodies would be listed in this subcategory once all TMDL(s) have been developed and approved by USEPA that, when implemented, are expected to result in full attainment of the standard. Where more than one pollutant is associated with the impairment of a water body, the water body will remain in Category 5 until all TMDLs for each pollutant have been completed and approved by USEPA. Monitoring would be scheduled for these water bodies to verify that the water quality standard is met when the water quality management actions needed to achieve all TMDLs are implemented.

Category 4B: Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future. Consistent with 40 CFR 130.7(b)(i), (ii), and (iii), water bodies would be listed in this subcategory when other pollution control requirements required by local, state, or federal authority are stringent enough to implement any water quality standard applicable to such waters. USEPA expects these requirements to be specifically applicable to the particular water quality problem. Monitoring would be scheduled for these water bodies to verify that the water quality standard is attained as expected.

Category 4C: Impairment is not caused by a pollutant. Water bodies would be listed in this subcategory if a pollutant does not cause the impairment. RWQCBs would consider scheduling these water bodies for monitoring to confirm that there continues to be no pollutant-caused impairment and to support water quality management actions necessary to address the cause(s) of the impairment.

Category 5: The water quality standard is not attained. The water body is impaired or threatened for one or more designated uses by a pollutant(s), and requires a TMDL. This category constitutes the section 303(d) list of waters impaired or threatened by a pollutant(s) for which one or more TMDL(s) are needed. A water body would be listed in this category if it is determined, in accordance with the state's assessment and listing methodology, that a pollutant has caused, is suspected of causing, or is projected to cause an impairment. When more than one pollutant is associated with the impairment of a single water body, the water body will remain in Category 5 until TMDLs for all pollutants have been completed and approved by USEPA.

For water bodies listed in this category, RWQCBs would provide monitoring schedules that describe when data and information will be collected to support TMDL establishment and determine if the standard is attained. USEPA recommends that while the state is monitoring the water body for a specific pollutant to develop a TMDL, it also monitor the watershed to assess the attainment status of other uses.

4. Integrate section 303(d) and section 305(b) reporting requirements but modify the use of the guidance to clearly state the consequence of listing and the conditions that would trigger listing in each category. Building on the USEPA Integrated Report Guidance (2003b), California's list structure could: (1) describe the purpose of the category or list; (2) organize the lists to distinguish waters that meet standards from those that do not; (3) state the consequence of being placed in a category or list; (4) state the conditions that would trigger listing in a category; and (5) modify the USEPA guidance to integrate with California's TMDL Program. This approach was recommended in the July 2003 version of the proposed Policy that was presented to the AB 982 PAG.

   Under this alternative, the SWRCB, in coordination with the RWQCBs, would develop an integrated water quality report that would present the condition of all the State's waters. The water quality of each water body would be assessed in the integrated report by comparison of measurements to applicable water quality standards. After the assessment, waters would be placed in the appropriate category. The categories of waters recommended for the California Integrated Water Quality Report correspond to the categories recommended by USEPA in the Integrated Report Guidance (2003b) as follows:

Categories	
USEPA Guidance	**California Integrated Report**
Category 1	Standards Fully Attained List
Category 2	Standards Partially Attained List
Category 3	Planning List and Monitoring List
Category 4A	TMDLs Completed List
Category 4B	Enforceable Program List
Category 4C	Pollution List
Category 5	Section 303(d) List of Water Quality Limited Segments

In order to comply with CWA sections 303(d) and 305(b), the integrated report would be divided into two sections. The first section would assess whether water quality standards are being met. This would be accomplished by determining whether there is sufficient data and information to conclude that water quality standards are being attained. The planning list would contain waters where some data and information are available but the data and information are insufficient to conclude that water quality standards are not attained. Waters not meeting standards would be placed on the section 303(d) list unless: (1) a TMDL has been completed, (2) other pollution control measures are in place, or (3) documented impacts are not caused by a pollutant. Several states have used a planning list or preliminary list as recommended by NAS (2001).

The second section addresses several CWA section 305(b) requirements. This section would contain the standards fully attained list, standards partially attained list, and the monitoring list. Waters on the standards fully attained list attain all standards. The standards partially attained list would include waters for which one or more standards are attained and data and information related to other standards are insufficient to determine attainment. Waters would be placed on a “monitoring list” if data or information were not available to determine if water quality standards are met.

Implementation of this alternative would require the development of eight lists or categories of waters as follows:

Waters that do not meet or potentially do not meet water quality standards

Planning List. Waters would be placed on this list if some data and information are available but are insufficient to determine whether water quality standards are attained. Water segments would be listed in this category when the data or information to support an attainment determination for any water quality standard is only partially available, consistent with the requirements of the State assessment and listing methodology.

The planning list would contain only a portion of the waters described in Category 3 of the USEPA guidance (2003b). Waters placed in this category exceed applicable water quality objectives infrequently, have too few samples to confidently assess that standards are exceeded, or lines of evidence contradict one another.

While the planning list would help focus the site-specific monitoring activities of the SWRCB and RWQCBs, it is possible that this list could be used to avoid listing waters on the section 303(d) list. To mitigate this potential problem, the planning list should have specific decision rules that require known but lower confidence for listing and require that monitoring is completed.

Waters on the planning list would be scheduled for monitoring to determine if water quality standards or beneficial uses are not attained. The waters on the planning list would also have high priority for monitoring before the next section 303(d) list is completed. Thus, the planning list would be used as the rationale to obtain the needed monitoring. Because of limited state funds available for ambient monitoring, a commitment from the SWRCB and RWQCBs to seek funding for monitoring from interested parties either on a voluntary basis or through existing regulatory mechanisms would be needed (e.g., using the authorities granted in CWC sections 13267 and 13225). As a last resort, the SWRCB and RWQCBs could use state funds identified for this purpose. State funds that could be used for this purpose include Surface Water Ambient Monitoring Program (SWAMP) funding (e.g., to complete site-specific monitoring to identify water quality problems) and TMDL program funding (e.g., to identify pollutants responsible for observed toxicity).

Section 303(d) List of Water Quality Limited Segments. Waters would be placed on this list if a water quality standard is not attained, the nonattainment is due to a pollutant or pollutants, and remediation of the standards attainment problem requires a TMDL.

This category would constitute the section 303(d) list of water quality limited segments for which one or more TMDL(s) are needed. A water segment would be listed in this category if it were determined, in accordance with the State assessment and listing methodology that a pollutant has caused or is suspected of causing non-attainment of standards.

This definition was used in the development of the 2002 section 303(d) list and narrows the scope of waters that need TMDLs to waters where the water quality problem is due to a pollutant or pollutants. As TMDLs are completed for the identified waters, the water segment-pollutant combination would be removed from this list. However, where more than one pollutant is associated with standards non-attainment for a single water segment, the water segment would remain on the section 303(d) list until TMDLs for all pollutants have been completed, are approved by USEPA, and an implementation plan is adopted.

Water Quality Standards are not met but the development of a TMDL is not required

TMDLs Completed List. Water segments would be placed in this subcategory once a TMDL has been developed and approved by USEPA and, when implemented, are expected to result in full attainment of the standard. Where more than one pollutant is associated with the listed water body, the water body would remain on the section 303(d) list until all TMDLs for each pollutant have been completed and approved by USEPA. This category or list shows progress in the completion of TMDLs even though standards are not met.

To track implementation of TMDL(s), monitoring would be scheduled for these water segments to verify that the water quality standard is met once the water quality management actions are implemented.

Enforceable Program List. Water segments would be placed in this category if pollution control requirements, other than TMDLs, were reasonably expected to result in the attainment of the water quality standard in the near future. Water segments would be listed in this subcategory when other pollution control requirements required by local, state, or federal authority are stringent enough to implement water quality standards applicable to such waters. Criteria would be developed to ensure that there is a high probability the existing program will address the identified water quality problem so that this category could not be used to avoid placement of waters on the section 303(d) list. Waters on this list would be scheduled for monitoring as part of the enforceable program to verify that the water quality standard is attained as expected.

Pollution List. This category provides an approach for acknowledging water quality problems that are not due to pollutants. Water segments would be listed in this subcategory if beneficial uses are impacted but a pollutant does not cause the impact. The problems identified on this list would be those described as pollution (i.e., the man-made or man-induced alteration of the chemical, physical, biological and radiological integrity of water (33 USC section 1362)) and would include invasive species, as well as, habitat, channel, or flow modifications that cause nonattainment of water quality standards.

Habitat, channel, or flow modification may affect water quality standards attainment under two sets of circumstances: (1) situations where these three factors cause direct impairment of beneficial uses; and (2) where they influence one or more water quality parameters (e.g., temperature or sediment) leading to impairment of beneficial uses.

The waters on this list would be scheduled for monitoring to confirm that there continues to be no pollutant-caused impairment and to support water quality management actions.

Waters that meet water quality standards or no data available

Standards Fully Attained List. Water bodies placed in this category attain all water quality standards. Water segments would be listed in this category if available data and information demonstrate standards are met and support a determination that all water quality standards are attained. Waters on this list may be scheduled for periodic monitoring to confirm that the waters are still clean.

Standards Partially Attained List. Waters placed in this category attain some water quality standards. Data and information are insufficient to determine if the remaining water quality standards are attained. Waters would be listed in this category if data and information support a determination that some, but not all, standards are attained. Attainment status of the remaining standards would be unknown because data or information is insufficient. Monitoring would be scheduled for these waters to determine if the previously attained standards remain in attainment, and to determine the attainment status of those water quality standards for which data and information was previously insufficient to make a determination.

Monitoring List. Waters would be placed on this list if data and information were not available to determine if water quality standards are attained. This concept is similar to the planning list. This list would be developed in stages because the number of waters with no information could be quite large. To be manageable, the development of this list would be completed on the same schedule as the rotating basin monitoring conducted by SWAMP.

5. <u>Narrow the focus of the Policy to section 303(d) list only</u>. The SWRCB could focus the Policy on the development of a narrowly defined section 303(d) list. The list would include only those waters that do not

meet water quality standards and a TMDL is needed to resolve the pollutant problem and those waters that do not meet standards but (1) other programs address water quality impacts or (2) a TMDL has been completed and an implementation plan has been approved. The section 303(d) list would, therefore, have two distinct categories of water quality limited segments: (1) waters still requiring a TMDL, and (2) waters where the water quality limited segment is being addressed.

General guidelines for the placement of the categories described above could be provided to assure that these categories are used consistently. For example, waters could be placed in the water quality limited segments still needing TMDLs category if the conditions are met for placement in the water quality limited segments category (section 3.1). Conversely, if a TMDL has been completed, the water could be placed in the second category if standards are not met and: (1) a TMDL has been approved by USEPA for the pollutant-water segment combination, and (2) an implementation plan has been approved for the TMDL.

Waters could also be put in the second category if water quality standards are not met and there is an existing regulatory program or programs being implemented to address the identified problem. General guidelines for including a water segment in this category could include a determination that:

- A regulatory program has been adopted and is being implemented by another state, regional, local, or federal agency, and the program will correct the impairment.
- Sufficient mechanisms exist to provide reasonable assurances that the program will address the impairment in a reasonable period of time.
- Sufficient mechanisms to enforce the program exist or the RWQCB otherwise has sufficient confidence that the program will be implemented.
- Water quality standards attainment can be demonstrated through an existing monitoring program or a future monitoring program with reasonable assurance of implementation.
- The program contains conditions that require trackable progress, and such progress is tracked.
- For alternative programs intended to control non-point source contributions to an impairment, such programs comport with the requirements of the Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, including, but not limited to, the Key Elements of an NPS Pollution Control Implementation Program (SWRCB, 2004a).

By using this alternative the scope of the Policy is limited to the section 303(d) list but this does not prevent SWRCB from using USEPA guidance (2003b) in developing the CWA section 305(b) report. For example, the SWRCB could accomplish the integration of these reporting requirements through the CWA section 106 work plan. A disadvantage of not linking the section 303(d) and 305(b) reporting requirements is that any needed monitoring to identify waters not meeting standards would not be mandated in statewide Policy.

This alternative is the preferred alternative because narrowly focusing the listing process on the section 303(d) list complies with the requirements of state law in developing the listing and delisting Policy. Waters that do not meet water quality standards related to pollutants or toxicity would be placed on the section 303(d) list. The additional category identifying water quality limited segments currently being addressed either through other programs or approved TMDLs would help the RWQCBs and SWRCB focus attention on waters where TMDLs are still required.

Recommendation: Alternative 5. See Policy section 2.

Issue 3: Weight of Evidence for Listing and Delisting

Issue: What factors should comprise California's weight-of-evidence approach? What should the relationship among the various factors be?

Issue Description: The 2001 Budget Act Supplemental Report required the use of a "weight of evidence" approach in developing the Policy for listing and delisting waters and to include criteria that ensure the data and information used are accurate and verifiable.

The expression "weight of evidence" describes whether the evidence in favor or against some hypothesis is more or less strong (Good, 1985). In general, components of the weight-of-evidence consist of the strength or persuasiveness of each measurement endpoint and concurrence among various endpoints. Confidence in the measurement endpoints can vary depending on the type or quality of the data and information available or the manner in which the data and information is used to determine impairment.

Scientists have used a variety of definitions for "weight of evidence." A scientific conclusion based on the weight of evidence is often assembled from multiple sets of data and information or lines of evidence. Lines of evidence can be chemical measurements, biological measurements (bioassessment), and concentrations of chemicals in aquatic life tissue.

Baseline: In 2002, SWRCB used a weight-of-evidence approach to evaluate RWQCB recommendations. Ten factors were used to assess the quality of the measurement endpoints: (1) extent to which data quality requirements are met; (2) linkage between measurement endpoints and beneficial use or standard; (3) correlation of stressor to response; (4) utility of measurement for judging if standards or uses are not attained; (5) water body specific information; (6) sensitivity of the measurement endpoint for detecting a response; (7) spatial representativeness; (8) temporal representativeness; (9) quantitativeness; and (10) use of standard methods. Each water body-pollutant combination was evaluated case-by-case.

Alternatives:

1. <u>Provide general description of the weight-of-evidence approach.</u> The Policy would, under this alternative, require a weight of evidence approach to confirm that the available data and information favors or does not favor placing waters on, or removing waters from, the section 303(d) list. In applying the weight-of-evidence approach to listing decisions, the Policy would provide guidance on data and information preprocessing, data and information processing; and data assessment (i.e., combining estimates of standards exceedance).

The weight of evidence approach would be a narrative process where individual lines of evidence are evaluated separately and combined using the professional judgment of the RWQCBs and SWRCB. The lines of evidence would be combined to make a stronger inference about water quality standards attainment. Lines of evidence are typically data or information that pertain to an important aspect of a water body. Using this approach the SWRCB and RWQCBs would use their judgment to weigh the lines of evidence to determine the attainment of standards based on the available data. This general approach was used by the SWRCB in developing the 2002 section 303(d) list (SWRCB, 2003a).

Using this approach, a single line of evidence, under certain circumstances, could be *sufficient by itself* to demonstrate water quality standards attainment. In other situations and with many data types, multiple lines of evidence would be needed to determine if standards are attained.

This approach would follow a two-step process to accommodate the variety of data that may be encountered. The first step is screening the available data and information for comparison with numeric water quality objectives that would be *sufficient by themselves* to demonstrate standards attainment. The second step would be to consider the available data and information using a variety of listing factors that require multiple lines of evidence for listing. The listing factors that require multiple lines of evidence include: (1) Human Health, (2) Toxicity, (3) Nuisance Condition, (4) Adverse Biological Response, (5) Degradation of Biological Populations or Communities, and (6) Trends in Water Quality.

It is possible that RWQCBs may have justification for listing or delisting a water body but, under the Policy listing factors, action would not be taken. In some instances, the available lines of evidence may conflict making it difficult or impossible to determine if water quality standards are attained. While most lines of evidence are addressed by the assessment and listing methodology, there may be circumstances when, due to additional or conflicting lines of evidence, RWQCBs may still feel compelled to place water bodies on the section 303(d) list. The Policy could approach this circumstance by specifying the factors to evaluate data and information, but also allow the use of additional lines of evidence, alternate data analysis procedures, and alternate exceedance frequencies depending on site-specific factors. However, an approach of this sort may exclude some data and information that still could support a listing or delisting decision.

Under these circumstances, RWQCBs should be allowed to recommend a listing, delisting, or maintenance of a listing based on a situation-specific weight of evidence (i.e., where there is information showing standards are attained or not attained). If this approach were used, RWQCBs would be afforded significant discretion in determining the basis for listing or delisting. To make sure the decision is transparent RWQCBs should be required to 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 reasonably be inferred;
- ♦ Demonstrating that the weight of 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.

SWRCB would consider the basis for the situation-specific analysis in the course of the approval of the section 303(d) list.

The disadvantage of a situation-specific weight of evidence listing and delisting factors is that listings could be decided inconsistently or data could be overlooked. The advantage is that the decision rules used for these cases would be transparent. In order to make sure that all data and information are used in the decision-making process the application of the situation-specific weight of evidence factors should be mandatory.

This alternative has been identified as the preferred alternative because the Policy would establish decision rules for assessing compliance with water quality standards and allow flexibility to interpret multiple lines of evidence as dictated by circumstances present in the water body.

2. <u>Provide specific description of the weight of evidence approach.</u> Under this alternative, the weight-of-evidence approach would be a numerical process where individual lines of evidence are evaluated separately and then combined by converting the data to a single format and comparing the line of evidence mathematically. Statistical weight of evidence approaches have been proposed (e.g., Smith et al., 2002; Bettinger et al., 1995) but have not been widely used for placement of waters on the section 303(d) list.

   Smith et al. (2002) presented a quantitative approach that provides a way to combine multiple lines of evidence in a calculation of a weight-of-evidence. A single number can then summarize the weight-of-evidence. In this example, the method uses statistical theory and odds ratios to combine the measures of risk from different lines of evidence. By collapsing many lines of evidence into one metric, this approach has the potential to lose information when the data are summarized. In addition, all types of data and information may not be amenable to such a quantitative approach.

The Massachusetts Weight-of Evidence Workgroup (Bettinger et al., 1995) defined weight-of evidence as the process by which measurement endpoint(s) are related to an assessment endpoint to evaluate if there is a significant risk of harm to the environment. This quantitative approach includes methods for: (1) weighting the individual measurement endpoints by evaluating how well they score against a set of ten attributes; (2) determining whether harm or lack of harm is indicated and the magnitude of response, and; (3) graphically displaying the measurement endpoints in a matrix so the concurrence can be examined. This approach uses quantitative methodology in order to make the assessment process more transparent and objective.

3. Use best professional judgment (BPJ) of each RWQCB to determine weight-of-evidence in all circumstances. Under this alternative, each RWQCB would use its own approach and make its own judgments of the methodology to use. This approach would allow RWQCBs to use a case-by-case assessment of which lines of evidence to use, alternate data analysis procedures, and exceedance frequencies depending on site-specific factors.

   While this approach would provide the maximum amount of flexibility for the RWQCBs, it is possible that the lists generated would be very inconsistent from region to region.

Recommendation: Alternative 1. See Policy sections 1, 3, 3.11, 4, and 4.11.

Issue 4: Listing or Delisting with Single Line of Evidence

A variety of numeric or narrative water quality objectives and beneficial uses can be used by themselves to assess whether water quality standards are attained. Using this approach, a single line of evidence, under certain circumstances, is strong enough to make a conclusion about water quality standards attainment. Approaches for assessing these lines of evidence that could be used by themselves include:

A. Numeric water quality objectives, criteria, or other applicable standards;

B. Marine bacterial standards;

C. Freshwater bacterial standards;

D. Narrative water quality objectives;

E. Tissue data;

F. Trash;

G. Nutrients; and

H. Invasive species.

These categories are discussed separately in Issues 4A through 4H.

Issue 4A: ***Interpreting Numeric Water Quality Objectives and Criteria***

Issue: How are exceedances of a water quality objective or criterion evaluated?

Issue Description: Water quality objectives or federally promulgated water quality criteria represent water quality levels that are not to be exceeded, or exceeded only infrequently, in order to protect the designated beneficial uses of state waters. Water quality objectives and the beneficial uses form two components of water quality standards; the third component is implementation of an antidegradation policy.

Water quality objectives or criteria can be either numeric or narrative. In general, numeric water quality objectives and criteria may quantitatively address magnitude, frequency and/or duration of exposure to toxic chemicals or conditions. The chemical concentration addresses the magnitude component of the objective (i.e., how much of a pollutant is allowable). Water quality objectives are the limit or level of a constituent or characteristic that is established for the reasonable protection of a beneficial use of the water or the prevention of a nuisance in a specific area [CWC section 13050(h)]. Water quality objectives are generally established as maximum levels or concentrations of a pollutant, but may be set as a minimum level for certain water quality parameters such as dissolved oxygen, or as a range for other parameters, such as pH. However, many water quality objectives are expressed as averages, medians, or as a percentage of samples that exceed a numeric value.

USEPA has promulgated numeric criteria for toxic pollutants that supplement existing state water quality standards. Regional water quality control plans (Basin Plans) contain designated beneficial uses, water quality objectives, and an implementation program to achieve these objectives. Applicable statewide plans and policies include, but are not limited to, the State Policy for Implementation of Toxics Standards in Inland Surface Waters, Enclosed Bays, and Estuaries; California Ocean Plan, the Thermal Plan, and State Water Resources Control Board Resolution 68-16. USEPA's criteria for toxic pollutants are found in the California Toxics Rule (CTR). Applicable standards are also promulgated by the California Department of Health Services (DHS).

Prior to conducting list assessments, RWQCBs should consider a number of factors. It should be determined if there is a sufficient number of samples and whether those samples are spatially and temporally representative of the water quality in the water segment. Additionally, the duration (i.e., averaging period) of concentrations expressed in the water quality objective or criterion should be addressed. Samples should, then be compared to the water quality objective to determine if an exceedance has occurred.

Baseline: During the 2002 section 303(d) listing process, data were evaluated on a case-by-case basis. RWQCB staff used the magnitude and duration expressed in the water quality objectives to assess the State's waters in the Basin Plans. Data evaluation was usually expressed as the number of samples exceeding the standard or guideline out of a total number of samples. When appropriate, the magnitude of the measurements was also considered.

Alternatives:

1. Evaluate numeric data using only the magnitude portion of numeric water quality objectives or criteria. Under this alternative, data would be compared to the magnitude component of water quality objectives only. Duration and frequency stated in the water quality objective would not be considered. This alternative would treat all water quality objectives as if the duration was expressed as an instantaneous maximum. The advantage of this approach is that the analysis is simple and data do not need to be assessed before statistical analysis. The major disadvantage is that the duration and frequency components of the water quality objectives are ignored and the water quality objectives are not interpreted as presented in the Basin Plans, statewide plans, or federal regulation.

2. Evaluate numeric data in terms expressed in the numeric water quality objective or criterion. The evaluation of numeric data should be consistent with the expression of the numeric water quality objectives or water quality criteria. If the water quality objectives or criteria state a specific averaging period and/or mathematical conversion, the data should be converted in a consistent manner prior to conducting list assessments. Sufficient data are frequently not available to assess compliance during the stated averaging period. In these cases, the available data should be used to represent the averaging period. For example, if the water quality standard is based on a four-day average and the RWQCB has only one sample for the four consecutive day period, that data should be used to represent the four-day average.

   Under this alternative, to the extent possible, RWQCBs would use the measure that corresponds directly with the duration, magnitude, and frequency portions of the water quality objective or criterion to represent the data set. Some examples follow:

   A. Several measures of central tendency are associated with a number of water quality standards, objectives, or criteria. Basin plans, statewide plans, and federal regulation contain standards with a variety of averaging periods, such as:

- Annual average
- Four-day average
- 24-hour average
- One-hour average
- Median
- Geometric mean

B. Several water quality objectives are based on the maximum value, minimum value, or worst case value of the data set. Basin Plans, statewide plans, and federal regulation contain water quality standards, objectives, or criteria focused on maximum values such as:

- Acute water quality criteria
- "Not to be exceeded" maximum or minimum water quality objectives

C. Some water quality objectives have built in exceedance frequencies. These types of water quality objectives include standards based on percentile of samples exceeded as stated in the water quality objective or criterion.

D. Many standards or objectives do not have stated averaging periods. For data that are not temporally independent (e.g., when multiple samples are collected at a single location on the same day), the measurements should be combined and represented by a single resultant value before the determination is made whether the standard is met. For these values, it is necessary to consider averaging the data, if it is likely that samples are not temporally independent. For example, samples collected at the same location less than seven days apart should be considered as one sample, with the median value used to represent the sampling period. A 7-day averaging period has been used by many states to avoid problems with temporal independence of samples (Arizona Department of Environmental Quality (DEQ), 2000. Florida Department of Environmental Protection (DEP), 2002).

Once raw data have undergone the necessary mathematical conversions to represent magnitude, frequency, and duration it is ready to be compared against water quality objectives or criteria to determine whether water quality standards are attained.

The disadvantage of this alternative is that when data are limited, assumptions about the duration and frequency portions of the water quality objective will have to be made unless it is determined that only large extensive data sets will be used to assess standards attainment. The advantage of this alternative is that the form and expression of the water quality objective is used in section 303(d) list assessments; therefore, staff has identified this alternative as the preferred alternative.

Recommendation: Alternative 2. See Policy sections 6.1.5.6 and 6.1.5.7.

Issue 4B: ***Interpreting Numeric Marine Bacterial Water Quality Standards***

Issue: How should numeric marine bacterial water quality standards be interpreted?

Issue Description: Water quality standards for beaches are contained in the California Ocean Plan and have been promulgated by DHS (pursuant to AB 411 [Title 17, CCR]). The Ocean Plan standards are implemented through NPDES permits. Local public health agencies implement the AB 411 standards and, if exceeded, beaches are posted. Postings indicate impaired water quality and the loss of a beneficial use.

Environmental health agencies may also permanently post a beach at storm drain outlets because the ocean water at the discharge (based on water quality monitoring) exceed bacterial standards or as a precautionary measure. The latter action may not be based on water quality monitoring data.

Baseline: Before 2002, RWQCBs used a variety of approaches for evaluating marine beach water quality data, postings, and closure information. The general approach for developing recommendations for the 2002 section 303(d) list related to bacterial standards exceedances, beach postings, and beach closures included:

- recommendations based on the frequency of water quality standards exceedances;
- the consideration of frequency of water quality standard exceedances and additional, site-specific information, when appropriate; and
- placement of a beach on the section 303(d) list when there was no other means to address the problem.

Ideally, the frequency threshold for listing was the number of water quality standard exceedances in a relatively unimpaired watershed. Since site-specific background data were not available, 10 percent of the total days exceeding standards per year was used as the threshold for listing. This value is based on studies of natural background conditions observed on some southern California beaches. If sample collection was consistent over the sampling period, the number of samples exceeding standards was equivalent to the number of days exceeding the standard per year.

Permanent postings were counted as exceedances when they were based on site-specific water quality data. "Precautionary" postings were not counted as exceeding water quality standards.

The number of postings (the posting of warning signs on the beach by the local environmental health agency) or the total number of days posted was not used in the assessment. "Rain Advisories" were considered in the same manner as precautionary postings. Site-specific data collected during storm events was used for listing determinations.

Alternatives:

1. Interpret water quality standards case-by-case. Under this alternative, RWQCBs would be given significant latitude in deciding what constituted a standards exceedance. For each circumstance, RWQCBs would decide which waters to list, after considering the available data and information for the site. The Policy would not provide guidance on data and information to use, standards exceedance frequency, estimated area affected, number of postings or closures that would trigger a listing, which standards to apply, or other factors. This alternative was used for section 303(d) listing decisions before 2002.

   This alternative would foster inconsistent interpretation of standards, posting, and closure data and information because each RWQCB would develop its own set of decision rules. Conceivably, this alternative would allow listing of beaches with little information available as well as listing of sites that are well studied. Broad interpretation of standards could lead to large portions of California's coastline, including enclosed bays and estuaries, to be placed on the section 303(d) list. A very broad interpretation would make it difficult for the SWRCB and RWQCBs in planning for the development of TMDLs and focus efforts where regulatory response is needed most.

2. Establish consistent process and decision rules to trigger listing. Under this alternative, the SWRCB and RWQCBs would assess compliance with each water quality standard using data and information generated by RWQCB regulatory activities and various local agencies. The data and information would come from the monitoring and regulatory activities of the local environmental health agencies, monitoring activities demonstrating compliance with NPDES permits, and special studies conducted by RWQCBs and recognized private and public institutions.

   During 2002, the Beach Water Quality Workgroup (BWQW) endorsed recommendations of their Monitoring and Reporting Subcommittee regarding criteria to support listing sites on the section 303(d) list (BWQW, 2003). The BWQW is a group of state agencies, environmental health agencies, environmental organizations, the regulated community, and other institutions focused on the improvement of water quality at beaches throughout California. The Monitoring and Reporting Subcommittee consists of representatives from the SWRCB, RWQCBs, local environmental health agencies, regulated dischargers and Heal the Bay.

Recommendations of the Monitoring and Reporting Subcommittee of the BWQW

A. **Listing should be based on the frequency of water quality standards exceedances.** The frequency of exceedances of water quality objectives established by the SWRCB in the Ocean Plan, and the exceedances of standards established by DHS (Title 17 CCR) should determine when an ocean water body/beach segment is listed. This represents the most appropriate means of measuring the failure to meet water quality objectives and the loss of a recreational (REC-1) designated beneficial use.

   Numerous studies indicate that bacterial levels vary considerably over short periods of time and distances. The magnitude of bacterial levels usually vary by source, the concentration of the source contaminate, and the volume of discharge. The magnitude of bacteria does not justify the use of bacterial levels for section 303(d) listing since they measure neither loss of beneficial use nor a failure to attain water quality objectives. Monitoring frequencies, with the exception of daily monitoring, employed by environmental health agencies and many dischargers do not accurately reflect the duration of the failure to meet the established standards. Consequently, only the frequency of exceedances should be used.

   SWRCB and DHS (AB 411, Statutes of 1997) have respectively established water quality objectives and bacterial standards for marine beaches. When these bacterial standards are exceeded, the local health officer/environmental health agency must warn the public that standards have been exceeded by posting warning signs on the beach where the standard exceedances have occurred. The posting of warning signs on the beach constitutes a failure to meet water quality objectives/standards and the loss of REC-1 beneficial use for that water body.

   Routine bacteriological monitoring of ocean water is conducted in accordance with the requirements of AB 411 and various NPDES permits issued by RWQCB. AB 411 monitoring is conducted by local environmental health agencies. The latter monitoring is conducted by agencies discharging sewage effluent into the ocean waters. The data collected in these monitoring programs should be used to identify beaches where water quality does not meet state bacteriological standards for marine beaches.

   Implementation: RWQCB staff may use the frequency of "postings" by the local environmental health agency as the "first screen" to determine if a water body should be listed. When beaches are rarely or never posted and when they are frequently posted, the RWQCB may be able to make the appropriate determination without reviewing the bacteriological data. This data must clearly be indicative of the water quality at the monitoring station in question. The number of postings and the total number of days a beach is posted should not be considered alone since postings may not accurately reflect the frequency that the water body does not meet the health standards or water quality objectives. An analysis of the bacteriological data should be conducted when posting data reported to the SWRCB by local agencies does not provide a clear method for making a listing decision.

A beach should be listed when there is no enforcement action available to address the water quality impairment, and the most appropriate means to address the water quality impairment is a TMDL. Generally, the number of beach closures should not be considered in the listing criteria since the causes of beach closures can usually be addressed by RWQCB enforcement actions. If site-specific conditions warrant their use, e.g., beach closures caused by high indicator bacterial densities with an unknown source, RWQCB staff may use this data. Other site-specific information should be considered when appropriate. For example, BMPs may have been instituted to address impairment and a TMDL may no longer be required to address the problem.

B. The threshold frequency for listing should be the number of water quality standard exceedances in a watershed that is minimally impacted by human activities. At least portions of total and fecal coliform and enterococcus bacteria are naturally occurring in the environment, and their presence does not necessarily indicate fecal pollution from human and domestic animals. As a result, the receiving water from natural runoff in creeks and streams may contain significant levels of coliform and enterococcus bacteria causing the water body to exceed the bacterial standards.

To adequately compensate for natural occurring indicator bacteria, each RWQCB should establish a "reference" beach in their region where possible. The reference beach is one where adequate bacteriological data has been collected and is available from a minimally impacted water body, i.e., one that is not impacted or only minimally altered by human activity. The frequency of exceedances at this site becomes the threshold for determining a bacteriological impaired water body. This requires the identification of watersheds within defined regions that have not been environmentally altered by human activity where possible.

If data is not available from a minimally impacted water body, USEPA recommends that the threshold for exceedances should be 10 percent of the total samples collected. If water quality monitoring at any given site is only conducted during the AB 411 period (April 1 through October 31), the threshold frequency for exceedances at that site should be set at 4 percent of the total samples (Noble et al., 1999).

Implementation: RWQCBs should identify, where possible, a minimally impacted water body within that region and collect bacteriological data to determine what is the appropriate threshold to use for the frequency criteria. Lacking a reference beach, the RWQCB must select and use the most appropriate threshold frequency. This will generally be either 10 percent or 4 percent of the samples as the exceedance threshold. Significant rainfall may occur during the AB 411 period, however. When this occurs, RWQCBs should consider excluding the wet-weather data from the data set if the 4 percent threshold is used since the use of 4 percent is based on dry-weather monitoring.

C. **Listing should be based on a valid data set. RWQCBs should have confidence that the bacteriological data set is adequate and unbiased for listing purposes.** In most instances, the data set for a given location should be derived from routine monitoring by either a discharger or the local environmental health agency.

   Implementation: RWQCB staff must ascertain the validity of their data set. There may be instances where the number of samples collected may be inadequate for determining the impairment of a water body or, when doubts exist, determining that it is unimpaired. Every effort should be made to collect a sufficient amount of data before this determination is made. This may involve special studies or increased monitoring.

D. **Listing should be based on the frequency of water quality standards exceeding the threshold number in multiple years**. The entire bacteriological data set for the time period between listings for any given site should be used to determine impairment and the need to implement a TMDL. The CWA calls for listings to be conducted every two years, but the period has been lengthened to three-year intervals.[1] Using multiple years of data is more likely to ensure the listing is representative of the actual water quality at the beach since an unusually wet or dry year should not unduly affect the data set.

   Implementation: The entire data set between listing periods should be used to determine if the frequency threshold has been exceeded, unless there is a reason to consider the data on a yearly basis. A suitable reason for considering less than the entire data set may be the implementation of a BMP. If only one year in the period exceeds the threshold, professional judgment should be exercised in determining if the water body in question should be listed.

[1] Some members of the Monitoring and Reporting Subcommittee believe that the minimum amount of data used for listing purposes should encompass a minimum of three years.

E. **Permanent postings should be counted as exceedances when they are based on site-specific water quality data.** "Precautionary" postings should not count as water quality exceedances. Local environmental health agencies may permanently "post" beach areas adjacent to storm drains and creek discharges with warning signs. These postings are long term and are based on the experience of the local agency and the accumulation of sufficient data to show that the ocean water in the area is often impaired when there is a discharge. This type of posting is a "permanent posting". There are other instances when warning signs are posted because the local health agency believes that the receiving water will be impaired by the discharge even though there is little or no confirmation monitoring to validate this belief. These are referred to as "precautionary postings".

As discussed under Recommendation A, beach listings for impairment due to elevated levels of bacteria should be based on water quality data. Since permanent postings are typically based on monitoring results, these postings should be counted as exceedances of water quality parameters and used in the listing process.

A permanent posting therefore constitutes water quality impairment and must be listed. Precautionary postings not supported by water quality data should not be considered in the listing process even though both types of postings result in a loss of beneficial use in the area of the posting.

Implementation: RWQCB staff must obtain posting information from each local environmental health jurisdiction to differentiate permanent postings from precautionary postings. A revised data collection and processing system to be employed by the SWRCB may allow this information to be posted on their web site.

F. **"Rain Advisories" should be considered in the same manner as precautionary postings**. "Rain advisories" are issued by local health jurisdictions when rainfall is imminent or after rainfall has begun. These advisories are precautionary in nature and are not issued on the basis of monitoring data. These advisories are usually issued in lieu of posting the beach during the non-AB 411 periods. During the AB 411 period, routine monitoring is required, and if the AB 411 standards are exceeded the beach must be posted. Consequently, monitoring data is usable to the degree that it is appropriate during rainfall.

AB 411 and its regulations do not authorize the use of "rain advisories". They are an activity that local health jurisdictions generally conducted before the passage of AB 411 and the practice has been continued. No protocols have been established for the issuance of these advisories.

Most routine bacteriological monitoring by both dischargers and environmental health agencies continues as scheduled during wet-weather periods. If an agency suspends monitoring during rainfall or within 72 hours of rainfall, the involved monitoring stations are, in effect, monitored only during dry-weather since bacterial levels usually revert to background levels 72 hours following rainfall. Consequently, the frequency threshold for listing should be reduced to 4 percent of the samples collected.

Implementation: No implementation issues exist since the recommendation essentially says to ignore these advisories.

G. **Establish monitoring stations at defined distances from storm drain discharges in order to enhance data consistency.** Monitoring locations have been established in NPDES permits by RWQCBs and the local health agency establishes monitoring locations for its AB 411 regulatory activities. AB 411 and its regulations do not prescribe the location of monitoring stations in relation to storm drain discharges. As a result, no consistency exists between the agencies conducting monitoring activities relative to the distances samples are collected from storm drain discharges.

The BWQW has recommended that the distance of a monitoring station from a storm drain discharge be set at 25 yards, but it is unknown how many health agencies or RWQCBs are following this recommendation.

Implementation: Neither RWQCBs nor DHS have the authority to establish a consistent location for monitoring stations from storm drain discharges. RWQCBs set the monitoring locations for NPDES compliance but they have no authority over health jurisdictions' monitoring locations. DHS may have the statutory authority to determine monitoring locations, but, if so, it did not exercise this authority in the regulations. TMDL compliance monitoring may further complicate any action regarding this recommendation.

H. **Differences in the results of laboratory analyses utilizing different laboratory methods are insignificant.** Currently, most health agencies use a defined substrate methodology for the laboratory analyses of their collected samples. Because USEPA has not approved this method, dischargers are either using membrane filter or multiple tube fermentation methodologies for sample analysis. Bight '98 studies (Noble et al., 1999) and correlation studies conducted by local public health laboratories and approved by DHS demonstrated that there was no significant difference in the results each method produced.

Implementation: No implementation issues exist.

I. **In the absence of site-specific data, the length of beach to be listed should be 50 yards on each side of the storm drain discharge.** The Monitoring and Reporting Subcommittee has recommended that monitoring stations be located 25 yards from the source of the impairment, e.g., storm drain discharge. When the bacterial standard(s) are exceeded, signs are routinely posted at 25 yards on each side of the source of the impairment. They can be seen for a distance of approximately 25 yards. Consequently, the loss of beneficial use is approximately 50 yards on each side of the source of impairment.

In order to assess the area of beach impacted by the storm drain discharge, "adaptive" sampling may be employed by some agencies when a monitoring station frequently exceeds bacterial standards. In these cases, signs are posted at a greater distance from the source discharge point. These distances are reported to SWRCB and are in the database.

In some cases, two monitoring stations may be linked by hydrological conditions. It may also be demonstrated, in the future, that the amount of flow and its pattern from the discharge point can significantly increase the amount of beach affected by the discharge. In both cases, the entire area affected should be listed.

Implementation: The distance recommended is for guidance purposes only. The establishment of a TMDL, when appropriate, should address the problem regardless of the distance cited in the listing.

SWRCB Staff Response to the BWQW Recommendations

A. **Listing should be based on the frequency of water quality standards exceedances.** Frequency of water quality standard exceedances should be used to determine compliance with California Ocean Plan and AB 411 standards. It is recommended that a beach be placed on the section 303(d) list when there is no other way to address the problem. For example, beach closures will not be listed if the closure is due solely to a pipe breakage because the most efficient way to address this problem would be through some form of enforcement action. Site-specific data and information shall be used to determine if a TMDL is the most appropriate approach to address the problem. RWQCBs shall be asked to assemble information regarding the implementation of other enforceable efforts to address the identified problem.

B. **The threshold frequency for listing should be the number of water quality standard exceedances in a watershed that is minimally impacted by human activities.** The threshold frequency for listing should be the number of water quality standard exceedances in a watershed that is minimally impacted by human activities. RWQCBs shall be asked to identify one or more reference beaches in a relatively unimpaired watershed to account for any naturally occurring indicator bacteria.

In the absence of site-specific background data or other site-specific study, 10 percent of the total samples collected will be used as the threshold for listing. If water quality monitoring is conducted only during April 1 through October 31, four percent of the total samples shall be used as the threshold for listing.

C. **Listing should be based on a valid data set.** The confidence in the data set used to make listing decisions shall be temporally and spatially representative of the conditions at the beaches.

D. **Listing should be based on the frequency of water quality standards exceeding the threshold number in multiple years**. The entire data set between listing periods (i.e., multiple years) shall be used to assess standards exceedance. Shorter time frames are allowable if management actions have been implemented that improve water quality. In these cases, only data and information collected after the management action implementation shall be used in the assessment.

E. **Permanent postings should be counted as exceedances when they are based on site-specific water quality data.** Permanent postings based on site-specific water quality data shall be counted as exceedances and placed on the section 303(d) list. Precautionary postings shall not be counted as water quality standards exceedances.

F. **"Rain Advisories" should be considered in the same manner as precautionary postings.** Site-specific data collected during storm events shall be used for listing determinations. If data collection by local agencies is halted during rainfall or within 72 hours of rainfall, the monitoring shall be considered dry weather monitoring and the four-percent exceedance frequency shall be used.

G. **Establish monitoring stations at defined distances from storm drain discharges in order to enhance data consistency.** Data from all monitoring stations shall be used in the assessments supporting the section 303(d) list. In reporting the spatial characteristics of the sample location, RWQCBs report the sample location distance from storm drains or other discharge points.

H. **Differences in the results of laboratory analyses utilizing different laboratory methods are insignificant.** The RWQCBs shall aggregate data from all methods and analyze as one data set.

I. **The length of beach to be listed shall be 50 yards on each side of the storm drain discharge**. The distance recommended is for guidance purposes only. The establishment of a TMDL, when appropriate, should address the problem regardless of the distance cited in the listing. If site specific data are available, RWQCBs should be allowed to determine the length of beach to list on a case-by-case basis, the length of beach to be listed on each side of the discharge point, or the sampling location. No specific guidance should be provided that limits the RWQCBs discretion to establish the area affected.

This alternative has been identified as the preferred alternative because it provides for consistent interpretation of the applicable standards, by standardizing, to the extent possible, the approach for interpreting marine beach water quality data and information.

Recommendation: Alternative 2. See Policy sections 3, 3.3, and 4.3.

Issue 4C: ***Interpreting Numeric Freshwater Bacterial Water Quality Standards***

Issue: How should numeric freshwater bacterial water quality standards be interpreted?

Issue Description: Several counties have ordinances containing bacterial standards that can trigger freshwater beach swimming warnings, postings, or closures (DHS, 2001). As with marine waters, postings are indicative of impaired water quality and the number of postings measure loss of a beneficial use.

The RWQCBs have not previously implemented a consistent approach for evaluating freshwater beach water quality data, postings, and closure information.

Baseline: During the 2002 listing process, RWQCBs developed recommendations for freshwater bacterial water quality objectives on a case-by-case basis. For freshwater bodies, each RWQCB compared monitoring data to Basin Plan water quality objectives. No specific approach or guidelines were mandated. Frequency of standards exceedance was used to assess nonattainment. Typically, RWQCBs used an exceedance frequency of 10 percent.

Alternatives:

1. Interpret freshwater bacterial standards on a case-by-case basis. Under this alternative, RWQCBs would be given significant latitude in deciding what constitutes a standards exceedance. For each situation, RWQCBs would decide which waters to list after considering the available data and information for the site. The Policy would not provide guidance on what data and information to use, standards exceedance frequency, estimated area affected, number of postings or closures that would trigger a listing, which standards to apply, or other factors. This alternative has been used for all freshwater bacterial standards section 303(d) listing decisions.

   This alternative would allow a region-specific interpretation of standards, posting, and closure data and information because each RWQCB would continue to develop its own set of decision rules. Conceivably, this alternative would allow listing of freshwater bodies with little information available as well as sites that are well studied. This alternative would allow for a broad interpretation of standards and place of large portions of California's lakes, rivers, streams, and canals on the section 303(d) list. A broad interpretation would not help the SWRCB and RWQCBs in correcting problems through the development of TMDLs. Additionally, it would be difficult to focus efforts where regulatory response is needed most.

2. Establish consistent process and decision rules to trigger listing based on the BWQW recommendations. Under this alternative, SWRCB and

RWQCBs would assess compliance with each water quality standard using the data and information generated by the regulatory activities of the RWQCBs and various local agencies. Data and information would come from the monitoring and regulatory activities of the local environmental health agencies, monitoring activities conducted to demonstrate compliance with NPDES permits, and special studies that may be conducted by RWQCBs or recognized private and public institutions. These changes would be compared to applicable water quality standards in regional water quality control plans (basin plans) or bacterial standards contained in CCR.

Although specifically focused on marine water quality, the BWQW recommendations could be used as the foundation for developing listing recommendations for freshwaters. The advantage of using these recommendations is that the State would use a consistent approach for addressing bacterial standards in fresh and saltwater. A possible disadvantage is that some of the BWQW recommendations are focused only on marine waters, such as the 4 percent exceedance frequency that was developed using measurements of bacteria in marine waters. However, there is nothing in the record and staff has no reason to believe that background fecal coliform or other fecal-related bacterial contaminant densities should be different in fresh waters (Petrailia, personal communication). Listings could be limited to locations where there is a high likelihood of human fecal contamination and where there is substantial water contact by people.

Another disadvantage is that the monitoring of freshwater lakes, rivers, streams and canals may not occur as frequently as monitoring on marine beaches. This problem could be addressed by providing limited guidance on the characteristics of an acceptable data set. For freshwaters, the data should be sufficient to assess compliance with applicable water quality standards. Data collected less frequently than weekly should be used with caution and monitoring collected during wet and dry conditions should be identified.

Monthly data or a limited, non-routine data set (e.g., sampling frequency is less than once per month) can be used when coupled with an understanding of the watershed, including potential sources of the bacteria, and bacterial fate and transport processes.

This alternative is the preferred alternative because it provides for the consistent interpretation of the applicable standard and standardizes, to the extent possible, the interpretation of freshwater bacterial water quality data and information.

Recommendation: Alternative 2. See Policy sections 3.1, 3.3, and 4.3.

Issue 4D: ***Interpreting Narrative Water Quality Objectives***

Issue: How should SWRCB and RWQCBs interpret narrative water quality standards?

Issue Description: Water quality standards often contain narrative water quality objectives to describe a requirement or a prohibition for a constituent or parameter that, if not exceeded, will provide reasonable protection for beneficial uses of the specified water body. The SWRCB and RWQCBs have used a variety of guidelines or scientifically derived values to interpret narrative water quality objectives.

Federal regulation explicitly states that narrative water quality standards should be assessed in developing the section 303(d) list. Narrative water quality standards are subject to substantial subjectivity in interpretation and typically take the form: *No toxics shall be discharged in toxic amounts*. For example, the San Diego RWQCBs Basin Plan toxicity objective states that "all 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." To ensure that the designated beneficial uses have been protected the toxicity objective further states, "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 Regional Board" (San Diego RWQCB, 1994).

Baseline: In developing the 2002 section 303(d) list, the determination of standard or use attainment were based on the RWQCB and SWRCB interpretation of narrative water quality objectives. Compliance with narrative water quality objectives was considered on a case-by-case basis using all relevant data submitted to the RWQCBs. Data were evaluated using relevant and well-accepted standards, criteria, guidelines, or other objective measures that interpret the sensitivity of a benchmark in determining standards or beneficial use attainment. Guidelines that were well accepted and had high levels of certainty and applicability were used. Each of these evaluation guidelines had a strong scientific basis. Examples included: NAS tissue guidelines, U.S. Food and Drug Administration (USFDA) action levels, USEPA screening values, Maximum Contaminant Levels (MCLs); fish advisories; approaches used in the Bay Protection and Toxic Cleanup Program (BPTCP); published temperature thresholds; published sedimentation thresholds; Federal agency and other state sediment quality guidelines (SQGs); DHS bacterial standards; California Department of Fish and Game (DFG) guidelines, Maximum Tissue Residue Levels (MTRLs), etc.

Evaluation guidelines with no scientific basis for judging standards or beneficial use attainment were not used. Overall, in the 2002 section 303(d) list, constituents that violated the narrative water quality objective and were not supported with acceptable evaluation guidelines were not listed or were recommended for placement on the monitoring list. The exceptions were two listings that exceeded the water quality standard for aquatic life. One was for sedimentation that was based on a 1998 DFG bioassessment report; and the second was a listing for nutrients, continued from the 1998 list that was a part of the Salton Sea TMDL.

Alternatives:

1. <u>Do not allow the use of any guidelines for interpreting narrative water quality standards.</u> This alternative would provide the RWQCBs with the greatest flexibility for interpreting narrative water quality standards and can be advantageous when applied to regional and site-specific water body conditions. However, with nine RWQCBs, multiple interpretations of narrative water quality standards could result and listing or delisting decisions could be inconsistent.

   When the interpretation of a narrative water quality standard has pointed to a listing decision, the SWRCB and RWQCBs have used available defensible guidelines to assess quantitatively the potential for standards to be exceeded. This includes guidelines used as translators and draft guidelines that have a strong scientific basis. Specific evaluation values should address the beneficial use, applicability of the evaluation value, previous use of the criteria, as well as other factors. Draft guidance could be used when no other criteria are available and the scientific foundation and application of the criteria are not in question.

   Narrative objectives have been interpreted in two ways–comparison to the strictly narrative objective or interpretation using local, state, or federal criteria or guidelines. An example of evaluation criteria based on State guidelines to protect a beneficial use is the Los Angeles RWQCBs use of DFG guidelines for macroinvertebrate and bioassessment, supporting the conclusion that sedimentation impacts were detrimental to aquatic life in the Calleguas Creek Watershed (Anderson et al., 1998). A determination of exceedance of the narrative water quality objective was based on the use of standard bioassessment methods and a 1998 bioassessment report. The DFG guideline further provides guidance in sampling and defines water quality objectives by statistical distribution when appropriate.

   The Central Valley RWQCB's water quality objective for color–"Water shall be free of discoloration that causes nuisance or adversely affects beneficial uses"–is an example of a narrative water quality objective, common in many Basin Plans, that does not have a quantitative translator. Narrative water quality objectives devoid of a translator are subjective; some rely primarily on BPJ. BPJ can be defined as the ability to draw conclusions and make interpretations based on experiments, measurements, literature, or other forms of information. BPJ is subjective and open to a variety of interpretations based on individual observations, knowledge, and experience. While BPJ differs among various personnel– the applicable knowledge and experience of each individual will vary– conclusions using BPJ must be based on scientifically defensible data.

Narrative water quality objectives do not quantify the water quality parameters necessary to clearly determine if beneficial uses are being protected. Presence of a pollutant does not automatically translate into impairment of a beneficial use. To be most useful, a narrative water quality objective should include a description of the process used to derive a quantitative evaluation value to help interpret the narrative water quality objective. Interpretive evaluation guidelines can identify the difference between the impaired and unimpaired state of the water body by using indicators as a quantitative measure of water quality and can be used to establish relationships between pollutants and their impact on water quality. Examples of indicators are suspended sediment concentrations, numbers of spawning fish, algal biomass, or total phosphorus concentration. The selected target value must lead to achievement of water quality standards.

The use of a narrative water quality objective without a translator is often not scientifically defensible because the interpretation of impairment becomes subjective. The water quality objective is presumed to be protective of beneficial uses. Without a quantifiable evaluation guideline, the water quality standard is only a description of the desired level of water quality; sufficient data to show cause for a listing is not provided.

2. On a case-by-case basis, allow RWQCBs to establish the method and approach for interpreting narrative water quality standards. This alternative would provide flexibility for the RWQCBs and would address site-specific concerns. Various guidelines and criteria are available from state and federal agencies, as well as other countries that the RWQCBs could use to ensure attainment of water quality objectives. However, guideline selection on a case-by-case basis would lack statewide consistency. USEPA (2002a) provides guidance on the organizational structure for documenting assessment and listing methodology and also provides information on the content of these methodologies.

   For narrative water quality objectives, USEPA (2002a) states –

   > "Narrative criteria are adopted to supplement numeric criteria or if numerical criteria cannot be determined. Narrative criteria are descriptions of the conditions necessary for a water body to attain its designated use, whereas numeric criteria are values expressed as

chemical concentrations, toxicity units, aquatic community index levels, or other numbers deemed necessary to protect designated uses. A "translator" identifies a process, methodology, or guidance to quantitatively interpret narrative criteria statements. Translators may consist of biological assessment methods (e.g., field measures of the biological community), biological monitoring methods (e.g., laboratory toxicity tests), models or formulae that use input of site-specific information/data, or other scientifically defensible methods. Translators are particularly useful for addressing water quality conditions that require a greater degree of sophistication to assess than can be typically expressed by numerical criteria that apply broadly to all waters with a given use designation. Criteria must be based on sound scientific rationale and should contain sufficient parameters or constituents to protect the designated use."

From the above guidance, interpretation of narrative water quality objectives without a translator would not be transparent or consistent and very difficult to defend if the scientific rationale for the listing is not presented. A number of guidelines and criteria exist that can be used to help interpret narrative water quality objectives. For example, translators of narrative water quality objectives can be pulled from numerous sources. Table 2 lists some beneficial uses and the guidelines that have been used by the various RWQCBs to interpret narrative water quality objectives. Under this alternative, the RWQCBs would be able to use any guidelines for interpreting narrative water quality objectives. However, without specific guidance to the RWQCBs in the interpretation of narrative water quality objectives, different endpoints could result leading to inconsistencies in interpretation of water quality standards.

TABLE 2: AVAILABLE GUIDELINES FOR THE INTERPRETATION OF NARRATIVE WATER QUALITY OBJECTIVES

Beneficial Use	Evaluation Guidelines
Aquatic Life	NAS tissue guidelines, BPTCP approaches to identify toxic hot spots, published temperature thresholds; published sedimentation thresholds; Federal agency and other state SQGs, DFG guidelines, Sediment Apparent Effects Thresholds from California and other states toxicity guidelines
Fish Consumption	NAS tissue guidelines, USEPA screening values fish advisories, State Action levels; Fish and Shellfish Consumption Advisories; USEPA Water Quality Advisories
Shellfish Harvesting	Shellfish harvesting bans

Beneficial Use	Evaluation Guidelines
Drinking Water	DHS Primary MCLs, Secondary MCLs; USEPA Primary MCLs, Secondary MCLs; MCL goals; Office of Environmental Health Hazard Assessment (OEHHA) Public Health Goals (PHGs); DHS Action Levels; Drinking Water Health Advisories; Water Quality Advisories; Suggested No-Adverse-Response Levels (SNARLs); Prop 65 levels; California Environmental Protection Agency (CalEPA), USEPA and NAS drinking water Cancer Risk
Taste and Odor	DHS Secondary MCLs, USEPA Secondary MCLs, State action levels (taste and odor-based), USEPA Drinking Water Contaminant Fact Sheets
Agricultural Water Supply	Agricultural Water Quality Goals published by the Food and Agriculture Organization of the United Nations

Adapted from Marshak, 2000.

3. Establish general guidance for the interpretation of narrative standards. State the types of interpretative guidelines that may be used. When selecting interpretative evaluation guidelines to translate narrative water quality objectives, the most appropriate water quality limit would be selected to protect the applicable beneficial use within a water segment. The examples of interpretative guidelines, presented in Table 2 could be used by the RWQCBs for interpreting narrative water quality objectives while still providing flexibility in dealing with site-specific circumstances. However, this list is not inclusive and, by itself, does not achieve the statewide consistency desired in a listing policy.

   When evaluating narrative water quality objectives or beneficial use protection, RWQCBs and the SWRCB should identify interpretative evaluation guidelines that represent standards attainment or beneficial use protection. The Policy should provide specific guidance on selection of interpretative evaluation guidelines to the extent possible. Guidance on selection of evaluation guidelines for tissue and sediment quality is presented in Issues 4E and 5C, respectively.

   For some parameters, however, evaluation guidelines may be required outside of those recommended by the Policy. In order to make sure the guidelines are selected transparently and are applicable to the circumstance before the RWQCB, an alternate evaluation guideline could be used if it can be demonstrated that the evaluation guideline is:

   - Applicable to the beneficial use
   - Protective of the beneficial use

- Linked to the pollutant under consideration
- Scientifically-based and peer reviewed
- Well described

RWQCBs should assess the appropriateness of the guidelines for use in the hydrographic unit and present justification for the alternate guideline in the water body fact sheet.

Staff has chosen this alternative as the preferred alternative because it provides RWQCBs the flexibility to identify the appropriate interpretative evaluation guideline that represents standards attainment or beneficial use protection while the mechanism used to reach the listing decision is transparent.

4. <u>Establish explicit guidance for specific parameters specifying which guidelines should be used</u>. List the guidelines in the Policy. The SWRCB and RWQCBs can strengthen the use of chemical, physical, and biological data in the assessment of narrative water quality objectives and develop a scientifically defensible listing process by establishing explicit guidance for the parameters that will be used to list a water quality impairment. A listing based strictly on a narrative water quality objective without a translator is subjective and relies exclusively on case-by-case judgment to list a water body as impaired on the section 303(d) list. Therefore, to make the mechanisms used to reach these judgements transparent, exceedances based on a narrative water quality objective must be suitable for calculation and specific evaluation guidelines should be presented in the Policy.

   Under this alternative, RWQCBs would be required to use specific values and would not have the flexibility to compare data sets to measures that best represent site-specific conditions. If specific guidelines were required, RWQCBs would not be able to incorporate the most recent versions of the available guidelines or the most recent research that may set values that are more protective of the designated beneficial use.

Recommendation: Alternative 3. See Policy section 6.1.3.

Issue 4E: Interpreting Aquatic Life Tissue Data

Issue: How should chemical residue concentrations in tissue be interpreted?

Issue Description: The presence of toxic substances in water bodies can be determined by analyzing tissues from aquatic organisms. Concentrations of toxic substances in water are often too low or transitory to be reliably detected through the more traditional methods of water sample analysis. Also, many toxic substances are not water soluble, but can be found associated with sediment or organic matter. Aquatic organisms are sampled because they bioaccumulate and bioconcentrate toxic substances to levels that may be many hundreds of times the levels actually in the water. This concentration factor facilitates detection of toxic pollutants.

The tissue pollutant levels of aquatic organisms, collected from a water body, determine whether substances are bioaccumulating and detect potential impacts to aquatic life and on human health from the consumption of fish and shellfish. Bioaccumulation reflects the uptake and retention of a chemical by an aquatic organism from all surrounding media (e.g., water, food, and sediment). Bioconcentration refers to the uptake and retention of a chemical by an aquatic organism from water only. Both bioaccumulation and bioconcentration can be viewed simply as the result of competing rates of chemical uptake and depuration (chemical loss) by an aquatic organism (USEPA 2000d).

Bioaccumulation is a measurable phenomenon, rather than an effect. Merely identifying the presence of a chemical substance in the tissues of an organism is not sufficient information to conclude that the chemical will produce an adverse effect. All chemical substances have the potential to produce adverse effects (e.g., toxicity). The likelihood that a chemical substance, in the tissues of an organism, will produce an adverse effect is a function of the physical and chemical properties of the substance, the concentration of the chemical in the tissues of the organism, and the length of time the organism is exposed to the compound. Environmental pollutants vary widely in their potential to produce toxicity. Therefore, pollutant-specific information must be used to determine the potential for a bioaccumulated substance to produce adverse effects.

Trace metals such as mercury and lead, and trace organic compounds such as DDT (dichlorodiphenyltrichloroethane), PCBs (polychlorinated biphenyls) and PAHs (polynuclear aromatic hydrocarbons) are bioaccumulative substances commonly measured. Fish and shellfish typically take in these substances at a greater rate than they can eliminate them, causing the substance to accumulate in tissue over their lifetimes. Concentrations in aquatic organisms from highly bioaccumulative chemicals may pose unacceptable human health risks from fish and shellfish consumption and may also biomagnify in aquatic food webs, a process whereby chemical concentrations increase in aquatic organisms of each successive trophic level due to increasing dietary exposures (e.g., increasing concentrations from algae, to zooplankton, to forage fish, to predatory fish) (USEPA 2000d).

Evaluation of tissue chemical concentrations are based on screening values established by USEPA, NAS, and additional criteria used in the State Mussel Watch Program (SMWP) reports, such as elevated data levels (EDLs) and MTRLs for the protection of human health and wildlife. Data is collected to determine the prevalence of selected bioaccumulative pollutants in fish and shellfish and to identify sources of these pollutants. In addition, human health risks are estimated for those pollutants for which cancer potency factors and/or reference doses have been established.

Baseline: In developing the 2002 section 303(d) list measures used to interpret chemical residue concentrations in tissue included MTRLs and public health guidelines. In addition to MTRLs, guidelines that were well accepted and had a strong scientific basis with high levels of certainty and applicability were used. Examples included: NAS tissue guidelines, USFDA action levels, USEPA screening values, MCLs; and fish advisories. The use of numeric evaluation values, focused on protection from consumption of aquatic species (e.g., MTRLs or USFDA values), was sufficient by themselves to demonstrate standards attainment. The State did not set a minimum number of samples; however, at least two samples were sufficient to determine attainment.

Alternatives:

1. <u>Do not use this factor.</u> It has been suggested that analysis of fish and shellfish tissue concentrations is not needed to determine attainment of water quality standards because scientifically defensible methods for determining standards attainment already exists through numeric ambient water quality criteria.

   Measurements for ambient water column concentrations of pollutants are a basis for determining impairment. However, the lack of pollutants in the water column does not always mean that designated uses are being protected. Water body-specific factors sometimes cause pollutants, including pathogens, to accumulate in fish and shellfish tissue at higher levels than predicted by the methodology used to derive numeric human health or aquatic life criteria. Examples of such factors include water temperature, nutrient levels, food web structure, the concentration of dissolved organic carbon in ambient water, and accumulations in the sediment. Therefore, a water body can meet numeric ambient water quality criteria, but not attain designated uses because fish or shellfish tissue concentrations exceed levels that are protective of human health or aquatic life.

The use of numeric evaluation values to interpret chemical residue concentrations in tissue is an important indicator that designated uses are being attained. The use of tissue measurements adheres to USEPA's guidance to use all readily available data and information.

2. Interpret bioaccumulation data on a case-by-case basis. This alternative provides the RWQCBs with the most flexibility, as it would account for a variety of site-specific conditions that could be encountered. However, this could also lead to inconsistencies in assessment methodology. Guidance by USEPA (2003b) recommends that, when determining whether a pollutant impairs a segment, listing methodologies should be consistently applied and scientifically valid. The decision rules in the methodology should provide the opportunity to see exactly how assessment decisions are made.

   There are many measurements that can be used to interpret chemical residue concentrations in tissue. Screening values developed by OEHHA and USEPA measure contaminant concentrations found in aquatic organisms for the protection of human health. The USFDA has also established maximum concentration levels for some toxic substances in human foods (USFDA, 1987) and NAS has established recommended maximum concentrations of toxic substances in animals (NAS, 1972). The USFDA levels are based on specific assumptions on the quantities of food consumed by humans and the frequency of their consumption. The USFDA limits are intended to protect humans from the chronic effects of toxic substances consumed in commercial foodstuffs and include economic considerations. The NAS limits were established not only to protect organisms containing toxic compounds, but also to protect species that consume these contaminated organisms. The NAS has set guidelines for marine fish but not for marine shellfish.

   MTRLs and measurement endpoints from other State and federal agencies, other states, and other countries are also available for comparison. MTRLs were developed by SWRCB staff from the human health water quality objectives in the 1997 *California Ocean Plan* (SWRCB, 2001b) and from the CTR (40 CFR Part 131, May 18, 2000). These objectives represent levels that protect human health from consumption of fish, shellfish, and water (freshwater only). MTRLs are used as alert levels or guidelines indicating water bodies with potential human health concerns. However, MTRLs are a calculated value derived by multiplying the human health water quality objectives by the bioconcentration factor (BCF) for each substance as recommended in the USEPA Draft Assessment and Control of Bioconcentratable Contaminants in Surface

Waters (USEPA, 1991a). They are an assessment tool and are not compliance or enforcement criteria. While MTRLs have value as alert levels, their use is questionable in assessing water bodies for placement on the section 303(d) list. MTRLs are not based on any site-specific considerations. As such MTRLs should not be used to evaluate fish or shellfish tissue data for listing decisions.

To ensure consistency in listing, specified numeric values should be used to trigger a listing. Consistent values can be developed to provide limited flexibility to address site-specific situations encountered by the RWQCBs. Without guidance, listings could be based on screening values that are not the most protective of the designated beneficial use.

3. Establish consistent value to trigger listing. Tissue concentrations are difficult to evaluate in terms of impact on aquatic life; however measures do exist to aid in the interpretation of chemicals bioaccumulated in fish or shellfish tissue. The NAS (1972) has evaluated tissue residues for several chemicals and has made recommendations that reflect scientific understanding of the relationship between aquatic organisms and their environment. Screening values (Table 3) represent levels that are protective of aquatic life.

   Screening values developed by the OEHHA and the USEPA assume that human exposure to contaminants can result from edible aquatic species and are based on the general U.S. population's average consumption rate for fish and shellfish. The criteria, therefore, represent concentrations in water that protect against the consumption of aquatic organisms containing chemicals at levels greater than those predicted to result in significant human health problems. The current values are listed in Table 4.

TABLE 3: WILDLIFE PROTECTION CRITERIA FOR EVALUATION OF BIOACCUMULATION MONITORING DATA

Contaminant	**NAS Guidelines***
Aldrin	100 µg/kg
Total DDT	1,000 µg/kg
Total PCBs	500 µg/kg
Chlordane (total)	100 µg/kg
Dieldrin	100 µg/kg
Endosulfan (total)	100 µg/kg
Endrin	100 µg/kg
Lindane (gamma hexachloro-cyclohexane)	100 µg/kg
hexachloro-cyclohexane (total)	100 µg/kg
Heptachlor	100 µg/kg
Heptachlor epoxide	100 µg/kg
Toxaphene	100 µg/kg

*NAS, 1972. µg/kg = micrograms per kilogram (measurements based on wet tissue samples)

The values from these two tables apply to muscle tissue (e.g., fillets) or edible flesh (e.g., whole mussels or clams) samples collected in all types of waters (marine, estuarine, fresh).

In the 2002 list, USFDA action levels were used as an evaluation value. However, USFDA action levels were established to address levels of contamination in foods sold in interstate commerce. Thus, the methodology used by USFDA in establishing tolerances is directed at health risks of contaminants in commercial fish and shellfish (for interstate commerce) rather than in locally harvested fish and shellfish and were never intended to be protective of local water bodies and recreational and subsistence fisherman. USEPA has concluded that USFDA action levels do not provide as great a level of protection for consumers of fish and shellfish caught and consumed than do human health criteria (USEPA, 2003b). Listings based on USFDA action levels may not be the most protective of beneficial uses and, therefore, should be accompanied by water body-specific data showing nonattainment of beneficial uses.

Additional values may also be available from the SMWP. The SMWP has been evaluating bioaccumulation in mussels, fresh water clams, and oyster tissues since mid 1970 and use EDLs and MTRLs. EDLs provide a comparative measure that ranks a given concentration of a particular substance with previous data collected by the SMWP. EDLs were determined by pooling all SMWP data from 1977 through 1997 by species and exposure, ranking the concentrations of each toxicant from highest to lowest concentration (including nondetects), calculating the cumulative frequency of occurrence and percentile ranking for all concentrations, and identifying and designating the concentrations of the toxic substance representing the 85th percentile (EDL 85) and the 95th percentile (EDL 95). EDLs are based on the relative ranking of each measurement, rather than a percentage of the highest concentration obtained and reflect the biases of the data upon which they have been based. EDLs do not assess adverse impacts, nor do they represent concentrations that may be damaging to the mussels, clams, or to a human consuming these species. They do not directly relate to MTRLs, FDA action levels, or NAS guidelines. Therefore, EDLs should not be used to evaluate shellfish or fish tissue data.

The use of consistent values aid in the interpretation of chemicals bioaccumulated in fish or shellfish tissue. Evaluation of tissue chemical concentrations based on screening values established by the USEPA and NAS provide consistent interpretation of the levels of chemical residue concentrations in tissue that impact beneficial uses.

TABLE 4: SCREENING VALUES FOR THE PROTECTION OF HUMAN HEALTH FROM THE CONSUMPTION OF FISH AND SHELLFISH

Contaminant	OEHHA Screening Values*	USEPA Screening Values**
Arsenic	1.0 mg/kg	1.2 mg/kg***
Cadmium	3.0 mg/kg	
Mercury	0.3 mg/kg	
Selenium	2.0 mg/kg	
Tributyltin		1.2 mg/kg
Total DDT	100 µg/kg	
Total PCBs	20 µg/kg	
Total PAHs		5.47 µg/kg
Chlordane (total)	30 µg/kg	
Dieldrin	2.0 µg/kg	
Endosulfan (total)	20,000 µg/kg	
Endrin	1,000 µg/kg	
Lindane (gamma hexachloro-cyclohexane)	30 µg/kg	
Heptachlor epoxide	4.0 µg/kg	
Hexachlorobenzene	20 µg/kg	
Mirex		800 µg/kg
Toxaphene	30 µg/kg	
Diazinon	300 µg/kg	
Chlorpyrifos	10,000 µg/kg	
Disulfoton	100 µg/kg	
Terbufos		80 µg/kg
Oxyfluorfen		546 µg/kg
Ethion	2,000 µg/kg	
Dioxin	0.3 ng/kg	

*Brodberg and Pollock, 1999
**USEPA, 2000c
***USEPA, 2000b

mg/kg = milligrams per kilogram (parts per million)
ng/kg = nanograms per kilogram
(measurements based on wet tissue samples)

4. Provide guidance to trigger listing. Various measures exist that can be used to interpret chemical residue concentrations in tissue. Tissue pollutant levels of organisms can be compared to values established by OEHHA or USEPA for the protection of human health or NAS for the protection of aquatic life to determine if beneficial uses have been impaired. Measurement endpoints from other State and federal agencies can also be used to translate appropriate narrative water quality objectives.

   Acceptable tissue concentrations can be measured either as muscle tissue (preferred) or whole body residues. Residues in liver tissue alone are not considered a suitable measure because livers are generally not targeted for consumption. Composite samples may yield a cost-effective and perhaps more accurate estimate of tissue concentration because many tissue samples are combined before chemical analysis.

Analyzing the tissue from one bottom-feeding fish species (a trophic level three species) and one predator fish species (a trophic level four species) at each site can adequately assess differences in bioaccumulation of various contaminants. Bottom-feeding species accumulate contaminant concentrations by consuming benthic invertebrates and epibenthic organisms living in contaminated sediment. Predator species are good indicators of persistent pollutants that can biomagnify through several trophic levels of the food web.

The discovery of specific contaminants during water quality or sediment studies, or the identification of pollutant sources is one reason for conducting fish tissue analysis. Site-specific information (water or sediment data, data from municipal and industrial sources, or pesticide use data) are critical factors in assessing the impact of a contaminant. Additionally, tissue from appropriate target species permits comparison of fish, and shellfish contamination over a wide geographic area.

This is the preferred alternative because RWQCBs would have the flexibility to compare data sets to the most appropriate measure that can be used to interpret chemical residue concentrations in tissue. Screening values that could trigger a listing decision are described in Alternative 3. By not requiring specific guidance, RWQCBs could incorporate the most recent versions of the aforementioned documents or the most recent research that may set values that are more protective of the designated beneficial use (as long as the evaluation guideline meet the criteria in section 6.1.3 of the Policy).

Recommendation: Alternative 4. See Policy sections 3.5, 4.5, and 6.1.3.

Issue 4F: ***Interpreting Data on Trash Impacts to Water Bodies***

Issue: How should data on trash be interpreted?

Issue Description: Trash or litter that accumulates in waterways may be offensive and cause a nuisance condition. Nuisance is defined in the CWC and in narrative water quality objectives in Basin Plans. Trash can be floating material, such as solids that can cause nuisance or adversely affect beneficial uses. Table 5 presents some examples of types and sources of floatable debris as reported by USEPA.

TABLE 5: TYPES AND SOURCES OF FLOATABLE DEBRIS

Source	Examples of Debris Released
Storm Water Discharges	Street litter (e.g., cigarette butts, filters, and filter elements), medical items (i.e., syringes), resin pellets, food packaging, beverage containers, and other material from storm drains, ditches, or runoff.
Combined Sewer Overflows	Street litter, sewage-related items (condoms, tampons, and applicators), medical items (i.e., syringes), resin pellets, and other material from storm drains, ditches, or runoff.
Beachgoers and Other Nonpoint Sources (NPS)	Food packaging, beverage containers, cigarette butts, toys, sewage, pieces of wood and siding from construction projects, and trash (e.g., beverage containers, food packaging) left behind by workers in forestry, agriculture, construction, and mining.
Ships and Other Vessels	Fishing equipment (e.g., nets, lures, lines, bait boxes, ropes, and rods), strapping bands, light sticks (used by recreational divers and by fishermen to light up fishing lines), plastic salt bags, galley wastes, household trash, plastic bags and sheeting, and beverage yokes (six pack rings for beverage containers).
Solid Waste Disposal and Landfills	Materials such as garbage and medical waste.
Offshore Mineral and Oil and Gas Exploration	Data recording tape, plastic drill pipe thread protectors, hard hats, gloves, and 55-gallon drums.
Industrial Activities	Plastic pellets and other materials
Illegal Dumping or Littering	Food packaging, beverage containers, cigarette butts, appliances, electronics, and ocean and street litter.

Adapted from Woodley, 2002.

Land-based sources of debris cause 80 percent of the marine debris found on our beaches and waterways (USEPA, 2003c). Floatable debris on beaches and in waterways is considered an aesthetic problem.

Suspended or settleable materials must also be considered as defined in the Basin Plans. Examples of these narrative water quality objectives are: "waters shall not contain suspended or settleable materials in concentrations that cause nuisance or adversely affect beneficial uses." Unlike floatables, settleable materials are not always noticeable. These materials include glass, cigarette butts, construction debris, batteries, and diapers. Settleables can be a source of bacteria and toxic substances and can also impact wildlife.

Many types of data and information can be used to support a finding of nuisance but primarily non-numeric information has been used. Some numeric data submitted comes from "Clean-Up Days". Organizations throughout the state sponsor cleanup days, usually along the coast or creeks typically for one day. These events result in trash and debris collections from the beaches and waterways.

Baseline: During the 2002 section 303(d) listing process, SWRCB and RWQCBs' received several submittals of non-numeric information and limited amounts of data in support of trash listing decisions. In general, it could not be determined if these submittals were temporally or spatially representative of water body conditions. Currently, there are 30 pollutant/water body combinations that are listed due to trash impacts.

Alternatives:

1. Use non-numeric information (such as photographs) to support listing decisions. Under this alternative, water bodies would be listed if non-numeric or qualitative information were available to show that water quality standards were not met. Non-numeric information would include visual assessments. Visual assessment documents waterway and watershed conditions and uses. These assessments require minimal technical equipment or training and rely primarily on an individual's sensory abilities and common sense.

   Photographic monitoring, also referred to as "photo documentation," provides a permanent visual documentation of specific waterway and/or watershed conditions. Visual assessments can be used to document conditions from the viewpoint of the individual observer, and are therefore usually qualitative or, at best, semi-quantitative. This type of assessment can be used as a baseline for gross problem identification, or for tracking gross changes over time. Photographs are easy to understand but interpretation between sites in a water body or between different locations is difficult to do in a consistent manner.

Using photo documentation by itself, without any other supportive information, to list a water body for trash raises some important issues. Photographs alone are difficult to interpret spatially and temporally. In addition, photographs can be easily modified or altered to portray the desired effect or the bias of the photographer.

Even though photographs by themselves may be equivocal evidence that standards are not met; they can be used to support listing decisions or indicate that additional monitoring is needed to better characterize trash accumulation. Photo documentation is most useful as a secondary line of evidence, used in conjunction with other lines of evidence.

2. List trash using numeric data with non-numeric information in the assessments to support numeric data. This alternative would require that both numeric and non-numeric data and information be used to support listing decisions. Even though there are limitations in using non-numeric information such as photographs in the listing process, this information could serve as an indication that additional monitoring needs to be performed to better characterize the problem.

   The types of numeric data that could be used include trash cleanup day data or spatially and temporally representative measurements of trash in waterways or at beaches. In order for these data to be interpreted, RWQCBs would need some numeric way of translating the narrative water quality objectives for nuisance so the data can be clearly and predictably interpreted. At present, numeric evaluation guidelines are not available to interpret trash data in terms of water quality objectives or beneficial use attainment. An alternative to a trash evaluation guideline is to compare trash accumulation to reference conditions (i.e., waters scarcely impacted by trash accumulations). Waters would be placed on the section 303(d) list if visual assessments and numeric water quality objectives or evaluation guidelines show that trash is a water quality problem.

   It would be difficult for the RWQCBs to implement either of these approaches.

3. Identify trash as a problem using numerical data and non-numeric information (as described in Alternative 2) but allow existing programs to address any identified water-related trash problem. This option would require placement of water bodies on the section 303(d) list, as described in Alternative 2, but would establish a specific mechanism to place waters in the Water Quality Limited Segments category where an existing program is addressing the water quality problem in lieu of a TMDL. Trash is typically thrown directly on beaches and into rivers and streams. Some trash enters waterways by blowing in from adjacent areas, but most

trash enters these waterways via storm drains. Litter is intentionally or accidentally discarded in watersheds and, during major storms, flushed through the storm drains into the rivers and streams.

If trash is a nuisance in water bodies of the State and storm drains are the major source, then existing storm water permits could be used to reduce the trash discharged via storm drains.

Typically, storm water permits require the permittee to develop and implement a Storm Water Management Plan (SWMP) that is intended to reduce pollutant discharged in storm water to the "maximum extent practicable." The SWMP provides the framework for the development and implementation of specific program components, ranging from legal authority and funding, to BMP programs. The storm water permits require that standards are met, but the mechanism used to meet the standards is the use of ever evolving and more effective BMPs, which can include structural controls. All permit requirements are enforceable.

Water bodies could be placed in the Water Quality Limited Segments Being Addressed category if an existing program or programs are addressing the water quality problem for trash. General guidelines for including a water segment in this category could include a determination that:

- A regulatory program has been adopted and is being implemented by another state, regional, local, or federal agency, and the program will correct the impairment.
- Sufficient mechanisms exist to provide reasonable assurances that the program will address the impairment in a reasonable period of time.
- Sufficient mechanisms to enforce the program exist or the RWQCB otherwise has sufficient confidence that the program will be implemented.
- Water quality standards attainment can be demonstrated through an existing monitoring program or a future monitoring program with reasonable assurance of implementation.
- The program contains conditions that require trackable progress, and such progress is tracked.
- For alternative programs intended to control non-point source contributions to an impairment, such programs comport with the requirements of the Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, including, but not limited to, the Key Elements of an NPS Pollution Control Implementation Program (SWRCB, 2004a).

Recommendation: Alternative 3. See Policy sections 2.2, 3.7, 3.7.2, and 4.7.2.

Issue 4G: ***Interpreting Nutrient Data***

Issue*:* How should nutrient data be interpreted?

Issue Description: Nutrients, in appropriate amounts, are essential to the health and continued functioning of aquatic ecosystems. Excessive nutrients, however, can result in undesirable growth of macrophytes or phytoplankton and potentially harmful algal blooms, leading to oxygen declines, imbalance of aquatic species, public health risks, and a general decline of the aquatic resource.

Excessive nutrient loading has been identified as one of the leading causes of water quality impairments of the nation's waters. Nitrogen and phosphorus are the primary causes of cultural eutrophication; the most recognizable manifestation is algal blooms. Other chronic symptoms include low dissolved oxygen (DO), fish kills, murky water, and depletion of desirable flora and fauna.

Narrative objectives for nutrients are not directly tied to a set pollutant concentration below which beneficial uses are protected. Basin Plans, for the most part, lack a set of numeric nutrient objectives.

Impairments occur when biostimulatory substances promote aquatic growths in concentrations that cause nuisance or adversely affect beneficial uses.

Baseline: RWQCBs recommendations for nutrient listings for the 2000 section 303(d) list included listings for DO, nitrates, ammonia and other nitrogen-related substances. The 2002 section 303(d) list also cited growth of noxious plants, algae, eutrophication, and increased turbidity (i.e., decreased water clarity) as problems.

Alternatives:

1. <u>Use criteria from USEPA.</u> Under this alternative, RWQCBs would use the USEPA recommended parameters for nutrient assessment, which are total phosphorus, total nitrogen, chlorophyll-*a*, and some measure of water clarity (USEPA, 1998c). USEPA criteria establish nitrogen and phosphorus as the main causal agents of enrichment and chlorophyll-*a* and water clarity as response variables. Criteria developed by USEPA uses an ecoregion approach, establish target regional nutrient ranges for phosphorus and nitrogen, and recognizes ambient "natural" background levels of nutrients in each region.

   This alternative is not preferable since the criteria are based on numerous assumptions that do not apply to the western U.S. Using USEPA reference-based values would result in the listing of a large number of potentially unimpacted water bodies. In the development of their guidance, USEPA recognized that flexibility is important and encouraged states to develop regional nutrient criteria. Therefore, in acknowledgement of the differences posed by the western U.S., the USEPA Region IX Regional Technical Advisory Group (RTAG) for developing nutrient criteria has unanimously chosen to develop its own criteria.

2. Wait for RTAG to complete its work before making any further nutrient listings. In 2001, the SWRCB created the State Regional Technical Advisory Group (STRTAG) to work with RTAG to develop nutrient criteria for California and better coordinate the activities of the RWQCBs.

   This alternative would provide the RWQCBs with consistent numeric endpoints upon which to base nutrient listings. However, this alternative would also require waiting at least two years for RTAG/STRTAG nutrient criteria to be developed and several more years before they are adopted and implemented.

3. Provide guidance to trigger listing. To place a water body on the section 303(d) list based on a narrative objective, it should be shown that a nuisance condition exists or that beneficial uses are being adversely impacted. Nuisance or adverse impacts may be established by showing: (1) degradation of the aquatic community or its habitat; (2) complaints from the public; (3) presence of objectionable tastes or odors in drinking water supplies; (4) presence of weeds that impede recreation or navigation; or (5) low DO.

   Once nuisance or an adverse impact is shown, it is necessary to demonstrate the problem is caused by excessive nutrients. Establishing the role of nutrients may be accomplished by: (1) using computer models; (2) reviewing relevant scientific literature; (3) making comparisons with historical data for the area; (4) comparing monitoring data with similar water bodies that are not impaired; or (5) any scientifically defensible method that demonstrates the observed nutrient concentrations result in excessive aquatic growths.

   Data requirements vary based on the rationale for listing and the availability of supporting information. If listing for nitrogen or phosphorus specifically, RWQCBs should consider whether the ratio of these two nutrients provides an indication of which is the limiting agent. Individual datum points should have an identifiable location, quality assurance/quality control (QA/QC) procedures, sample collection methods and analytical methods.

   In the absence of RTAG/STRTAG nutrient criteria, RWQCBs should use models, evaluation guidelines for excessive algae growth, unnatural foam, odor, and taste, scientific literature, data comparisons to historical values or to similar but unimpacted streams, Basin Plan objectives, or other scientifically defensible methods to demonstrate that nutrients are to blame for the observed impacts. Nutrient-related nuisance may also be placed on the section 303(d) list when a significant nuisance condition exists when compared to reference conditions.

RWQCBs should first determine the endpoints that are impacted and whether the nutrient is causing or not causing biostimulation. Next the RWQCBs should determine the beneficial use that is impacted (Figure 13). RWQCBs should follow the guidance provided below when nutrient listing decisions are being made:

Listing for excessive nitrates

Compare the nitrate data to water quality objectives intended to protect drinking water quality or compare data to the MCL. If it is suspected that the aquatic life use is impacted, compare the nitrate data to relevant guidelines available that meet the requirements of section 6.1.3 of the Policy. If listing for nitrogen or phosphorus specifically, RWQCBs should consider examining whether the ratio of these two nutrients provides an indication of which is determined to be the limiting agent.

Listing for violating ammonia objectives to protect aquatic life

Compare the ammonia data to appropriate use-specific objectives and use the approach described for other toxics.

Listing for violating DO objective

Compare the DO data to appropriate use-specific objectives. Data should be sufficient to document the extent and severity of the impairment as well as any temporal/seasonal trends.

When continuous monitoring data are available, the seven-day average of daily minimum measurements should be assessed. For depressed DO, if measurements taken over the day (diel) show low concentrations in the morning and sufficient concentrations in the afternoon, then it should be assumed that nutrients are responsible for the observed DO concentrations if riparian cover, substrate composition or other pertinent factors can be ruled out as controlling DO fluctuations. In the absence of diel measurements, concurrently collected measurements of nutrient concentration should be assessed as described in section 3.1 to applicable and appropriate water quality objectives or acceptable evaluation guidelines (section 6.1.3). If diel pattern is not seen, the impairment may be the result of excessive biological oxygen demand (BOD) or chemical oxygen demand (COD).

When continuous monitoring data is not available, but data are available from at least seven days in any 30-day period, the average of the lowest measurement on seven consecutive days on which measurements were taken should be assessed.

This is the preferred alternative because in the absence of RTAG/STRTAG nutrient criteria, the Policy provides general guidance in the use of models and applicable evaluation guidelines.

Recommendation: Alternative 3. See Policy sections 3.1, 3.2, 3.7.1, 4.1, 4.2, and 4.7.1.

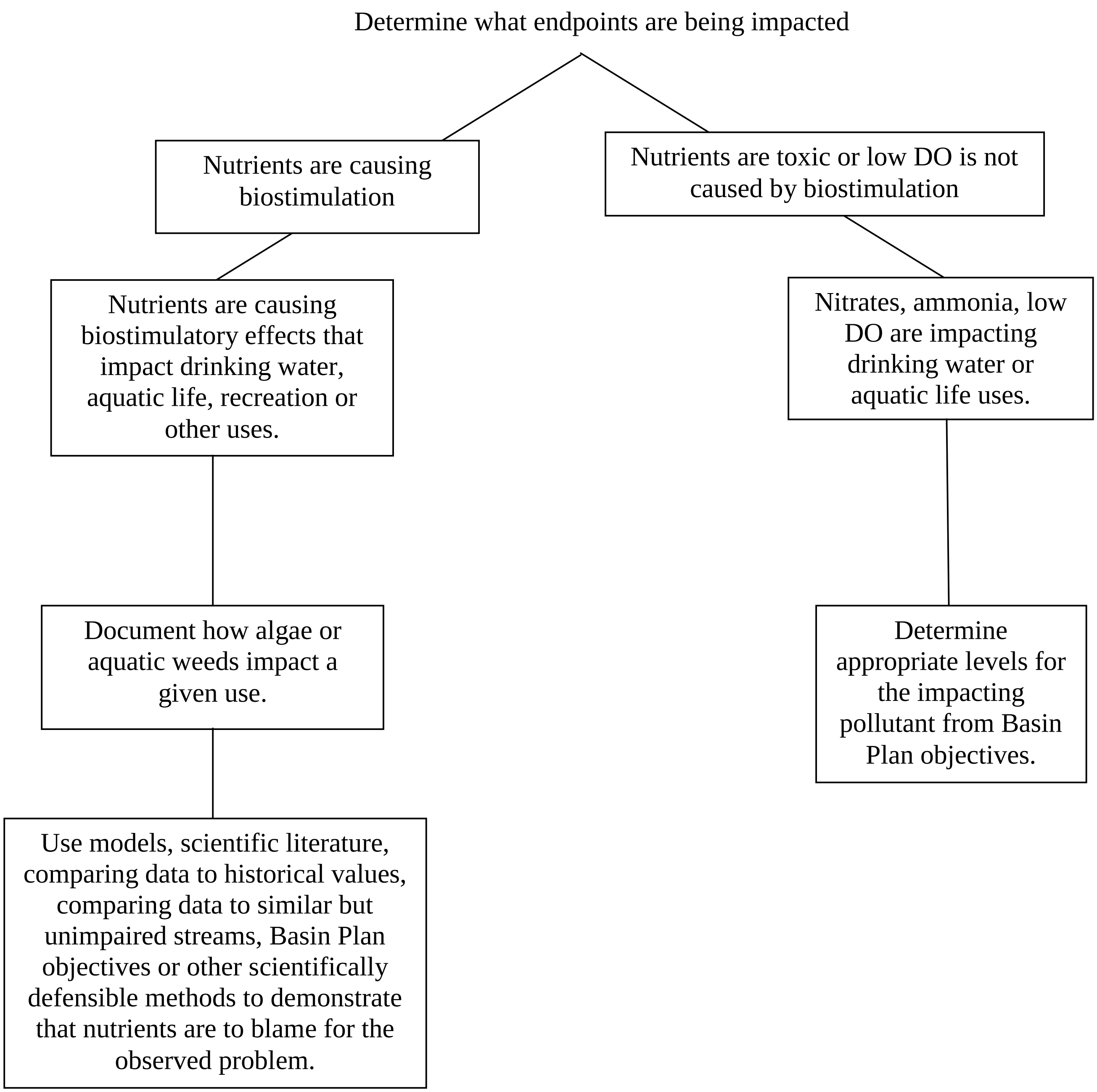


FIGURE 13: NUTRIENT LISTING OPTIONS FLOW CHART

Issue 4H: ***Impacts of Invasive Species on Water Quality***

Issue: How should invasive species impacts be addressed?

Issue Description: Natural barriers, such as mountains, deserts, and oceans have historically acted to restrict the natural dispersion of different types of plants and animals. Human activities, the advent of progressively more advanced technologies in worldwide transportation, and increased global trade have helped reduce the effects of these natural barriers allowing nonindigenous organisms to become introduced into new habitats. Although many of these introduced organisms have minimal or no effect on their new habitats, some have caused enormous negative impacts on the environment and economy.

Human activities have helped to remove the effects of natural barriers through the:

- discharge of organisms from ships ballast water and ships surfaces;
- release of organisms from home aquariums;
- dumping of live bait containers and packing materials;
- discharge of organisms attached to recreational boats, shipping crates, or fishing gear;
- escape of organisms from shipments of live seafood, soil, or seed;
- transfer of aquaculture products or fish stocks;
- intentional introduction of organisms to establish new fisheries;
- propagation of landscape plantings or ornamental ponds; and
- intentional introduction of organisms to control other pests.

As a result of increasing introductions from many sources, nonindigenous aquatic organisms can now be found in many coastal and inland waters across the state, e.g., San Francisco Bay (Cohen, 1998; Cohen and Carlton, 1997; Veldhuizen, 2001).

Recent studies indicate that the rate of such introductions are increasing exponentially, with more invasions being reported along the Pacific coast than the Atlantic or Gulf coasts (Ruiz et al., 2000). It is likely that the rate of introductions will continue, as ships and port systems become larger as global commerce grows, and as investigators find new organisms from other sources. These invasive organisms can clog waterways, impair recreational boating, threaten shellfish production, and interfere with irrigation operations and power generation.

Nonindigenous organisms present unique challenges; they are natural biological entities that have been translocated from one ecosystem to another, either by natural biogeographical processes or by human activities. The introductions of such species occur through point and nonpoint sources. The organisms vary widely, ranging from virus and bacteria unicellular organisms to vascular plants, clams, crabs and fish. Each type of organism can cause different problems. Nonindigenous invasive organisms are capable of creating public health hazards, disrupting trophic structures, and displacing native organisms by out-competing native species for resources and upsetting predator-prey relationships.

Once introduced into a new habitat, invading organisms are virtually impossible to eliminate. Nonindigenous species propagate to become invasive causing permanent impacts that amplify over time.

Many interested parties are attempting to prevent the introduction of nonindigenous species through public awareness, education, and the implementation of non-regulatory prevention practices. A number of federal and state agencies are in the process of implementing laws designed to prevent and /or eradicate all or specific introduced species.

A recent petition to USEPA requested that ballast water discharges be regulated under the NPDES program (USEPA, 1999b). However, USEPA denied the petition (USEPA, 2003g). NPDES permits impose effluent limits designed to remediate the discharge of pollutants to waters of the state from point source discharges. The goal of developing and imposing effluent limits in NPDES permits is to allow the discharge of specific levels of pollutants at specifically calculated concentrations so that designated beneficial uses of the receiving waters are still protected. The issued permits allow discrete loads of pollutants to be discharged into receiving waters.

Another alternative has been to use invasive species as a factor for section 303(d) listing eventually leading to the development of TMDLs.

Baseline: The San Francisco Bay RWQCB listed San Francisco Bay for exotic species on the 1998 section 303(d) list, which was ultimately approved by the SWRCB.

In the 2002 section 303(d) listing process, the SWRCB did not list any new water bodies proposed for listing under section 303(d) for invasive species.

Alternatives:

1. List water bodies under CWA section 303(d) for invasive species that impact water quality and develop TMDLs. At present, documented population explosions of many introduced invasive species have a significant impact on designated beneficial uses in many of our state's waters. Examples include: disruption of commercial and recreational

fisheries beneficial use (COMM), interfering with the delivery of agriculture water supply (AGR) and industrial process supply (IND), obstruction of waterways (navigational beneficial use, NAV), and obstruction of hydropower generation structures (POW). Invasive species can also impact native aquatic habitats.

If the presence of invasive species were used as a listing factor, a TMDL would need to be developed for the impacted water body. Although it may be possible to list a water body for invasive species under section 303(d), it may not be possible to develop a TMDL. Invasive species can affect beneficial uses by obstructing waterways, industrial and agricultural water conveyance structures, affecting water quality parameters such as DO, or causing human health hazards due to population explosions. However, most documented impacts to beneficial uses due to degraded water quality are usually not caused by invasive species. Many invasive species prevent indigenous organisms from maintaining a "balanced indigenous population" but this impact is not the result of a water quality parameter being affected. Obstruction-related impacts require immediate response for which there are some controls already in place, such as eradication and removal. Other impacts, require time to naturally subside. The TMDL process would not be the most effective or appropriate way to address these specific impacts.

The section 303(d) listing and TMDL process comprises the next remediation step in reducing waste loads in water bodies that do not meet water quality standards. TMDLs not only take into account the sum of individual point source waste load allocations established through permits, but also the load allocations for nonpoint sources, plus the natural background loads from tributaries or adjacent water segments. As with the application of NPDES permits, TMDLs are remediation plans designed to further reduce pollutant loads in a more comprehensive fashion while still allowing discrete loads of pollutants to be discharged into receiving waters.

It would be theoretically possible to develop TMDLs based on either taxa or a specific-sized population for the discharge of nonindigenous species into receiving waters. The International Maritime Organization and the U.S. Coast Guard are currently developing such standards for ballast water (Federal Register, 2002; Globalast, 2002). Initially, such loads would be driven by current treatment technology, which would not necessarily protect water bodies from invasive species impacts. There would be no assurance that any or all organisms discharged as part of the load allocation would not become invasive at some time in the future. The load allocations would need to be restrictive enough to impart confidence that the organisms being discharged have a very low probability of survival. The same assurances would also need to be extended for discharges or releases from other sources of introduction. This would include discharges and releases from surfaces of boats or ships, aquariums, or authorized and unauthorized releases of nonindigenous organisms. Regulation and control of these types of discharges would be very difficult to achieve.

It would, therefore, be impractical to regulate invasive species through load allocations that would allow for the discharge of nonindigenous species into the waters of the state without assurance that any organism discharged would not become invasive.

2. Do not list waters impacted by invasive species on the section 303(d) list. Instead, place such identified waters on a subcategory list for impacts not caused by a pollutant. Water bodies impacted by invasive species could be listed under a subcategory for impacts to beneficial uses not caused by a pollutant (USEPA, 2003b). TMDL development would not be required for these waters; the listing would support other appropriate water quality management actions that would address the cause of the impact. Water bodies placed on this list would still be included as part of the water quality monitoring and assessment report submitted in compliance with CWA sections 305(b) and 303(d), creating the much-needed awareness regarding this increasingly important problem.

   At present the SWRCB, must rely on USEPA to determine that nonindigenous species fall under the CWA definition of “pollutant”. The CWA defines “pollutant” to include such things as dredge spoils, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical waste, biological material, radioactive materials, heat, wrecked and discarded equipment, rock, sand, cellar dirt, and industrial, municipal and agricultural waste discharges. Some courts have found that biological organisms such as bacteria, dead and live fish, and plant materials are pollutants. While some invasive organisms may be considered pollutants, USEPA has not concluded that all aquatic invasive species are pollutants (USEPA, 2001a). At this time, USEPA believes that invasive species should not be included within the definition of “pollutant”, as defined by the CWA, and, therefore, State’s are under no obligation to develop TMDLs for waters impacted by nonindigenous species under section 303(d) (USEPA, 1999c).

   A TMDL would not be the most appropriate tool to address invasive species because this program is designed to remediate water quality problems by reducing load amounts from different sources into receiving waters in an attempt to restore beneficial uses. If the intent were to prevent further introductions of nonindigenous species into waters of the state, then allowing some predetermined load to be discharged would seem inappropriate.

Current ballast water management law in effect prohibits the discharge of ballast water unless the master in charge of the vessel employs one of several ballast water management practices. This includes exchanging ballast water in mid-ocean, retaining ballast water, removing or killing nonindigenous organisms in the ballast water through the application of an alternate treatment technology, or discharging ballast water in an approved facility.

The draft San Francisco Bay RWQCB TMDL (2000) reached essentially the same conclusion and recommended a load of zero discharge of nonindigenous organisms into regional waters.

3. Do not list waters impacted by invasive species on the section 303(d) list and delist already listed waters during subsequent listing cycles. Since invasive species are not pollutants (refer to Alternative 2 for discussion) and USEPA has found NPDES permits or TMDLs are not needed for these types of problems, RWQCBs would not need to list waters for invasive species. In 1999, USEPA did not disapprove the inclusion of San Francisco Bay waters listed in the 1998 section 303(d) list for impacts associated with invasive species (USEPA, 1999c). However, USEPA stated that neither the State nor USEPA had an obligation under current regulations to develop TMDLs for such waters because a pollutant was not impacting such waters.

   Under this alternative, exotic species listings currently on the section 303(d) list would be removed during the next listing cycle. Invasive species impacts continue to be addressed through other regulatory and non-regulatory approaches, and other programs would continue to support the research necessary to effectively prevent and eradicate invasive species in California's aquatic systems. Waters impacted by invasive species could be acknowledged in fact sheets but no judgment would be made on their disposition with regard to section 303(d) listing. However, this information would be useful in the development of the section 305(b) report.

   In the 1998 section 303(d) listing process, nine water body segments were listed for exotic species impacts. During the 2002 303(d) listing cycle, SWRCB did not adopt any further additions to the list. Current listings focused on exotic species would be removed from the section 303(d) list.

   This alternative is the preferred alternative because USEPA does not consider invasive species to be a pollutant and it would be difficult or impossible to develop TMDLs for invasive species.

Recommendation: Alternative 3.

Issue 5: Listing or Delisting with Multiple Lines of Evidence

For many data types, multiple lines of evidence are needed to determine if standards are attained. Listing or delisting with multiple lines of evidence is based on the weight of evidence assembled from multiple sets of data and information, the strength or persuasiveness of each measurement endpoint, and concurrence among various endpoints. With the exception of toxicity, the listing factors that require multiple lines of evidence are:

A. Health advisories;

B. Nuisance condition;

C. Toxicity (listings may be made with or without the pollutant identified);

D. Sedimentation (under certain circumstances);

E. Water temperature (under certain circumstances);

F. Adverse biological response;

G. Degradation of biological populations or communities; and

H. Trends in water quality.

These categories are discussed separately in Issues 5A through 5H.

Issue 5A: ***Interpreting Health Advisories***

Issue: How should health advisory information be interpreted?

Issue Description: When water bodies contain fish with high levels of chemicals or metals, OEHHA issues health advisories. Health advisories advise against fish consumption or provide guidelines for limiting consumption in particular areas. The guidelines usually specify how many meals of specific fish, if any, may safely be eaten per week or per month. Often the guidelines specify lower eating limits for some population subgroups, such as pregnant or nursing women or children, because of their higher sensitivity.

Section 101(a)(2) of the CWA establishes as a national goal "water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water, wherever attainable." These are commonly referred to as the "fishable/swimmable" goals of the Act. USEPA interprets "fishable" uses to include, at a minimum, designated uses providing for the protection of aquatic communities and human health related to consumption of fish and shellfish. In other words, USEPA views "fishable" to mean, not only can fish and shellfish thrive in a water body, but when caught can also be safely eaten by humans.

Fish consumption rates are a factor in the development of water quality standards and are used to prevent human risk. In order to characterize human exposure to contaminated fish and shellfish, the population at-risk must be identified, the consumable concentrations of contaminants in fish and shellfish tissues must be measured, and the types and quantities of fish and shellfish consumed must be determined. OEHHA health advisories are an important indicator that beneficial uses have been impacted and, because they are typically based on the water body of concern and describe actual consumption rates of fish and/or shellfish, are an appropriate indicator of potential health impacts.

The major types of advisories and bans issued to protect both the general public and specific subgroups are:

- No consumption advisories;
- No consumption advisories targeted to sensitive subgroups;
- Advisories recommending either the general population or sensitive subgroups restrict their consumption of a specific species; and
- Commercial fishing bans which prohibit the commercial harvest, sale and, by inference, consumption of the species identified in the ban.

Fish advisories developed by OEHHA are published in the California Sport Fishing Regulations and California Sport Fish Consumption Advisories (OEHHA, 2001a).

Baseline: In the past, water bodies with issued health advisories or shellfish bans were automatically considered water quality limited segments and subsequently listed on the section 303(d) list. The approach for developing recommendations for the 2002 section 303(d) list related to health advisories required multiple lines of evidence to list or delist a water body. Each of these lines of evidence generally needed the pollutant(s) that caused or contributed to the adverse condition.

Alternatives:

1. Use OEHHA advisories alone or as an indicator of beneficial use impairment. Health advisories issued against the consumption of edible resident non-migratory organisms or shellfish harvesting bans by OEHHA are acknowledged as indicators that the beneficial use to protect human health is impaired. OEHHA's fish advisories are based on site-specific samples from the water body in question. Additionally, supporting data, when available, is analyzed to assess the likelihood and degree of human exposure. These advisories are based on chemical specific values for tissue concentrations that are intended to protect human health.

   OEHHA is the agency responsible for evaluating potential public health risks from chemical contamination of sport fish. Therefore, fish advisories issued by OEHHA provides scientifically credible evidence of an impairment of the fishable beneficial use. However, advisories can be issued to be protective of subgroups or restrict consumption. Levels of fish tissue contamination may, therefore, be lower than the value set in the Basin Plan or statewide water quality objective. More than one criterion may be necessary to determine impairment. Additionally, USEPA and local health agencies can issue advisories for fish, as well as for drinking water and swimming impacts. Using only OEHHA advisories would disregard valid advisories issued by these other agencies. Therefore, to be most protective of the fishable beneficial uses, all lines of evidence should be considered.

2. Use all types of advisories. Fish or shellfish consumption advisories are sometimes issued by a local agency or a national health advisory can be issued by USEPA. Local advisories can be relied upon if the advisory is based upon methodologies similar to OEHHA and data supporting the advisory exists. To use a health advisory issued by an agency other than OEHHA, the advisory should demonstrate:

   - The advisory is based on fish or shellfish tissue data;
   - The chemical or biological contaminant is associated with sediment or water in the segment;

- The data are collected from the specific water body in question; and
- The risk assessment parameters (e.g., toxicity, risk level, exposure duration and consumption rate) of the advisory or classification are cumulatively equal to or less protective than those in the water quality standards.

This applies to all pollutants that constitute potential risks to human health, regardless of the source of the pollutant.

Some health advisories are based on exceedances of the USFDA action levels. As discussed in Issue 4E, USEPA has concluded that USFDA action levels should not be the sole basis for a decision to list a water body. Water bodies with a fish or shellfish consumption advisory based on USFDA action levels should only be listed as impaired when site specific data support nonattainment of the water quality criteria for human health.

DHS and USEPA issue drinking water health advisories as well. Where drinking water is a designated use, USEPA recommends the inclusion of the drinking water exposure pathway for derivation of the ambient water quality criteria for human health. Water Quality Advisories contain human health related criteria that assume exposure through both drinking water and consumption of contaminated fish and shellfish from the same water. For waters that are sources of drinking water, exposure is assumed both from drinking the water and consuming aquatic organisms (fish and shellfish) that live in the water. For waters that are not sources of drinking water, exposure is assumed to be from the consumption of aquatic organisms only. Aquatic organisms are known to bioaccumulate certain toxic pollutants in their tissues, so as to magnify human exposures. The criteria also include threshold health protective criteria for non-carcinogens. Incremental cancer risk estimates for carcinogens are presented at a variety of risk levels. Organoleptic (taste- and odor-based) levels are also provided for some chemicals to protect human welfare.

Health Advisories are published by USEPA for short-term (1-day exposure or less or 10-day exposure or less), long-term (7-year exposure or less), and lifetime human exposures through drinking water. Health advisories for non-carcinogens and for possible human carcinogens are calculated for chemicals where sufficient toxicologic data exist.

MTRLs are an assessment tool, developed by SWRCB that have been used to access concentrations of chemicals in fish. As discussed in Issue 4E, MTRLs should not be used to evaluate fish or shellfish tissue data for listing decisions.

Health advisories are issued based on real water quality or fish tissue data or they can be issued as a precautionary tool. If the advisory is based on water quality data from a specific water body, the water quality limited segment of the water body should be listed. If the advisory is based on regional water quality and the advisory is precautionary, the data may be used as evidence in support of a listing but should not be used as the sole basis for a listing.

3. <u>Use advisories if associated with water measurements.</u> The issuance of a health advisory provides sufficient evidence that some portion of a water body is impaired due to a specific pollutant as described in Alternative 2. However, a health advisory for an entire water body issued as a public health precaution should not be used alone as basis for placement of a water on the section 303(d) list because some areas covered by the advisory may not reflect the contaminant problems identified in the advisory. In evaluating water segments for the section 303(d) list, the assessment needs to evaluate the segment and determine if the contaminant is associated with water concentrations or tissue burdens in the segment.

   When using health advisories to list a water quality limited segment, it is important to consider if their use targets a population subgroup, recommends restricting consumption, or is preventative. In these instances, the level of contamination in fish tissue may be lower than the value set in the Basin Plan, statewide plan, or CTR. More than one criterion may be necessary to determine if the water segment is impaired.

   Additional indicators to assess attainment with fish and shellfish consumption-based advisories include:

   - Chemical data – from fish tissue and water column;
   - Shellfish growing area classifications – developed by the National Shellfish Sanitation Program (NSSP); and
   - Bacteria criteria – the use of fecal coliform as a water quality indicator.

   There are several advantages to combining the above data with health advisories. Direct measurements of the levels of chemical pollutants in fish tissues can be used in support of health advisories for calculating human health screening values and determining fish consumption levels in the contaminated segment. Additionally, levels of chemical pollutants in fish tissue tend to reflect an integration of the wide fluctuations that occur in chemical concentrations in the water column over time. Measurements of tissue data are also an indicator of the bioaccumulation processes that occur in fish and shellfish that can be concentrated at levels higher than those present in the water column.

Site-specific measurements of chemicals in the water column can provide a link from the source of contamination to the health advisory. Water column data are typically based on total concentrations of chemicals in the water. For some chemicals that require relatively long periods of time before they are detected in fish and shellfish tissues, changes in water column concentrations may occur on a more rapid time scale compared to the corresponding changes in tissue concentrations. Therefore, chemical concentrations found in tissue samples may have little resemblance to measurements based on water column concentrations which are averaged over a sufficient period of time.

Shellfish growing area classifications developed by NSSP uses water column and tissue data (where available). NSSP classifications are not appropriate to consider when performing a beneficial use assessment but they can provide supporting documentation. Measurements of fecal coliform are used to determine if water quality is safe for shellfish consumption.

In some cases, it may not be appropriate to list a water body even though an advisory has been issued (e.g., where an advisory covers a large geographic region, but the sampling data were limited to certain water bodies or where an advisory pertains to migratory or highly mobile species). Also, a water body need not be listed if more recent data or information indicates that designated beneficial uses are being attained and that the advisory is no longer representative of current conditions.

This alternative is the preferred alternative because this alternative provides additional evidence that pollutants in the water segment contribute to the conditions addressed in health advisories. The use of all the lines of evidence listed above would support the use of a health advisory by providing additional documentation that the chemical or biological contaminant is associated with water or tissue in the segment.

4. Use Advisories if associated with water or sediment measurements but do not specify how to evaluate the measurements in the Policy. This alternative would provide the RWQCBs with more flexibility in determining how to evaluate water and sediment measurements in association with health advisories. However, without guidance to assist in evaluating measurements, interpretations could vary by region and evaluation guidelines could be used inappropriately. For example, measurements of sediment concentrations can potentially provide a picture of the levels of environmental contamination for those contaminants that are metabolized by physiological processes in fish tissues. However, as a method of evaluation, direct toxicity testing of sediments provide a chemical-by-chemical specification of sediment concentrations that would

be protective of benthic aquatic life but have not been used in association with impacts on human health.

USEPA is implicit in it's guidance that for purposes of determining whether a water body is impaired and should be included on the section 303(d) list, the methodology and documentation should clearly describe the rationale for identifying potential violations of numeric and narrative criteria. In its 2004 guidance, USEPA (2003b) stresses the need for a consistent approach and thorough documentation of the scientific and technical rationale for listing impaired water bodies.

Recommendation: Alternative 3. See Policy sections 3.4 and 4.4.

Issue 5B: ***Interpreting Data Related to Nuisance***

Issue: How should data related to nuisance conditions (e.g., odor, foam, oil sheen, excessive algae, taste, and color) be interpreted?

Issue Description: As defined in CWC section 13050(m), nuisance is anything that is injurious to health, indecent or offensive to the senses, or an obstruction to the free use of property and interferes with the comfortable enjoyment of life or property. The Basin Plans variously define nuisance as solids, liquids, foams, oils, taste, color, odor, floating material and scum in concentrations that can cause nuisance or adversely affect beneficial uses.

The extent, to which beneficial uses are impacted, in many of the Basin Plans, relies on a narrative objective and is defined as "concentrations that adversely affect beneficial uses." For example, the objective for color in the North Coast RWQCB Basin Plan states "Waters shall be free of coloration that adversely affects beneficial uses" (North Coast RWQCB, 1994). The Los Angeles RWQCB Basin Plan has a similar narrative objective for oil and grease. It states, "waters shall not contain oils, greases, waxes or other materials in concentrations that result in a visible film or coating on the surface of the water or on objects in the water that cause nuisance, or that otherwise adversely affect beneficial uses" (Los Angeles RWQCB, 1995).

The SWRCB and RWQCBs have received information describing nuisance conditions in many waters of the State. This documentation, for the most part, has been qualitative (e.g., photographs, accounts from individuals, etc.). Some numeric data have been provided that describes nuisance conditions (e.g., measures of algae cover or water color).

Baseline: In 2002, water segments were not recommended for placement on the section 303(d) list for nuisance conditions related to assessments of color, odor, excessive algae, and scum.

Alternatives:

1. <u>Use only quantitative data in the evaluation of nuisance.</u> The Basin Plans provide narrative objectives for the various types of nuisance conditions. These types of narrative objectives are subjective and difficult to interpret unless there is a numeric evaluation guideline available that represents a quantifiable level of beneficial use protection.

   Some Basin Plans have numeric objectives that protect waters from nuisance. An example is the San Diego RWQCB's Basin Plan objective for color. The objective is:

> "Waters shall be free of coloration that causes nuisance or adversely affects beneficial uses. The natural color of fish, shellfish, or other resources in inland surface waters, coastal lagoon, or bay and estuary shall not be impaired. Inland surface waters shall not contain color in concentrations in excess of the numerical objectives described in Table 3-2 (20 Color Units)."

When a numeric water quality objective or guideline is available for nuisance conditions, it provides a comparative value upon which numeric data can be directly assessed to determine if water quality standards are met.

A benefit of listing, based on such numeric water quality objectives, is that it is less subjective and reproducible. With all other listing requirements satisfied, such as data quality and quantity requirements, if the data shows an exceedance of the objective and is not attaining standards than the determination that the water segment is impacted is scientifically defensible.

In many cases, nuisance conditions are symptoms of problems and are the manifestation of the effects of pollutants. For example, excessive algae growth is typically caused by unnaturally high concentrations of nutrients. Therefore, a listing based on nutrient-related impairment may be more appropriate. Caution should be exercised in listing decisions related solely to nuisance conditions because many of these factors can also be natural conditions of water bodies (e.g. foam, algae growth, and odors).

2. Use qualitative information to evaluate nuisance. Photographic information and other types of visual assessments are useful as supporting documentation of water quality problems but its value is debatable unless accompanied by quantitative data.

   Visual assessments require minimal technical equipment or training and rely primarily on the individual's sensory abilities and common sense to document water body conditions. There are two general approaches used to develop visual assessments. The first, a narrative approach, involves the use of standardized forms to interpret visual (and other sensory) observations into words or numeric descriptions. The second approach, photographic monitoring also referred to as "photo documentation," provides a permanent visual documentation of specific waterway and/or watershed conditions.

   The RWQCBs have, in previous listing cycles, recommended water segments for the list using qualitative information. For example, Calleguas Creek Watershed-Conejo Creek/Reach 9B was recommended for listing due to unnatural foam and scum during the development of the 2002 section 303(d) list. The recommendation was based on photographic documentation. The photographic evidence provided was for one photograph (SWRCB, 2003a). The pollutant was not identified, the potential sources were unknown, and the only evidence provided to document impairment were photographic visual assessments.

Photographs and other qualitative information can be subject to multiple interpretations. Used alone it is difficult to differentiate between natural and human–caused water quality problems. Qualitative information alone (even if it is subject to multiple interpretations and sampling bias) can be used to evaluate the potential for nuisance conditions and to plan for future monitoring efforts.

3. Use both quantitative and qualitative data and information in the evaluation of nuisance. Qualitative information and quantitative data in combination can provide a strong basis for placement of waters on the section 303(d) list. Qualitative information can be used to evaluate the potential for nuisance conditions and to plan for future monitoring efforts. Qualitative information should not be discouraged. When qualitative information is combined with quantitative data related to pollutants, such as excessive nutrients, multiple lines of evidence provide strong support for placement on the section 303(d) list.

   When submitting photo documentation to support a listing, the submission should describe events or conditions that indicate impairments of water quality that are outside the expected natural range of conditions. The documentation should also provide linkage between the measurement endpoint (e.g., a study that may have been performed for some other purpose) and the water quality standard of interest. Documentation should include the analysts' credentials and training, and be verifiable by the RWQCB or SWRCB.

   For photo documentation to be most useful the date and location on a general area map should be provided. If known latitude/longitude coordinates should be provided or the location marked on an U.S. Geological Survey (USGS) 7.5-minute quad map. The documentation should provide a thorough description of the photo(s) and describe conditions that are not represented by the photo in surrounding areas. For photo documentation of impairment, linkage should be provided between photo-represented conditions and conditions that indicate impairments of water quality that are outside the expected natural range of conditions. The photographer's rationale for the area photographed, the camera settings utilized, and scale should be provided. The organization submitting photos should submit its entire photo set for a given condition in order to document spatial/temporal conditions for the time frame specified.

For the section 303(d) list, the pollutant or pollutants that cause or contribute to the observed impacts should be identified. To do this, the RWQCBs should rely on existing numeric water quality objectives (related to nutrients or other pollutants) or evaluation guidelines that represent an acceptable level of beneficial use protection. The guidelines should satisfy the requirement of section 6.1.3 of the Policy. It is also defensible to compare water bodies conditions to reference conditions, if they have been identified.

This alternative represents the preferred alternative because using established guidelines or comparisons to reference conditions for quantitative and qualitative data and information could lead to better assessments of nuisance conditions.

Recommendation: Alternative 3. See Policy sections 3.7, 3.7.2, 4.7, 4.7.2, and 6.1.3.

Issue 5C: ***Interpreting Toxicity Data***

Issue: How should toxicity data be interpreted?

Issue Description: Toxicity is a direct measurement of the health of the water body. Toxicity measurements assess the response of aquatic organisms to pollutants by directly measuring the organism's exposure to a water or sediment sample. Assessing the response of a number of different organisms ensures a greater opportunity to identify water quality problems. Toxicity measurements can assess the relationship of complex mixtures of pollutants or individual substances and can evaluate acute or chronic exposures in test systems.

Toxicity tests are conducted in water or sediment for freshwater, estuarine, and marine environments. Several lines of evidence can be used to identify toxic effects and several approaches are available to assess what pollutant might have caused or contributed to the observed toxicity.

Baseline: During the development of the 2002 section 303(d) list, toxicity testing was used as a basis for listing as long as concurrently sampled chemical data was available to show the chemical caused or contributed to the toxic effect.

Alternatives:

1. Provide no guidance on methods or approaches for interpreting toxicity data. Under this alternative, the RWQCBs would be given significant flexibility on the use of toxicity data for determining the attainment of water quality standards. Guidance would not be established in the Policy for evaluating toxicity information and data. The RWQCBs would be able to exercise BPJ in determining which waters would be placed on the section 303(d) list. The disadvantage of this alternative is that it would allow potentially significant inconsistencies in listings for toxicity among the various RWQCBs.

2. Use toxicity alone as a listing factor. Using this alternative, the RWQCBs would be required to use well-established toxicity testing methods to make listing determinations, as long as appropriate reference and control measures are included in the toxicity tests.

   One disadvantage of this alternative is that it is very difficult to complete a TMDL on toxicity alone. In addition, there are no examples in California where a TMDL has been developed for toxicity in the absence of the pollutant. When toxicity has been identified, the RWQCBs have, in a few cases, sponsored studies to identify the pollutant causing the toxicity (e.g., Foe et al., 1998). The performance of these types of studies may delay development of TMDLs. To reduce the effect of this disadvantage, TMDLs should be scheduled to proceed even if the pollutants are not identified. Federal regulation allows for developing TMDLs for the identified pollutants causing or expected to cause water quality standards violations (40 CFR 130.7(b)((4)). The exception is toxicity. The definition of a TMDL (40 CFR 130.2(i)) allows for "TMDLs to be expressed in terms of either mass per time, toxicity or other appropriate measure." In order for TMDLs to be expressed in terms of toxicity, it is necessary for TMDLs to be developed for toxicity.

In assessing toxicity data several considerations need to be addressed including:

- toxicity test methods;
- assessment of statistical significance of toxicity; and
- persistence of toxicity.

Toxicity Test Methods

Several species have been used in acute and chronic toxicity testing for fresh and marine waters. Toxicity tests typically compare ambient water to either standard control waters or unpolluted receiving water (as specified in the testing manual) or sediments to a reference condition.

Currently, no single toxicity test can adequately characterize the toxicity that pollutants may cause in water or sediment. For freshwaters, USEPA (1991f) recommends selection of toxicity tests, using species from ecologically diverse taxa and the screening of ambient water with three species (a fish, an invertebrate, and a plant) for chronic testing and two species (a fish and an invertebrate) for acute testing (Table 6). This recommendation is based on differences in species sensitivity among groups of organisms to different toxicants.

TABLE 6: FRESHWATER TOXICITY TESTS

Species	Effect	Reference
Fish		
Fathead minnow, *Pimephales promelas*	Survival; Survival and growth	USEPA, 1993c* USEPA, 2002d* USEPA, 1994c** USEPA, 2002c** ASTM, 2002c
Rainbow trout, *Oncorhynchus mykiss*	Larval survival	USEPA, 1993c* USEPA, 2002d* ASTM, 2002c

Species	Effect	Reference
Brook Trout, *Salvelinius fontinalis*	Larval survival	USEPA, 1993c* USEPA, 2002d* ASTM, 2002c
Bluegill Sunfish, *Lepomis macrochinus*	Survival and growth (48 hours to 32 days)	ASTM, 2002c
Channel Catfish, *Ictalurus punctatus*	Survival and growth	ASTM, 2002c
Rotifer, *Brachionus calyciflorus*	Embryo survival	ASTM, 2002e
Invertebrate		
Water flea (Invertebrate), *Ceriodaphnia dubia*	Survival	USEPA, 1993c* USEPA, 2002d* ASTM, 2002b
	Survival and reproduction	USEPA, 1994c** USEPA, 2002c** ASTM, 2002b
Water flea (Invertebrate), *Daphnia pulex* and *Daphnia magna*	Survival	USEPA, 1993c* USEPA, 2002d* ASTM, 2002b
Water flea (Invertebrate), *Daphnia magna*	Survival, growth and reproduction	USEPA, 1994c** USEPA, 2002c** ASTM, 2002b
Rotifer, *Brachionus calyciflorus*	Embryo survival	ASTM, 2002e
Plant		
Green algae, *Raphidocelis subcapitata* (=*Selenastrum capricornutum*)	Growth	USEPA, 1994c** USEPA, 2002c**

*Acute test
**Chronic test

For marine waters (Table 7), a variety of tests are included in the California Ocean Plan that address the responses from a range of organisms (SWRCB, 1996; SWRCB, 2001b).

TABLE 7: MARINE WATER TOXICITY TESTS

Species	Effect	Reference
Giant Kelp, *Macrocystis pyrifera*	Percent germination; germ tube length	USEPA, 1995** SWRCB, 1996**
Red abalone, *Haliotis rufescens*	Abnormal shell development	USEPA, 1995** SWRCB, 1996**
Pacific Oyster, *Crassostrea gigas*; Mussels, *Mytilus* spp.	Abnormal shell development; percent survival	USEPA, 1995** SWRCB, 1996**
Urchin, *Strongylocentrotus purpuratus*; alternate species (*S. franciscanus, S. droebachiensis, Dendraster excentricus, L. pictus*) Sand dollar, *Dendraster excentricus*	Percent normal development	USEPA, 1995** SWRCB, 1996**
Urchin, *Strongylocentrotus purpuratus*; alternate species (*S. franciscanus, S. droebachiensis, Dendraster excentricus, L. pictus*) Sand dollar, *Dendraster excentricus*	Percent fertilization	USEPA, 1995** SWRCB, 1996**
Shrimp, *Holmesimysis costata*	Percent survival; growth	USEPA, 1995** SWRCB, 1996** ASTM, 2002h
Shrimp, *Americanmysis (Mysidopsis) bahia*	Percent survival; Growth	USEPA, 1993c* USEPA, 2002d* USEPA, 1994b** USEPA, 2002e** ASTM, 2002h
Shrimp, *Neomysid mercedis*	Percent survival	US EPA, 1994b** USEPA, 2002e** ASTM, 2002h
Topsmelt, *Atherinops affinis*	Larval growth rate; percent survival	USEPA, 1995** SWRCB, 1996** ASTM, 2002a

Species	Effect	Reference
Silversides, *Menidia beryllina*	Larval growth rate; percent survival	USEPA, 1993c* USEPA, 2002d* USEPA, 1994c** USEPA, 2002c** USEPA, 2002e** ASTM, 2002a

*Acute test **Chronic test

Toxicity tests are also available for fresh and marine sediments (Tables 8, 9, and 10). A variety of tests have been used throughout the state by a number of monitoring programs (e.g., SWAMP, SCCWRP (Southern California Coastal Water Research Project), SFEI (San Francisco Estuary Institute), and BPTCP). These programs have used well-developed and accepted toxicity tests with amphipods, polychaete worms, and midges, etc. Toxicity tests are available to test toxic effects on organisms of pore water (i.e., the water between sediment particles) or the sediment-water interface (the effect of chemicals released from the sediment to water).

TABLE 8: MARINE SEDIMENT TOXICITY TESTS

Species	Effect	Reference
Amphipods: *Rhepoxynius abronius, Eohaustorius estuarius, Leptocheirus plumulosus, Grandidierella japonica, Ampelisca abdita*	Acute survival	USEPA, 1994a ASTM, 2002g
Polychaete, *Nereis (Neanthes) arenaceodentata*	Survival (10 day)	ASTM, 2002f USEPA, 1998a
	Survival and Growth (28 day)	ASTM, 2002f

TABLE 9: FRESHWATER WHOLE SEDIMENT AND POREWATER TEST ORGANISMS

Species	Effect	Reference
Amphipod, *Hyalella azteca*	Survival and Growth (10 days)	USEPA, 2000e
Amphipod, *Hyalella azteca*	Survival, Growth, and Reproduction (28-42 days)	USEPA, 2000e
Midge, *Chironomus tentans*	Survival and Growth (10 days) Survival and Growth (long-term)	USEPA, 2000e USEPA, 2000e

TABLE 10: CHRONIC TESTS FOR MARINE SEDIMENT PORE WATER AND SEDIMENT-WATER INTERFACE

Species	Effect	Reference
Porewater		
Urchin, *Strongylocentrotus purpuratus*	Percent normal development	USEPA, 1995 SWRCB, 1996
Urchin, *Strongylocentrotus purpuratus*; alternate species *S. franciscanus, S. droebachiensis, Dendraster excentricus, L. pictus,*	Percent fertilization	USEPA, 1995 SWRCB, 1996
Bivalve, Bay Mussel *Mytilis galloprovincialis*		USEPA, 1995 SWRCB, 1996
Sediment-water Interface		
Urchin, *Strongylocentrotus purpuratus*	Percent normal development	USEPA, 1995 SWRCB, 1996
Bivalve, Bay Mussel, *Mytilis galloprovincialis*	Abnormal shell development; percent survival	USEPA, 1995 SWRCB, 1996

Many toxicity tests are used by a variety of monitoring programs throughout the State. These methods should be encouraged for use in section 303(d) listing decisions. Acceptable methods include those listed in water quality control plans or used by SWAMP (Puckett, 2002), SCCWRP (SCCWRP, 1998), USEPA Environmental and Assessment Program (EMAP) (USEPA, 1997a; USEPA, 2001b; USEPA, 2003d), the Regional Monitoring Program (RMP) for SFEI (Lowe et al., 1999), and BPTCP (Stephenson et al., 1994). Other SWRCB and RWQCB-approved methods should also be encouraged on a case-by-case basis.

Assessing Significant Toxicity

In toxicity tests, the most common approach to assess endpoints is to statistically compare the ambient water or sediment toxicity to a reference condition. Other approaches have been used extensively and are also valid. For example, comparison of ambient toxicity to reference conditions using a "reference envelope" or to a percentage of the minimum significant difference (MSD) have been used in water quality protection programs such as the BPTCP (SWRCB, 1998). The reference envelope is a statistical approach (Smith, 2002; Fairey et al., 1996) that allows a comparison of sites to reference sites. The approach considers all sources of field and laboratory variation.

The MSD compares differences between the control and ambient waters to determine whether the sample is toxic. Using this approach, the magnitude of difference depends on the selected Type I error rate (e.g., $p<0.05$; refer to Issue 6 for more complete description of Type I error), the level of between-replicate variation, and the number of replicates specific to the experiment. With the number of replicates and the error level held constant, the MSD varies with the degree of between-replicate variation. The "detectable difference" for a specific toxicity test protocol can be determined by the magnitude of difference detected by the protocol 90 percent of the time (Schimmel et al., 1994; Thursby and Schlekat, 1993) and is equivalent to setting the level of statistical power at 90 percent (refer to Issue 6 for definition of statistical power). This is accomplished by determining the MSD for each t-test conducted, ranking them in ascending order, and identifying the 90^{th} percentile MSD; the MSD that is larger than or equal to 90 percent of the MSD values generated (Anderson et al., 1998). The MSD considers laboratory variation only and is specific to each toxicity test protocol.

Another common method for assessing statistical significance in toxicity tests is by comparing reference or control conditions to ambient waters using a statistical test like the "t-test". A "t-test" compares the differences between an ambient water sample and control. If the difference is large, relative to the variance observed, then the difference is significant. In many cases, however, a low between-replicate variance causes a comparison to be considered significant, even though the magnitude of toxicity may not be biologically meaningful (Anderson et al., 1998).

Each of these approaches have been used to decide if a water or sediment sample is toxic and could be used to support section 303(d) listing decisions.

Persistence of Toxicity

Another factor that should be considered when assessing toxicity is persistence in water or sediments. As with all kinds of measurements of environmental conditions, toxicity measurements are uncertain because of the inherent difficulty in using sampling data to represent actual environmental conditions (USEPA, 2000b). In most cases, the smaller the data set, the larger the statistical uncertainty. The uncertainty of these toxicity test measurements is reduced when acute and chronic toxicity is measured on a number of samples. USEPA (Denton and Narvaez, 1996) has recommended consideration of the following factors when selecting the frequency of toxicity monitoring:

- environmental significance and the nature of the pollutant,
- cost of monitoring relative to the capabilities and benefits obtained,
- history of the health of the water body,
- water and sediment variability,
- the presence of legacy pollutants, and
- the number of samples required to make an assessment.

Toxicity testing is integrative of environmental conditions, depending on the length of exposure to pollutants that may cause or contribute to the toxic effect. While it is desirable to have a large number of samples for decision making, findings of repeated occurrences of toxicity can be determined with relatively few samples. In one program, two samples was the minimum number of samples needed to assess the persistence or recurrence of toxicity (SWRCB, 1998).

3. <u>Use a weight of evidence approach to determine the pollutant(s) that may cause toxicity.</u> This alternative would require that toxicity be used as one line of evidence to place waters on the section 303(d) list (as described in Alternative 2). In general, pollutants need to be identified before a TMDL can be developed for a water placed on the section 303(d) list (40 CFR 130.7; USEPA, 2003b). Toxicity is not a pollutant, but is a manifestation of effects caused by pollutant concentrations.

   A second line of evidence to justify placement of waters on the section 303(d) list would be concurrently collected chemical data.

Chemical data would be interpreted using evaluation guidelines, toxicological information, or studies that identify the pollutant causing the toxicity. The advantage of this alternative is that if pollutants are associated with the observed toxicity, RWQCBs will have a better chance of completing TMDLs.

There are several approaches available that can be used to assess if pollutants in ambient water or sediment contribute to toxic or other effects. These approaches include:

- ♦ Toxicity Identification Evaluations;
- ♦ Sediment Quality Guidelines; and
- ♦ Statistical Correlation.

Toxicity Identification Evaluations (TIEs)

TIEs are scientific studies used to determine the cause of toxicity or other biological effect. To complete TIEs, water or sediment is separated into various components to assess which portion causes the toxicity. Sediment, water, and porewater samples can be manipulated to alter or render biologically unavailable generic classes of chemicals (USEPA, 1991c). Because sediments, water, and porewater posing potential risks are usually toxic to aquatic organisms, portions or fractions of the water or sediment exhibiting toxicity can reveal the nature of the toxicant(s). Depending upon the response, toxicant(s) can be tentatively categorized as having chemical characteristics of non-polar organics, cationic metals, or confounding factors, such as ammonia. TIE methods identify the toxicant group, the chemical causing the effect, and confirm the toxicant effects (Table 11).

TABLE 11: TIE PROCEDURES FOR EFFLUENT AND AMBIENT WATER, SEDIMENT EULTRIATE, PORE WATER, AND LEACHATES

Test	Reference
Characterization Procedures	USEPA, 1991c
Procedures for samples exhibiting acute and chronic toxicity	USEPA, 1993a
Confirmation Procedures	USEPA, 1993b
Characterization Procedures for Marine Species	USEPA, 1996b

Sediment Quality Guidelines (SQGs)

When SQGs are used to determine the toxic effect of a sample, concurrently collected measurements of chemical concentrations can be used to associate toxic effects with toxicity or other biological effects. SQGs are widely used, empirically derived guidelines that predict or associate the chemical concentrations likely to be associated with the measurable biological response.

Several evaluation guidelines are available that can be used to assess association between toxicity or other measures of effect and the pollutants that may cause or contribute to the observed effects.

The predictability of toxicity, using the sediment values reported (Long et al., 1998), is reasonably good and is most useful if accompanied by data from biological analyses, toxicological analyses, and other interpretative tools. These measures are most predictive of toxicity if several values are exceeded. Since these values often are not good predictors of toxicity alone, SQGs that predict toxicity in 50 percent or more samples, should be used in making decisions to place a water body on the section 303(d) list. The guidelines presented in Table 12 are the guidelines most predictive of biological effects.

TABLE 12: SEDIMENT QUALITY GUIDELINES FOR MARINE, ESTUARINE, AND FRESHWATER SEDIMENTS

	Marine and Estuarine Sediments			**Freshwater Sediments**
Chemical	**Effects Range-Median**[1]	**Probable Effects Level**[2]	**Other Sediment Quality Guidelines**	**Probable Effect Concentration**[3]
Antimony	25 ug/g dw			
Arsenic	70 ug/g dw			33.0 mg/kg dw
Cadmium		4.21 ug/g dw		4.98 mg/kg dw
Chromium	370 ug/g dw			111 mg/kg dw
Copper	270 ug/g dw			149 mg/kg dw
Lead		112.18 ug/g dw		128 mg/kg dw
Mercury			2.1 ug/g[4]	1.06 mg/kg dw
Nickel				48.6 mg/kg dw
Silver		1.77 ug/g dw		
Zinc	410 ug/g dw			459 mg/kg dw
Chlordane				17.6 ug/kg dw
Total Chlordane	6 ng/g[5] dw			
Dieldrin	8 ng/g dw			61.8 ug/kg dw
Sum DDD				28.0 ug/kg dw
Sum DDE				31.3 ug/kg dw
Sum DDT				62.9 ug/kg dw
Total DDTs				572 ug/kg dw
Endrin			0.76 ug/g oc[6]	207 ug/kg dw
Lindane			0.37 ug/g oc[8]	4.99 ug/kg dw

Chemical	Marine and Estuarine Sediments Effects Range-Median[1]	Probable Effects Level[2]	Other Sediment Quality Guidelines	Freshwater Sediments Probable Effect Concentration[3]
Total PCBs			400 ng/g[7]	676 ug/kg dw
Anthrazene				845 ug/kg dw
Fluorene				536 ug/kg dw
Naphthalene				561 ug/kg dw
2-methyl-naphthalene		201.28 ng/g dw		
Phenanthrene		543.53 ng/g dw		1170 ug/kg dw
Low molecular weight PAHs		1442 ng/g dw		
Benz[a]anthrazene		692.53 ng/g dw		1050 ug/kg dw
Benzo[a]pyrene		763.22 ng/g dw		1450 ug/kg dw
Chrysene		845.98 ng/g dw		1290 ug/kg dw
Dibenz[a,h]-anthrazene	260 ng/g dw			
Fluoranthene				2230 ug/kg dw
Pyrene		1397.4 ng/g dw		1520 ug/kg dw
High molecular weight PAHs	9600 ng/g dw			
Total PAHs			1800 ug/g[8]	22800 ug/kg dw

[1]Long et al., 1995
[2]MacDonald et al., 1996
[3]MacDonald et al., 2000a
dw = Dry Weight
[4]PTI Environmental Services, 1991
[5]Long and Morgan, 1990
[6]USEPA, 1993d.
[7]MacDonald et al., 2000b
[8]Fairey et al., 2001
oc = Organic Carbon

The SQGs in Table 12 are based on empirical data compiled from numerous field and laboratory studies performed in North America. Chemistry data and a variety of different types of biological data for numerous taxa were derived from bioassays of field collected samples, laboratory toxicity test of clean sediments spiked with specific toxicants, benthic community analyses, or equilibrium-partitioning models. These guidelines are not intended as toxicity thresholds above which effects are always expected. Rather, the use of these values is to determine the incidence of significant toxicity among samples that exceed the values.

SQGs should be used with caution because they are not perfect predictors of toxicity and are most useful when accompanied by data from in situ biological analyses, other toxicologic assays, and other interpretive tools, such as metals-to-aluminum ratios and other guidelines derived either from empirical approaches and /or cause-effects studies.

The following sections briefly describe several SQGs:

Effects Range Median (ERM), Probable Effects Level (PEL)

Two related efforts provide approaches for evaluating the quality of marine and estuarine sediments. They are the National Oceanic Atmospheric Administration (NOAA) guidelines (Long et al., 1995) and the sediment weight-of-evidence guidelines developed for the Florida Coastal Management Program (MacDonald, 1992 and 1994).

Long et al. (1995) assembled data from throughout the country that correlated chemical concentrations with effects. These data included spiked bioassay results and field data of matched biological effects and chemistry. The product of the analysis is the identification of two concentrations for each substance evaluated. One level, the Effects Range-Low (ERL) was set at the 10^{th} percentile of the ranked data and represents the point below which adverse effects are not expected to occur. The second level, the ERM, was set at the 50^{th} percentile and is interpreted as the point above which adverse effects are expected. A direct cause and effect linkage in the field data was not a requirement for inclusion in the analysis. Therefore, adverse biological effects recorded from a site could be attributed to both a high concentration of one substance and a low concentration of another substance, if both substances were measured at a site. Either one, both, or neither of the two substances of concern could cause the adverse effect in field data.

The State of Florida efforts (McDonald, 1994) revised and expanded the Long and Morgan (1990) data set and identified two levels of concern for each substance: the "TEL" or threshold effects level, and the PEL. Some aspects of this work represent improvements in the original Long and Morgan analysis. First, the data was restricted to marine and estuarine sites, thereby removing the ambiguities associated with the inclusion of freshwater sites. Second, a small portion of the original Long and Morgan (1990) database was excluded, while a considerable increase in the total data was achieved due to inclusion of new information.

The development of TELs and PELs differ from the development of ERLs and ERMs in that data showing no effects were incorporated into the analysis. In the weight-of-evidence approach recommended for the State of Florida, two databases were assembled: a "no-effects" database and an "effects" database. Taking the geometric mean of the 50^{th} percentile value in the effects database and the 85^{th} percentile value of the no-effects database generated the PEL. Taking the geometric mean of the 15^{th} percentile value in the effects database and the 50^{th} percentile value of the no-effects database generated the TEL. By including the no effect data in the analysis, a clearer picture of the chemical concentrations associated with the three ranges of concern – no effects, possible effects, and probable effects, can be established.

Probable Effect Concentrations (PECs)

For freshwater sediment, another benchmark is available, the consensus based PEC. PECs are based on empirical measurements that relate pollutant concentration to harmful effects on sediment-dwelling organisms and are intended to be predictive of those effects. These values were derived from a large database with matching sediment chemistry and toxicity information from field studies conducted throughout the United States. The SQG, expressed on an organic carbon-normalized basis, were converted to dry weight-normalized values at one percent organic carbon (MacDonald et al., 1994; MacDonald et al., 1996; USEPA, 1997d). PECs are intended to identify harmful effects on sediment-dwelling organisms from contaminant concentrations.

Equilibrium Partitioning (EqP)

EqP values are theoretical SQGs, derived from effect concentrations measured in water only exposures. In sediment exposures, the effect is predicted to occur when the same concentration occurs in the pore water of the sediment. The premise of the EqP SQG is that if chemical concentrations in pore water are not at toxic levels, then the sediment will not be toxic. EqPs were developed for non-ionic chemicals. This approach is based on the distribution of contaminant between sediment solids and pore water, and is predictable based on their physical and chemical properties, assuming continuous equilibrium exchange between sediment and pore water.

The EqP approach is supported by the results of spiked-sediment toxicity tests, which indicate that positive correlation exists between the biological effects observed and the concentration of the contaminants measured in pore water. The primary strength of this approach is that the bioavailability of a class of compounds is addressed. The SQG is calculated by using the appropriate water quality criteria (i.e., final chronic value, or equivalent value; USEPA 1997d) in conjunction with the sediment-water partition coefficient for the specific contaminants. However, other effect concentrations can be used, such as an LC_{50} (lethal concentration for fifty percent of the population) for a particular species. The EqP predicts fifty percent mortality occurs at a pore water concentration equal to the water only LC_{50}.

Correlations

Correlations between toxicity, or other effects, and chemical concentration can be used to show the relationship between these factors. Correlation analysis is most useful in assessing which chemicals, study-wide (or throughout a specific data set), may contribute to toxicity or benthic effects (Fairey et al., 1996; Anderson et al., 1997). Correlations provide additional evidence that the observed toxicity could be caused by sediment-based or water concentrations of chemicals. Simple rank correlation can be used to determine the co-occurrence of chemical concentrations and toxicity or other effects.

The preferred alternative is a combination of alternative 2 and 3 because the CWA allows the placement waters on the section 303(d) list for toxicity alone; however, once the pollutant is identified, the pollutant causing or contributing to the toxicity should be added to the section 303(d) list as soon as possible (e.g., during the next listing cycle). Alternative 3 lists various approaches that can be used to identify the pollutant.

Recommendation: Alternative 2 and 3. See Policy section 3.6, 4.6, and 6.1.3.

Issue 5D: ***Interpreting Sedimentation Data***

Issue: How should impacts due to sedimentation be addressed?

Issue Description: Increased sedimentation can cause nuisance or adverse effects to many beneficial uses. Water quality objectives for sediment are typically narrative and based on nuisance condition or an adverse effect to a beneficial use from increased sediment loads over natural levels. Sediment-related water quality objectives are also expressed as numeric objectives based on turbidity.

RWQCBs face a variety of challenges when determining whether a water body is impacted by sediment. Data that characterize beneficial use impairment due to excess sedimentation often do not lend themselves to conventional measures of data quality. Given the natural variability in sediment supply and transport capacity, representativeness of data is difficult to establish. Determining cause and effect relationships for sediment-related impacts is challenging due to changes in sediment supply, transport capacity, and channel configuration, which can all produce similar effects in a water segment.

For most RWQCBs, determining the impacts of sediment has been based on non-attainment of numeric water quality objectives and the threat to designated beneficial uses. Basin Plans contain applicable water quality objectives for sediment, settleable material, and turbidity. Examples of Basin Plan water quality objectives for sediment, settleable material, and turbidity include:

> "The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses." (Lahontan RWQCB, 1995)

> "Water shall not contain substances in concentrations that result in deposition of material that causes nuisance or adversely affect beneficial uses." (North Coast RWQCB, 1994)

> "Turbidity shall not be increased more than 20 percent above naturally occurring background levels. Allowable zones of dilution within which higher percentages can be tolerated may be defined for specific discharges upon the issuance of discharge permits or waiver thereof." (North Coast RWQCB, 1994)

Baseline: Sediment or sedimentation listings for the 2002 section 303(d) list were based primarily on exceedances of numeric objectives.

Alternatives: 1. Interpret case-by-case. Establish general guidelines to trigger listing. This alternative provides the RWQCBs with the most flexibility, as it would account for a variety of site-specific conditions that could be encountered. However, this could also lead to inconsistencies in assessments. USEPA (2003b) recommends that, to determine whether a pollutant impairs a segment, decision rules in the listing methodology should provide the opportunity to see exactly how assessment decisions were made.

There are many measurements that can be used to interpret concentrations or loads of sediment in water or in the channel. For example, with respect to cold freshwater habitat, beneficial uses may be threatened due to conditions either in the water column (e.g., suspended sediment and/or turbidity) or on the streambed (settleable material), or both. Indicators of streambed condition include channel morphology, such as riffle (pool ratios, residual pool depth), the index V* (a measure of the sediment which has filled in pools), cross-section, and thalwag profiles. Substrate conditions, such as percent of fine sediment in the total bulk core sample, median particle size, and riffle embeddedness are also indicators of the stream bed condition. Beneficial use impairment can be assessed by evaluating site specific suspended sediment concentrations, turbidity levels, and/or substrate conditions and comparing the data to threshold levels and/or critical aquatic life stage requirements.

Under this alternative, a water body would be listed if any one of the following conditions were met:

- **Beneficial use impairment caused by increased sediment loads**. This condition would require evidence that beneficial use impacts are caused by increased sediment loads. Evidence of beneficial use impacts could include documentation of adverse biological responses, degradation of aquatic life populations or communities, or restrictions on recreation, navigation, or other beneficial uses. Comparison to reference conditions within watersheds or ecoregions would be appropriate in order to establish these impacts, as would documented declines in aquatic populations and aquatic community diversity.
- **Evidence that beneficial use impacts are caused by sediment should describe the link between the documented impact and the presence of sediment in the water, or stored in the channel.** This evidence could include documented occurrence of conditions that are recognized as having the impacts observed. For example, the filling of a stream's pools with fine sediment reduces rearing opportunities for certain fish and, as a consequence, reduces their populations. Where no single condition is compelling, multiple lines of evidence could support the determination that an impact has occurred, or that the impact is caused by sediment.
- **Nuisance caused by sediment loads (CWC section 13050).**

Nuisance conditions could be documented through visual assessment or other methods conducted in a manner consistent with QA practices for reducing error and subjectivity.

- **Exceedance of turbidity objective, where turbidity is caused by increased suspended sediment loads**. Water bodies would not be listed for sediment based on turbidity unless it can be demonstrated that the cause of increased turbidity is an increased delivery of sediment. For example, increased turbidities that are related to reservoir releases should not lead to a sediment listing.

Determinations that Basin Plan turbidity objectives are exceeded, due to increased delivery of sediment, should be based on data collected from the water body over a period of time that accounts for the variable nature of sediment delivery and transport.

This alternative is the preferred alternative because waters would be listed based on sufficient credible data and information that indicate water quality standards for sediment are not met by comparison to acceptable evaluation guidelines, or that impacts to beneficial uses are caused by sediment. This alternative would result in no change to existing listings, and would help provide guidance if other sedimentation listings are proposed. At present there are 135 pollutant/water body combinations that are listed due to sediment impacts.

2. <u>Provide specific guidance to interpret narrative objectives.</u> Under this alternative, all the requirements of Alternative 1 would apply but the RWQCBs would also be required to compare data sets to selected evaluation guidelines in order to interpret sediment concentration or load data. A disadvantage of this alternative is that these evaluation values may not be applicable throughout the State.

Scientific understanding of linkage between sediment supply and specific impacts to aquatic species in a given watershed is often poor because habitat conditions in streams are shaped not just by sediment load, but also by the interactions of stream flow and in-channel and streamside vegetation and obstructions. Literature related to suspended sediment/turbidity and streambed condition thresholds or life stage requirements and measurements that could possibly be used to interpret these impacts are reviewed briefly below.

It is generally accepted that for fish, the severity of the effect of suspended sediment increases as a function of sediment concentration and duration of exposure. However, identification of a specific threshold causing impairment is difficult. While research to date is suitable for assessing effects of discrete suspended sediment (or turbidity) events, it is unsuitable for measuring the cumulative effect of multiple events over the course of a storm season. Fish experience reduced short term feeding rates and feeding success when exposed to a suspended sediment concentration of 20 mg/L (milligrams per liter; parts per million) for three hours (Newcombe and Jensen, 1996). Additionally, juvenile and adult salmonids have been shown to undergo major physiological stress and experience long-term reduction in feeding rates and feeding success when exposed to suspended sediment concentrations exceeding 148 mg/L for a duration of six days (Bjornn and Reiser, 1991). Direct mortality of under yearling salmonids has been tied to suspended sediment concentrations of 1,200 mg/L, while concentrations in the 300 mg/L range caused reduced growth and feeding (Meehan, 1991). Feeding and territorial behavior have been reported to be disrupted by short term exposures (2.5-4.5 days) to turbid water with up to 60 NTU (nephelometric turbidity units) (Bjornn and Reiser, 1991). Juvenile coho salmon avoid water with turbidities that exceeded 70 NTU (Bisson and Bilby, 1982). Additionally, turbidities in the 25-50 NTU range (equivalent to 125-275 mg/L of bentonite clay) reduced growth and caused more newly emerged salmonids to emigrate from laboratory streams than did clear water (Sigler et al., 1984).

As the percentage of fine sediment (percent fines) in a channel increases as a proportion of the total bulk core sample, the survival to emergence decreases. The percent fines ≤0.85-mm (millimeter) is defined as the percentage of subsurface fine material in pool tail-outs ≤0.85 mm in diameter. Identifying a specific percentage of fines that can comprise the bulk core sample and still ensure adequate embryo survival is not clearly established. Research conducted in unmanaged streams (streams without a history of land management activities) in Washington recommended the use of 11 percent fines ≤0.85-mm as a target. Percent fines ≤0.85 mm ranged from four percent in the Queen Charlotte Islands to 28 percent on the Oregon Coast, with a median value for all the data of about 11 percent (Bjornn and Reiser, 1991).

A three-year study was conducted in Northern California streams, including three streams classified as unmanaged (Burns, 1970). The values for fines <0.85 mm ranged from 17 to 18 percent, 16 to 22 percent, and 18 to 23 percent. The numeric target representative of properly functioning conditions for fines <0.85 mm used in several TMDLs for North Coast streams is 14 percent. Another evaluation tool, V*, is representative of the in-channel supply of mobile bedload sediment (Lisle and Hilton, 1992). The usefulness of this parameter is further demonstrated by comparing annual sediment yields of select streams with their average V* values. The comparison indicated that V* is well correlated to annual sediment yield and quickly responded to changes in sediment supply. For example, V* values in French Creek, a tributary to the Scott River in the North Coast Region, decreased to approximately one-third the initial value soon after an erosion control program focusing on roads was implemented. V* values for Elder Creek, an undisturbed tributary of the South Fork Eel River averaged only 0.09 (Lisle and Hilton, 1999). A study of over sixty streams in Northern California found that mean V* values of 21 percent or less represented good stream conditions (Knopp, 1993). The difference in the V* values is indicative of the variability inherent in V* measurements.

Recommendation: Alternative 1. See Policy sections 3.1, 3.2, 3.7.2, 3.8, 3.9, 4.1, 4.2, 4.7.2, 4.8, and 4.9.

Issue 5E: ***Interpreting Temperature Water Quality Objectives***

Issue: How should water temperature data be interpreted?

Issue Description:

> "Water temperature is a catalyst, a depressant, an activator, a restrictor, a stimulator, a controller, a killer, one of the most important and most influential water quality characteristics to life in water."- The Federal Water Pollution Control Administration (USEPA, 1986).

Temperature can adversely affect the beneficial uses of water. Beneficial uses that are related to temperature impacts include cold water fisheries; warm water fisheries; wildlife habitat; and aquatic organisms migration, spawning, reproduction, and endangered species.

Ambient water temperature is one of the most important factors affecting the success of fish and other aquatic life. With regard to coho salmon and steelhead trout, temperature influences growth and feeding rates; metabolism; development of embryos and juveniles; timing of life history events, such as upstream migration, spawning, freshwater rearing, and seaward migration; and food availability (North Coast RWQCB, 2000). Elevated temperatures can cause stress and lethality.

Water quality objectives for temperature are specified in Basin Plans and the "Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays of California" (SWRCB,1975). Generally, Basin Plans define temperature objectives in two parts:

> "The natural receiving water temperature in (intrastate and/or inland surface) waters shall not be altered unless it can be demonstrated to the RWQCB that such alteration in temperature does not adversely affect beneficial uses." (North Coast RWQCB, 1994)

> "At no time or place shall the temperature of any cold (and/or warm) freshwater habitat be increased by more than 5^{o}F (2.8^{o}C) above natural receiving water temperature." (North Coast RWQCB, 1994)

In most circumstances, natural receiving water temperature is not defined. The Thermal Plan describes natural receiving water temperature as "The temperature of the receiving water at locations, depths, and times which represent conditions unaffected by any elevated temperature, waste discharge, or irrigation return waters."

The major difficulty in assessing whether a water body is meeting water quality objectives requires making a determination of the natural receiving water temperatures. Determining "natural receiving water" temperature is limited by the availability of historic temperature monitoring data that is considered representative of unaltered and/or natural conditions in a water body.

Baseline: In 2002, section 303(d) listings were proposed for several North Coast rivers. These recommendations were based on evaluation of the Maximum Weekly Average Temperature (MWAT) data ranges, as compared to evaluation values for impacts on anadromous fish species. In addition, the temperature data were evaluated with respect to the current and historic presence of cold water fish. If a stream, which exhibits temperatures within the chronic reduced-growth MWAT ranges, and had a decreased salmonid fishery compared with historic levels, then it was listed using inferred historical stream MWATs. At present there are 37 pollutant/water body combinations that are listed due to temperature impacts.

Alternatives:

1. List using the Basin Plans objective(s) for temperature as the sole basis for listing. When data of sufficient quantity and quality are available, a comparison of current and "historic" or "natural" receiving water temperatures can be made to determine whether water quality objectives are being met.

   Determination of "natural receiving water" temperatures is limited by the availability of natural background and ambient temperature monitoring data for water bodies. Assessment of natural receiving water temperatures is complicated by the fact that water temperature of streams vary substantially due to drainage area, stream size, geographical location, riparian vegetation, seasonal climatic conditions, elevation, and other factors (Lewis et al., 2000). Consequently, there are no generally available natural receiving water temperature data sets for stream segments that can be used because these natural levels are so site-specific.

   Without natural receiving water temperatures it is impossible to interpret the Basin Plan and Thermal Plan water quality objectives.

2. List water body segments for temperature using an alternative approach focused on beneficial use impacts and likely effects of elevated temperature on sensitive species. "The evolution of freshwater temperature criteria has advanced from the search for a single 'magic number' to the generally accepted protocol for determining mean and maximum numerical criteria based on the protection of appropriate desirable or important fish species or both" (Brungs and Jones, 1977).

   When "historic" or "natural" temperature data are not available, alternative approaches could be employed to assess temperature impacts. The approach presented in this alternative deals with comparing recent temperature monitoring data for a specific water body to the temperature requirements of resident aquatic life. In many cases, fisheries, particularly salmonids, represent the beneficial uses most sensitive to temperature. Information on the current and historic condition and distribution of the sensitive beneficial uses (e.g., fishery resources) in the water body is necessary, as well as recent temperature data on conditions experienced by the most sensitive life stage of the aquatic life species. If temperature data is from the past (historic) when the beneficial use was fully supported are not available, information about presence/absence or abundance of sensitive aquatic life species can be used to infer past temperature conditions. Therefore, this approach assumes that a decrease in the population and distribution of sensitive aquatic life species when compared to past levels is due, at least in part, to a change in temperature conditions.

Determination of life stage temperature requirements of sensitive aquatic life species should be based on peer-reviewed literature. Similarly, evaluation of temperature data should be based on metrics reflective of the temperature requirements for sensitive aquatic life species. For example, a common metric for assessing chronic (i.e. sub-lethal) effects on salmonids, is the MWAT, the mathematical mean of multiple, equally spaced, daily temperatures over a 7-day consecutive period (Brungs and Jones, 1977). The MWAT of a particular water body can be compared to MWAT growth requirements for salmonids.

To maintain growth of aquatic organisms at rates necessary for sustaining actively growing and reproducing populations, the MWAT, in the zone normally inhabited by the species during the season, should not exceed the optimum temperature plus one-third of the range between the optimum temperature and the upper incipient lethal temperature of the species.

MWATs are derived from a range of studies that looked at sub-lethal and acute temperature thresholds, incorporating information from laboratory-based research, field observations, and risk assessment approaches. Calculated MWAT metrics for growth range from 14.3°C to 18.0°C for coho salmon, and 14.3°C to 19.0°C for steelhead trout. This approach suggests that upper thresholds for the MWAT of 14.8°C for coho and 17.0°C for steelhead will reduce growth 10 percent from the optimum. Thresholds for the MWAT of 19.0°C for both coho and steelhead will reduce growth 20 percent from optimum (Sullivan et al., 2000).

While these thresholds relate to reduced growth, temperatures at sub-lethal levels also can effectively block migration, inhibit smoltification, and create disease problems (Elliot, 1981). Further, the stressful impacts of water temperatures on salmonids are cumulative and correlate to the duration and severity of exposure. The longer the salmonid is exposed to thermal stress, the less chance it has for long-term survival (Ligon et al., 1999).

The upper lethal limit for salmonids ranges from 27°C to 30°C (Jobling, 1981). Acute threshold values, causing death or total elimination of salmonids from a location, range from 21.0°C to 25.5°C for coho, and 21.0°C to 26.0°C for steelhead (Sullivan et al., 2000).

In streams, however, temperature is not uniform in space or time. Therefore, a single exceedance of the temperature threshold does not necessarily mean that temperature conditions are impairing salmonids, and would not necessarily result in a determination of impairment. On the other hand, consistent exceedance of these thresholds in disperse monitoring locations throughout a sub-basin and over two or more seasons likely does mean that temperature conditions are impairing salmonids, and therefore, could lead to a determination that water quality standards are exceeded.

This alternative is the preferred alternative because it provides a mechanism for addressing potential temperature problems in the absence of often-unavailable temperature background data. This alternative is based on the assumption that aquatic life beneficial uses (e.g., cold and warm water fisheries) are most sensitive to modifications to natural temperature. Other beneficial uses that may also be affected by temperature include recreation and aquaculture; other approaches for assessing temperature impairment may be more appropriate for these beneficial uses.

Recommendation: Alternative 2. See Policy sections 3.2, 4.2, and 6.1.5.9.

Issue 5F: ***Interpreting Data Related to Adverse Biological Response***

Issue: How should data related to adverse biological response be interpreted?

Issue Description: An organism's response to pollutants is typically assessed with toxicity tests or by observation of changes in the biological population or community. There are also studies that address the exposure and response of individual organisms to chemical stressors. For example, adverse effects may be assessed by visual means for necropsy or for morphological deformities, defects, or other pathological changes in specific tissues or organs. Lesions in these tissues are often correlated with death, deformity, or poor general fitness (condition indices) of the animal, and include cancerous or precancerous transformations in tissues such as the gills, liver, or reproductive organs, etc. Some abnormalities can, however, appear in the early stages of development of more damaging pathologies that may be reversible (these are indications of exposure rather than actual adverse effects).

Baseline: In 2002, listings for adverse biological response were not recommended. However, in previous lists (prior to 2002), some waters were placed on the section 303(d) list for abnormal fish histology.

Alternatives:

1. <u>RWQCBs should interpret adverse biological response data on a case-by-case basis</u>. Interpreting adverse biological response in an organism is a highly complex process. Complexities involve patterns of exposure, seasonal effects, bioavailability, age, gender, prior history of exposure and physiologic conditioning of the host, and species residence in the water bodies in question. Under this alternative, general guidelines would be outlined in the Policy.

   General guidance for adverse biological response would require the comparison of endpoints to reference conditions, the identification of pollutants suspected of causing or contributing to the adverse response, and the association of pollutants with an adverse response. Endpoints for this factor would be stated in the Policy but no specific evaluation values would be proposed. The endpoints would include fish kills, reduction in growth, reduction in reproductive capacity, abnormal development, histopathological abnormalities, and other adverse conditions. Evidence that pollutants or pollution are capable of causing or contributing to the adverse condition would be the same process as described in the toxicity testing section (Issue 5C). The major factors identified include:

   Growth Measures: Reductions in growth can be addressed using suitable bioassay through measurements of field populations.

Reproductive Measures: Reproductive measures must clearly indicate reductions in viability of eggs, offspring, or reductions in fecundity. Suitable measures include: pollutant concentrations in tissue, sediment, or water which have been demonstrated in laboratory tests to cause reproductive impairment, significant differences in viability, or development of eggs between reference and test sites. Toxicity testing is also a measurement tool used to identify impairment in reproduction.

Abnormal Development: Abnormal development can be determined using measures of physical or behavioral disorders or aberrations. Evidence that the disorder can be caused by toxic pollutants, in whole or in part, must be available.

Histopathology: Abnormalities representing distinct adverse effects, such as carcinomas or tissue necrosis, must be evident. Evidence that toxic pollutants are capable of causing or contributing to the disease condition must also be available.

A disadvantage of this alternative is the lack of specific guidance could lead to inconsistencies among RWQCBs depending on the expertise and experience of the staff preparing the water body listing assessments.

This alternative is the preferred alternative because due to the complexity of interpreting these types of measurements, RWQCBs would be given significant flexibility to interpret adverse biological response data.

2. <u>The Policy should establish specific guidance and evaluation tools to interpret adverse biological response data and information</u>. The Policy would provide specific guidance to interpret adverse biological response data. For example, specific methods for interpreting biomarker data (Okihiro and Hinton, 1996; Malins et al., 1987), histopathology data, or growth measures (Bay and Jirik, 1993; Cooper, 1995) could be provided. A process for interpreting adverse biological response in an organism would be presented in the Policy.

   Under this alternative, the Policy guidance for adverse biological response would require that RWQCBs use specified endpoints and approaches. Endpoints for this factor would be listed in the Policy and possibly specific cutoff values would be proposed.

The major disadvantage of this alternative is RWQCB would be limited by the approaches presented and would not be able to interpret the various kinds of data and information that may be submitted. These types of data are typically water body-specific; often are not collected using standard procedures; are usually the result of research projects; and are not part of major ambient monitoring programs. The only advantage is the more specific guidance could lead to greater consistency among RWQCBs.

Recommendation: Alternative 1. See Policy sections 3.8 and 4.8.

Issue 5G: ***Degradation of Biological Populations or Communities***

Issue: How should bioassessment information be used in determining whether a water body is attaining water quality standards?

Issue Description: The diversity and condition of biological communities reflect overall ecological integrity (i.e., chemical, physical, and biological integrity). Therefore, bioassessments are important for evaluating ecosystem health and providing crucial water quality planning information for managing more complex water quality problems (Barbour and Hill, 2003).

The effects of different pollutants such as excess nutrients, toxic chemicals, increased temperature, and excessive sediment loading are integrated by biological communities and provide an overall measure of pollutant impact. The response of biological populations and communities to stresses of all degrees often occurs over time. Therefore, information on disturbances within the community is not always evident with episodic water chemical measurements or discrete toxicity tests. The purpose of assessing the biological condition of aquatic populations and communities is to determine how well a water body supports aquatic life.

Aquatic community structure (organisms that live in the water or sediments) can be used to assess whether sites with substantially similar physical characteristics differ in terms of the species present and number of individuals of each species. These types of measures focus on the population or community level. The results can then be analyzed using various indices, ordination techniques, principal component analysis, or other techniques to identify potential causes of any differences detected.

The analysis of community composition provides not only direct assessment of impacts, but also an opportunity to identify indicator species, i.e., species that respond predictably or characteristically in the presence or absence of degraded conditions, such as those produced by a polluted environment. Due to the numerous forces influencing the composition of a community or population, it is often difficult to determine whether pollution or pollutants are responsible for such changes.

Bioassessment serves four primary functions or uses:

- Screening or initial assessment of conditions;
- Characterizing the magnitude of impairment;
- Assisting in the diagnosis of causes to impairment; and
- Monitoring of temporal trends to evaluate improvements or further degradation.

Baseline: In 2002, the section 303(d) list based listings on data types that considered degradation of aquatic life populations or communities and required multiple lines of evidence. Each of these multiple lines of evidence generally needed the pollutant(s) that caused or contributed to the adverse condition.

Alternatives:

1. Do not use bioassessment as a water quality indicator. This alternative would fail to meet the state's responsibility under CWA to protect and restore the biological integrity of the state's waters. Chemical, physical, and biological integrity define the overall ecological integrity of a water body. Biological integrity is a strong indicator of ecological integrity and serves as a useful measure of a water body's environmental status. Biological systems are more variable than the chemical and physical properties that were the basis of the state's water quality regulations.

   This alternative would also be contrary to USEPA's focus on the development of sound scientific approaches to determine the health of the nations aquatic ecosystems and the stressors most closely associated with the impairment. In keeping with its responsibilities under CWA, USEPA initiated, in the late 1980's, EMAP, a long-term research effort to enable status and trend assessments of aquatic ecosystems. EMAP addresses monitoring the conditions of estuaries, streams, and lakes in selected geographic regions, as well as examining the surrounding landscapes in which these resources occur. This is the first step in USEPA's overall strategy for environmental protection and restoration and EMAP forms the basis for the research needed to establish the condition of the nation's resources.

   Traditionally, RWQCBs have measured biological conditions indirectly, through the use of chemical-specific analysis and toxicity. These measures assess the suitability of a water to support a healthy community, but do not assess the communities health itself. Assessment of the biological community measures the resident aquatic community structure and function to determine biological and ecological integrity.

2. Interpret case-by-case. Assessing the biological condition of aquatic communities is an indication of how well a water body supports aquatic life. This indicator is measured against a reference condition--the baseline against which human effects can be compared. Understanding reference conditions requires distinguishing and classifying ecological systems within and between regions. It also requires defining standards for each of those systems, that is, quantitative benchmarks corresponding to conditions with little or no human influence (Karr and Chu, 1997).

   As RWQCBs seek to develop bioassessment programs, the lack of biocriteria for specific areas within each region leads to the interpretation of impairment on a case-by-case basis. Currently, the SWRCB and the RWQCBs have only recently begun to use bioassessment programs to assess ecological conditions and there is no one program that is currently favored in the state. Five programs exist in California that have scientifically valid methods, similar purposes and scope, and could provide the framework for the implementation of a statewide bioassessment approach. In lieu of development of a statewide program, the RWQCBs should look to these programs for assistance:

- California DFG Aquatic Bioassessment Laboratory – California Stream Bioassessment Procedure (CSBP) – the most widely used in the state, CSBP was developed for point-source assessments. CSBP has collected nearly 9,000 samples at 2,500 sites. An adaptation has been developed for non-wadeable streams and ambient water quality monitoring.
- Lahontan RWQCB Biological Assessment Program – Sierra Nevada Aquatic Research Laboratory (SNARL) Method – the Lahontan RWQCB has collected samples using SNARL protocols. Since 2000, they have evaluated benthic macroinvertebrates, periphyton, and physical attributes using SNARL, CSBP, and the River Invertebrate Prediction and Classification Scheme (RIVPACS).
- USFS – Pacific Southwest Region Bioassessment Program – this program has established reference conditions by collecting macroinvertebrates from a network of perennial and intermittent wadeable streams on Forest Service Lands throughout the state.
- USGS: National Water Quality Assessment (NAWQA) Program – this program describes the status of and trends in the quality of surface water and groundwater to provide scientific understanding of natural and human-induced factors that assess water quality. NAWQA has assessed the Sacramento Basin, the San Joaquin-Tulare Basins and the Santa Ana Basin.
- USEPA Central Valley Regional Environmental Monitoring and Assessment Program (REMAP) – focuses on assessing the biological integrity of agriculture-dominated water bodies throughout the Central Valley. USEPA is also collecting bioassessment data in California as part of the EMAP Western Surface Water pilot study, a five-year research and monitoring project to assess the ecological condition of streams and rivers throughout the Western U.S.

With the lack of a statewide bioassessment program, guidance on the use of bioassessment data for listing decisions becomes increasingly important. While this alternative would give the RWQCBs added flexibility to develop bioassessment programs, it lacks the consistency necessary to ensure that listing decisions comply with this Policy and USEPA guidance.

3. Establish consistent value(s) to trigger listing. The implementation of an effective bioassessment program requires the establishment of consistent values that trigger listings. However, while a standardized program is important for the listing process, biocriteria still needs to be appropriately tailored to the regional setting.

   Options:

   A. **Use professional judgment of qualified scientists to interpret data.** The development of biocriteria relies on the examination of raw data in the field and in the laboratory. The need for interpretation of data by qualified scientists is necessary but expert judgment alone is not an acceptable substitute for scientifically valid data. Professional judgment can be incorporated into approaches using multivariate techniques and the regional reference approach. The use of professional judgment to interpret data is most valuable once quantitative criteria for determining what constitutes exceptional, good, fair, poor and very poor water body conditions has been established. At that point, professional judgment is but one of the components used to tailor the biocriteria process to regional conditions.

   B. **Express factors in terms of changes in numbers, species diversity, indices of community metrics, etc.** Direct measurements of ambient biological communities including plants, invertebrates, fish, and microbial life have been used by many states as indicators of the health of a water body. Data on the biological assemblages present in a water body:

      - Provide a functional definition of biological integrity,
      - Minimize problems with interpreting the natural geographic and temporal variability of data by aggregating within regions of ecological similarity,
      - Use reference conditions for specific geographic areas, and
      - Combine several assemblage attributes to produce a single numeric measure of biological integrity.

      Water body measurements require an indicator species or community which possess particular requirements with regard to a known set of physical or chemical variables, such that changes in presence/absence, numbers, morphology, physiology, or behavior of the species or community indicate that the given physical or chemical valuables are outside its preferred limits. The ideal biological indicator should have the following characteristics (Barbour et al., 1996):

      - Taxonomic soundness and easy recognition,
      - Cosmopolitan distribution,

- Numerical abundance,
- Low genetic and ecological variability,
- Relatively large body size,
- Limited mobility and relatively long life history,
- Well known ecological characteristics, and
- Suitable for use in laboratory studies.

There are indexes of biological conditions, which have been extensively developed for freshwater systems, and are effective for assessing ecological conditions in a variety of settings, with many taxa, and in diverse geographic regions. They are objective, scientifically rigorous, and easy to communicate to non-technical audiences.

One system, the Index of Biological Integrity (IBI) is a synthesis of diverse biological information, which numerically depicts associations between human influence and biological attributes. It is based on a combination of tested biological attributes (metrics or indices) that are sensitive to changes in biological integrity caused by human activities. The multi-metric (a compilation of metrics) approach compares what is found at a monitoring site to what is expected using a regional baseline condition that reflect little or no human impact (Barbour et al., 1999). The IBI provides a cumulative site assessment as a single score value and is the endpoint of a multi-metric analytical approach.

Another approach, RIVPACS uses empirical models that predict the aquatic macroinvertebrate fauna expected to occur at a site in the absence of environmental stress. RIVPACS sampling strategy and end product are similar to the IBI approach. However, these approaches use fish assemblages in assessing the quality of rivers and streams. In California, it is difficult to integrate metric values for fish into one IBI score because aquatic systems are: inherently low in species richness especially in trout streams; abundant in populations of introduced fish; and altered due to pressures from fish stocking and angling pressure.

A promising approach for California is the use of a benthic macroinvertebrates index (BMI) for water resource monitoring. Benthic macroinvertebrates are ubiquitous, relatively stationary and their large species diversity provides a range of responses to environmental pressures. Individual species reside in the aquatic environment from a period of a few months to several years and are sensitive, in varying degrees to temperature, DO, sedimentation, scouring, nutrient enrichment, and chemical and organic pollution. Aquatic invertebrates also represent a significant food source for aquatic and terrestrial animals. In addition to the advantages listed above, the taxonomy of many groups and the response of many species are well known, and data analysis methods have been developed for community level bioassessment.

The California Aquatic Bioassessment Laboratory Network (CAMLnet) has current information on the taxonomy of macroinvertebrate taxa found in California streams and lakes (www.dfg.ca.gov/cabw/cabwhome.html). It also describes the standard level of taxonomic effort that has been defined for bioassessment projects using the CSBP. Specialized references are suggested for particular taxa.

C. **Identify appropriate reference conditions within watersheds or ecoregion.** Variation is fundamental to biological communities and measures of biotic integrity based on these communities vary accordingly. Most bioassessment techniques account for variation through the use of reference sites. Reference sites can be used to characterize the range of biotic conditions expected for minimally disturbed sites. The conditions of aquatic life found at these sites help to detect both the cause and level of risk to biological integrity at similar sites in a region. Reference sites determine the overall base condition for waters of a certain type within a region. In keeping with the strategy of not degrading the resource, interim reference conditions - like the criteria they help define - are expected to be upgraded with each improvement to the water resource. Biological criteria should not be based on data derived from degraded reference sites.

In order for a bioassessment program to be meaningful and defensible, the RWQCBs should strive toward objective procedures for selecting reference sites. This could include the use of Geographic Information Systems (GIS) to allow identification and selection of "minimally-impaired" reference sites based on objective criteria.

One approach for selecting reference sites has been developed by DFG in collaboration with SNARL. The approach uses GIS to identify areas within the region that exhibit minimal impacts (target areas). Suitable stream reaches within these target areas are identified resulting in reference sites for the region of interest. The procedure consists of the following five steps:

1. Define region of interest and classes of stream types to be evaluated,
2. Identify regions with major disturbances and quantify potential impacts to different areas within the region using GIS techniques,
3. Use GIS-based impact estimates to identify least-disturbed candidate areas in the region,

4. Undertake field reconnaissance of candidate areas for selection of reference sites for sampling, and
5. Assess local conditions quantitatively to confirm high quality environments.

Most reference sites selected in bioassessment studies have been selected for comparison to local conditions and have not been selected using common criteria that would allow comparison among projects. These studies have relied almost exclusively on BPJ in the selection of reference sites. While there is legitimacy in this approach, BPJ is rarely quantified and is not repeatable. This complicates comparison with other projects. Additionally, recent USEPA analyses indicates that reference sites chosen by BPJ often do not have significantly different biological signatures from sites chosen randomly. A standardized and objective approach to selecting reference sites would improve consistency and repeatability across bioassessment studies.

4. Use bioassessment data and information if associated with water and sediment measurements. Provide guidance on values for association assessment. Bioassessments are an effective tool for evaluating ecosystem health because biological assemblages (fish, macroinvertebrates, etc.) integrate relevant chemical, physical, and biological factors in the environment. However, bioassessment by itself may not present enough information to determine attainment for a particular water body, depending on its designated uses. Relying on bioassessment alone does not allow for determination of associated causes and sources of impairments necessary to determine attainment of a beneficial use.

   Evaluation of biological data begins with selection of a reference site. Wide variability among natural surface waters prevents the establishment of a single reference site. Reference sites may be established using historical data, unimpaired habitat or empirical data. Reference site selection should take into account the level of human disturbance, stream size, stream channel type, location, and historical records of resident biota.

   RWQCBs should clearly document how reference sites are selected and used. Specific guidelines for selecting reference sites are described in Alternative 3. Guidance is also available from USEPA on selecting reference sites. Using USEPA guidance (1990), RWQCBs can select site specific, upstream downstream, near field-far field, regional, paired watershed, or ecoregional reference sites.

   Site-specific reference conditions are used to evaluate impacts from point discharges on waters with strong directional flow and require a comparable habitat within the same watershed. This approach is difficult to establish when significant contamination from nonpoint sources exists, extensive habitat modification has occurred, contamination comes from multiple sites, or the impacted site is significantly different than the reference site.

Upstream-downstream reference conditions are used in rivers and streams where habitat characteristics are similar above and below the point of discharge. This approach may be cost effective when bioassessment of the upstream reference condition reflects the attainable condition of the impacted site. However, assessment of several upstream sites may be needed to describe the natural variability of the reference biota.

Near field-far field reference conditions, effective for establishing reference sites in unique water bodies, measure habitat characteristics and the gradient of impairment. This approach may provide an effective method to establish biological criteria for estuaries, large lakes, or wetlands.

Regional reference conditions are based on the assumption that surface waters integrate the character of the land they drain. Reference sites, therefore, would incorporate ecological features, such as soil type, vegetation, land-surface form, climate and land use that directly or indirectly relate to water quality.

Paired watershed reference conditions are established by identifying similar unimpaired water bodies that are comparable to the type and habitat of impaired water. This method is used in the Rapid Bioassessment Protocols (Barbour et al., 1999).

Ecoregional reference conditions identify water bodies of similar type in regions of ecological similarity. Reference sites should be as minimally disturbed as possible, yet represent similar habitat type and be representative of the region.

Once reference sites are selected, bioassessment data should be used in conjunction with water and sediment measurements, physical habitat data, and other water quality data to support conclusions about the status of the water body. These methods should be used together to support an integrated water quality assessment, each providing an independent evaluation of nonattainment of a designated use. Bioassessment, water and sediment assessments, and habitat data provide different and complementary types of information about the source and extent of impairment.

Properly developed sampling methods, combined with the use of metrics and reference conditions, provides a direct measure of the ecological condition of a water body. The determination of impairment to beneficial uses relies on the strength of the biological survey, as well as on the availability of quantitative data-intensive physical and chemical monitoring at all test sites and reference sites. This data is critical to the refinement of bioassessment models because it allows for the identification of physio-chemical factors that have the ability to influence natural community variation. The interpretation and assessment of toxicity measurements and sedimentation are discussed more thoroughly in Issues 5C and 5D respectively.

RWQCBs should describe the habitat they are sampling and why it was chosen. Sampling considerations should include adherence to strict QC procedures to provide consistency and avoid sampling error. RWQCBs should also document the index period (time of year and duration) when it will sample the condition of the biological community, or specify that it would sample year-round. Index periods should be established for a particular season, time of the day, or other window of opportunity when signals are determined to be strong and reliable. Further, only results from similar index periods should be compared.

Bioassessment Guidelines

To accurately assess degradation of populations and communities, RWQCBs should identify water bodies and ecoregions of interest and collect data from representative samples of water bodies in the target population (e.g., EMAP).

RWQCBs should clearly document how the natural variability of its biological data is determined. Classification of water bodies may be based on water body type (e.g., rivers, streams, lakes, wetlands, estuaries), watershed drainage size, ecological regions, elevation, temperature, and other physical features of the landscape and/or water body.

RWQCBs should also document how reference sites are selected and used. A reference condition, an empirical model of expectations that may include knowledge of historical conditions, or a model extrapolated from ecological principles can be derived from reference sites. A reference site may be natural, minimally impaired (somewhat natural), or best available (altered system). Actual sites that represent best attainable conditions of a water body should be used. Where reference sites are not available (e.g., for large ecosystems such as rivers, estuaries, nearshore coastal areas, and in significantly altered systems such as urban centers and cropland areas), a disturbance gradient may be constructed to extrapolate to an appropriate reference condition (Karr and Chu, 1997).

RWQCBs should verify the current conditions of candidate reference sites. A candidate site should be eliminated if conditions preclude its ability to serve as a reference for high-quality water.

RWQCBs should document both the assemblages used as indicators and the level of taxonomy used to assess them. Biological indicators can be separated into four principal assemblages that are used for assessing water quality standards attainment/impairment decisions: benthic macroinvertebrates, fish, algae, and aquatic macrophytes.

Benthic macroinvertebrates - Macroinvertebrate community structure generally is a function of past conditions in the specific water body. Genus/species taxonomic identification provides the most representative information on ecological relationships and best resolution in sensitivity to impairment. A representative of each taxon in the macroinvertebrate for each major basin, ecoregion, site class, or other appropriate study unit can serve as a basin record and reference for checking identification as well as providing a data quality check.

Fish - Bioassessments using a fish assemblage requires that all fish species (and size classes), not just game fish, be collected. Fish are good indicators of long-term effects and broad habitat conditions because they are relatively long-lived, mobile and integrate various features of environmental quality, such as food and habitat availability (Simon and Lyons, 1995). The objective of a fish assemblage is to collect a representative sample of all species (except rare species) in the assemblage and provide a measure of the relative abundance of species in the assemblage. All fish should be identified to species level.

Periphyton or phytoplankton - Algae are primary producers and responsive indicators of environmental change. The periphyton assemblage serves as a good biological indicator in streams and shallow areas because of its naturally high number of species and rapid response to exposure and recovery. Additionally, this assemblage integrates physical and chemical disturbances to a stream reach. Algae should be identified to the species level in rivers and wadeable streams. Identifying diatom genera in assemblages can provide valuable characterizations of biotic integrity and environmental conditions. For assessing lakes, phytoplankton assemblages should be sampled and counted and cells should be identified to the order or genus level.

Aquatic macrophytes - Aquatic macrophytes include vascular plants (grasses and forbs) and may be emergent or submergent. Vascular aquatic macrophytes are extensive primary producers and provide valuable habitat for fish and waterfowl. Important in estuaries and wetlands, macrophytes are identified to species level or categorized as emergent, submergent, or floating leaf for purposes of assessment.

There are three basic macroinvertebrate habitat types commonly used to sample aquatic organisms. They are artificial substrate, multihabitat, and single habitat. The following considerations should be met when selecting which one to sample: (1) adherence to strict QC procedures to provide consistency and avoid sampling error, (2) reliance in choosing a single habitat type based on its availability and dominance as a productive organism habitat (e.g., cobble in streams, kelp beds in coastal areas, or mud in estuaries), (3) preference for a multihabitat approach in systems with diverse habitat, and (4) use of artificial substrates, which leads to sampling habitat that is natural for the system(s) under study (e.g., rock baskets in cobble streams or lakes, or substrates to represent woody debris in streams). The RWQCBs should describe which habitat type it is sampling and why it was chosen.

Bioassessments are most useful when the sample is representative of the site examined and the assemblage measured; the data are an accurate reflection of that sample; and the methods distinguish natural and measurement variability (i.e., "noise") from a true environmental effect (i.e., "signal").

This alternative represents the preferred alternative because bioassessment of natural communities directly assesses the status of a water body relative to the primary goal of the CWA. General guidance is needed because of the diversity of measurements and analyses needed to interpret bioassessment data. Association of bioassessment data with water or sediment concentrations of pollutants is necessary to show that the population or community changes observed are potentially caused by pollutants.

Recommendation: Alternative 4. See Policy sections 3.9, 4.9, and 6.1.5.8.

Issue 5H: ***Trends in Water Quality***

Issue: How should trends in water quality (Antidegradation Policy and threatened waters) be used?

Issue Description: Waters that currently meet standards but show a declining trend in water quality may not meet antidegradation requirements and could be considered for inclusion on the section 303(d) list. Antidegradation is a primary component of water quality standards.

State Antidegradation Policy calls for maintenance of water quality where it exceeds existing water quality standards unless degradation will provide maximum benefit to the public, not unreasonably affect existing/potential beneficial uses, and not diminish quality below existing water quality objectives.

Federal regulation also calls for the identification of threatened waters as part of the section 303(d) listing process (40 CFR 130.2(j)).

Baseline: In 2002, all section 303(d) listing proposals were based upon data and information that showed water quality objectives were exceeded. No data and information used showed trends in water quality that did not also indicate standards were exceeded.

Alternatives:

1. Provide no guidance in the section 303(d) process on the use of the antidegradation component of standards or for threatened waters. Under this alternative, RWQCBs would be given significant latitude in deciding what constitutes a violation of the antidegradation portion of water quality standards or if threatened waters should be identified on the list. For each circumstance, RWQCBs would decide which waters to list after considering the available data and information. The Policy would not provide guidance on the analysis of data and information for the antidegradation portion of water quality standards or for threatened waters. Each RWQCB would address trends in water quality, threatened waters, and antidegradation in their own manner. This alternative was used for section 303(d) listing decisions before 2002.

   This alternative may foster inconsistent interpretation of antidegradation requirements because each RWQCB would develop its own set of decision rules. Existing practices would continue and it is likely that many waters that show declining trends in water quality would not be considered for the section 303(d) list.

2. Provide general guidance on trends in water quality. The goal of many monitoring programs is to identify changes or declining trends in water quality over time. If trends in pollutant concentrations are declining to

levels that may eventually not meet water quality objectives, it is possible that the antidegradation provisions of water quality standards are not met or that water might be threatened. Consequently, numeric, pollutant-specific water quality objectives need not be exceeded to satisfy this listing factor.

Data and information to properly substantiate the decline of water quality requires the application of unique trend analysis approaches to account for such factors as seasonal or weekly systematic variations, and auto-correlation in the data due to interventions or sampling procedural changes. Such approaches currently exist and are accepted for documenting trends in water quality (USEPA, 2000a). Although there are some trend data already available from some long-term monitoring programs the data may be statistically difficult to analyze and interpret because of problems with the characteristics of the data mentioned above (Gilbert, 1987). The RWQCBs should take into consideration the following factors in specifying statistical approaches used to evaluate the declining trend in water quality measurements:

Changes in analytical procedures

If analytical procedures are changed during the implementation of a long-term monitoring program, changes in the trend may be due to these changes alone and not due to the underlying factors that influence the pollutant or condition data. These problems can be reduced through side-by-side comparisons of the methods (Gilbert, 1987). Changes in analytical detection can also have a large effect on the trend. If detection limits are lowered and censored data are used in the trend analysis, this change could induce an artificial downward trend (Smith and McCann, 2000).

Seasonal changes

Many water quality parameters change seasonally making it difficult to identify trends. To characterize seasonal changes, data should be available for several years and, depending on the circumstances, more than two seasons should be available.

Correlated data

When analyzing trend data using statistical procedures, it is important that measurements be independent. In trend analysis, data collected at closely spaced sites or over relatively short periods of time can be positively correlated and not independent.

Baseline conditions

The significance of trends is compared to a time or series of measurements early in the monitoring effort to establish baseline conditions. If less accurate or precise data are used during the early stages of the monitoring effort, it may induce an artificial downward trend merely because of the analytical methods used (Smith and McCann, 2000).

Specific guidance on trend analysis that applies to the variety of circumstances encountered cannot be provided. General guidance for assessing trends in water quality include:

1. Using data collected for a minimum of three years [data covering several years are needed to address systematic variation such as seasonality (USEPA, 2000a)];
2. Establishing specific baseline conditions;
3. Specifying statistical approaches used to evaluate the declining trend in water quality measurements;
4. Specifying the influence of seasonal effects, inter-annual effects, changes in monitoring methods, changes in analysis of samples, and other factors deemed appropriate;
5. Determining the occurrence of adverse biological response, degradation of biological populations and communities, or toxicity; and
6. Assess whether the declining trend in water quality is expected to not meet water quality standards by the next listing cycle.

Waters should be placed on the section 303(d) list if the declining trend in water quality is substantiated (steps 1 through 4 above) and impacts are observed (step 5). It should also be acknowledged in the Policy introduction that waters should be listed where water quality standards are not expected to be met by the next listing cycle (currently two years).

Relationship to Antidegradation Requirements

Federal antidegradation policy applies to situations where existing water quality may be changed. These situations include: establishment or revision of water quality objectives, changes in water quality objective implementation procedures, permit and waste discharge requirement decisions, some cleanup and abatement orders, remedial action plans, waivers or exceptions from Plans, and water right decisions. Where the antidegradation policy applies, it does not absolutely prohibit changes in water quality. The application of the policy depends on the conditions existing in water bodies. The antidegradation policy (40 CFR 131.12) lays out a three-tiered approach for the protection of water quality.

"Tier I" (40 CFR 131.12 (a)(1)) of antidegradation maintains and protects existing uses and the water quality necessary to protect these uses.
"Tier II" (section 131.12(a)(2)) protects the water quality in waters whose quality is better than that necessary to protect "fishable/swimmable" uses of the waterbody. Outstanding national resource waters (ONRWs) are

provided a high level of protection under the antidegradation policy ("Tier III").

The focus of the Listing Policy provisions related to trends is focused on determining compliance with Tier I or Tier III. In general, States must assure protection of beneficial uses, including aquatic life. Reductions in water quality (declining trends) should not be allowed if this change would result in serious harm to any species found naturally in the water. Water quality must be maintained at levels that result in no mortality or significant growth or reproductive impact of resident species (Attwater, 1987). If numeric water quality standards are met but there is a declining trend (the prohibited change in water quality) and beneficial uses are impacted, the antidegradation portion of standards is not met.

Tier II waters are not addressed under the Listing Policy because (1) no action or activity is being proposed that would require a finding that the lowered water quality is necessary to accommodate important economic or social development in the area in which the waters are located, (2) beneficial uses are not impacted, and (3) numeric water quality objectives are achieved.

This alternative represents the preferred alternative because trends in water quality should be used to assess compliance with the antidegradation portion of standards and to address threatened waters. General guidance should be used because very specific guidance might not be applicable to the wide range of trend data that may be encountered.

Recommendation: Alternative 2. See Policy sections 1, 3.10, and 4.10.

Issue 6: Statistical Evaluation of Numeric Water Quality Data

Issue: Should statistical procedures be used to evaluate numeric water quality information for section 303(d) listing and delisting decision-making?

Issue Description: Decisions to list or delist a water body should be based on accurate, representative, and verifiable information and on up-to-date conditions in the water bodies in question. However, water quality conditions can rarely be known at all times and at all water body locations. If the section 303(d) process is to be consistent, a methodology is needed to assess the validity of the water quality data. Information submitted to RWQCBs and SWRCB is often qualitative (i.e., verbal, anecdotal, photographic, or otherwise non-numeric). When quantitative data is submitted (i.e., samples of water column chemistry, bacterial colony counts, concentrations of pollutants in sediment, and chemical concentration in fish tissue, etc.), it often needs to be appropriately summarized and assessed to reach accurate listing decisions.

To help resolve these concerns, scientists commonly rely on careful sampling methodologies and statistical test procedures to help ensure that decisions made, based on inferences from sampled data, are as error-free as possible. Proper statistical procedure is intended to help answer the question: Does a water quality sample accurately reflect actual conditions in the water body?

Statistics helps raise confidence in decisions that are based on limited information. Statistical tools can assist in the handling and processing of numeric information that might otherwise be confusing, or at times contradictory, leading to clear, meaningful, and defensible conclusions about actual conditions in the water body.

Section 303(d) listing decisions can be made with or without reliance on statistical assessments of sampled data. However, the lack of statistical assessment on numeric water quality data could affect the confidence in and reliability of section 303(d) listing decisions.

Relationship between water quality standards and statistics

Concern has been raised that statistical analysis of water quality data will result in an inappropriate revision of existing water quality objectives or criteria. This concern was addressed by USEPA in its Consolidated Assessment and Listing Methodology (CALM) guidance (USEPA, 2002a). The following briefly describes the relationship between existing water quality standards and statistical analysis of data to assess compliance with standards.

Water quality criteria and objectives apply to water segments in their entirety—to every portion of a water body. USEPA has described these types of criteria as “ideal standards” (USEPA, 2002a). Ideal standards include USEPA acute and chronic chemical criteria or criteria set as maximum levels not to be exceeded. Ideal standards rarely address variation or uncertainty; therefore assessment of attainment implies that available monitoring data provides a perfect understanding of chemical concentration throughout the population (i.e., at all points in the water segment and at all times).

Water quality monitoring programs are not capable of monitoring all points in a water segment and at all times. Consequently, monitoring programs collect samples in water segments to determine attainment with water quality standards. Sampling water segments requires that scientists estimate the characteristics of water segments based on the characteristics observed in the water samples. Unfortunately, sample characteristics are not always identical to characteristics in the entire water body. Additionally, sampling introduces inherent bias from the sampler. For these reasons, sampling introduces variability, uncertainty, and the potential for error.

Statistical analysis provides the means to produce a quantifiable level of confidence that a water body achieves or does not achieve a water quality standard. Statistical tests assess with known certainty whether ideal standards are attained or not attained. With respect to the section 303(d) list, the end product of statistical testing is the number of samples, representative of the water body being sampled, that exceed the water quality standard out of all samples available.

Water quality standards themselves are not changed by statistical analysis. Statistics test the validity of the sample and provides the numerical means to verify compliance based on imperfect and randomly variable sampling data. Further, the use of statistics, as described in the proposed Policy, is to be used only for the purpose of developing the section 303(d) list. If standards were changed by the use of statistical analysis then the standards would be different for all purposes (i.e., development of effluent limits, enforcement, etc.). The use of statistics to assist in the development of the section 303(d) list does not change the calculation of effluent limits derived from water quality objectives or criteria nor does section 303(d) statistical analysis change the level of enforcement of water quality standards.

If a State’s listing methodology is inconsistent with existing water quality standards, USEPA is compelled by CWA to disapprove the State-submitted section 303(d) list and make its own listing decision. A challenge to one state’s listing process based on statistical analysis has been found to neither formally nor in effect establish new or modified existing water quality standards or policies generally affecting those water quality standards (Florida Public Interest Group et al. vs. USEPA et al., 2003).

Baseline: During prior section 303(d) listing/delisting activities, RWQCBs gathered and received numeric information but little or no statistical validation of data was employed by any RWQCB in making recommendations to the SWRCB.

Alternatives:

1. Do not require that information gathered or submitted in support of section 303(d) listing/delisting activities be evaluated with statistical procedures. This alternative provides the RWQCBs the greatest flexibility, possibly leading to listing/delisting recommendations lacking statistical or other verification. If statistics were used without guidance from the Policy, statistical methodology could vary significantly from region-to-region. RWQCBs might choose to forego statistical analysis.

   The advantage to this alternative is that it gives the RWQCBs the least regulatory constraints and would not increase the RWQCBs workload. RWQCB staff could rely on BPJ in reaching conclusions based on numeric information.

   A disadvantage to this alternative is the chance that water bodies may be listed or delisted erroneously increases. At the very least, it would be impossible to predict listing decisions with a given dataset and to understand and quantify decision error. Inconsistencies in section 303(d) list decision-making would continue among the RWQCBs, and SWRCB would have difficulty justifying and defending final listing/delisting decisions.

2. Require that information gathered or submitted in support of section 303(d) listing/delisting activities be evaluated with statistical procedures. This alternative would require that the RWQCBs base section 303(d) recommendations on valid statistical procedures for analysis of numeric water quality data. An appropriate statistical procedure would be presented in the Policy and proposed for use in section 303(d) listing recommendations. Appropriate scientific/statistical methodologies would be followed and guidelines recommended for establishing hypotheses to be tested, sampling design, numeric analyses, and statistical testing.

   This alternative is the preferred alternative because this alternative would increase confidence in section 303(d) decision making, allow quantification in the level of assurance (i.e., that decisions are correct), increase decision predictability, and follow standard scientific protocols for decision-making based on numeric information. The disadvantage of this alternative is that it would require additional effort by RWQCB and SWRCB staff in evaluating information.

Recommendation: Alternative 2. See Policy sections 3 and 4.

The following sub-issues 6A though 6E describe various considerations and provide recommendations necessary to develop a consistent standardized set of tools and principles that can be used across the Regions to evaluate numeric data. Each of the sub-issues assumes the recommendation of this issue.

Issue 6A: ***Selection of Hypotheses to Test***

Issue: Which preliminary hypothesis should be tested in order to determine whether a water body should be placed on the section 303(d) list? What hypothesis should be tested to remove the water body from the list?

Issue Description: Hypothesis testing evaluates individual hypotheses about the population (i.e., water body or segment) and eliminates those that do not pass statistical muster, until one hypothesis appears to satisfy the facts (based on sampling data) and, therefore, can not be rejected. In statistics and in science in general, likely hypotheses are never proven; they are simply not rejected and stand until, possibly another hypothesis takes its place.

Hypothesis testing begins by selecting a *null hypothesis* (H_0). The null hypothesis assumes that the testable statement (based on sampling data) will be "no different" from (or less than or equal to) some particular value or range of values. If the null hypothesis cannot be rejected based on statistical tests performed on sample data, information about the population as a whole can be inferred with a certain degree of confidence. If, on the other hand, the null hypothesis is rejected (i.e., found likely to be false), then an *alternative* or *alternate hypothesis* (H_a) must be considered.

More complete and technical descriptions of statistics and hypothesis testing are presented in USEPA (2000a, 2000b) and CALM (USEPA, 2002a).

In analyzing many experimental and field sampling situations, a number of null and alternative hypotheses may be possible. However, for section 303(d) listing and delisting, only two general premises need to be considered:

1. The water body in question achieves water quality standards.
2. The water body does not achieve water quality standards. [2]

The critical question for section 303(d) listing activities is which form of the two hypotheses should be used as the null hypothesis?

Considering Errors in Hypothesis Testing

The choice of null hypothesis is important because the form of the initial assumption to be tested determines which of two types of statistical error can be most easily controlled. One type of error takes place when a water

[2] More precise forms of these two alternative hypotheses are: $\boldsymbol{\theta} \leq \mathbf{k}$, and $\boldsymbol{\theta} > \mathbf{k}$, where $\boldsymbol{\theta}$ represents a (population) pollutant parameter of concern (e.g., [dissolved copper]) and $\mathbf{k}$ is an applicable water quality criterion (for those criteria that are upper boundaries).

body is incorrectly listed (or delisted); the other, when a water is erroneously not listed (or not delisted).

Decision error may occur when an incorrect conclusion is reached about the total population (i.e., water body or segment) because the collected sample data, by chance, has been misleading or unreliable. For example, when sampled data for a particular water body is analyzed to determine if beneficial uses are impaired, the assumption of the initial (null) hypothesis to be tested is: The water body is meeting water quality standards. If this hypothesis is indeed correct (i.e., the water body is not impacted) and the statistical analysis leads to that conclusion, then a correct decision to not reject the null hypothesis will be made. Therefore, beneficial uses are not impaired and the water body will not be recommended for placement on the section 303(d) list.

On the other hand, the samples, by chance, can indicate a greater degree of impairment in the particular samples than actually occurs across the water body as a whole. In that case, the samples would not represent the true population and, an erroneous conclusion would be made that the water segment as a whole does not meet water quality standards. Following proper statistical procedures, the null hypothesis would be rejected and the water would mistakenly be recommended for placement on the section 303(d) list. This is an example of a *Type I error*, incorrectly rejecting a true null hypothesis (Figure 14).

However, if the null hypothesis is false (i.e., the water is impacted) an error can still be made if the non-representative sample data, by chance, suggests that the water body is not polluted although as a whole it really is. This is called a *Type II error* (failing to reject an untrue null hypothesis).

In similar fashion, if the null hypothesis states the water body is not meeting water quality standards (i.e., it is assumed from the start to be polluted), unreliable data can again lead to either a Type I or Type II error (refer again to Figure 14). In those cases, the form of the starting premise (null hypothesis) is the opposite of what it was in the first example; therefore, the precise forms of the Types I and II error will likewise be reversed.

Decision	Reality	
	H_0 is True	**H_0 is False**
Reject H_0	**Type I (false positive) Error**	**Correct Decision**
Do not reject H_0	**Correct Decision**	**Type II (false negative) Error**

FIGURE 14: THE TWO TYPES OF STATISTICAL ERROR

Importance of the Form of the Null Hypothesis

The null hypothesis, H_0, represents an assumption that has been put forward, either because it is believed to be true or because it is to be used as a basis for argument, but has not been proved. Once data have been analyzed in an attempt to reject a null hypothesis, the null hypothesis is rejected only if the evidence against it is sufficiently strong. The alternative hypothesis, H_a, on the other hand, is a statement of what a statistical hypothesis test is set up to establish.

If it is concluded that the null hypothesis cannot be rejected, it does not mean that the null hypothesis is true, it only suggests that there is not sufficient evidence against H_0 in favor of H_a.

The form of the null hypothesis is important for at least two reasons, relating to the two types of error. The first reason is ability to limit, and hence control, Type I error. Most basic statistical tests only allow direct control (i.e., limitation) over Type I error rates. The form of the Type I error depends directly on the form of the null hypothesis.

Statistical tests are designed *a priori* to allow the maximum Type I error to be directly chosen, and hence controlled. For example, if a Type I error rate is desired no more than 10 percent of the time (i.e., sampling data are correct 90 percent of the time), the statistical test calculations can be directly manipulated to achieve that goal (or at least approach it as mathematically close as a particular sample size will allow).

Type II error rates, on the other hand, cannot be so easily controlled within most statistical tests. Type II errors are lowered (controlled) most effectively by increasing sample size, increasing the size of the effect, or decreasing the overall range/distribution of sample values. Fortunately, when only two opposing hypotheses are being considered, Type I and Type II errors change places depending on which hypothesis is chosen to be the null hypothesis.

Baseline: No hypothesis testing or choice of null hypothesis was performed by the RWQCBs on previous section 303(d)-related data.

Alternatives:

1. The form of the null hypothesis is: the water segment meets water quality standards. To place waters on the section 303(d) list, the form of the null hypothesis and alternate hypothesis would be:

   H_0: The water segment meets water quality standards.
   H_a: The water segment does not meet water quality standards.

   To remove waters from the section 303(d) list, the two hypotheses would be reversed:

   H_0: The water segment does not meet water quality standards.
   H_a: The water segment does meet water quality standards.

   For listing, if H_0 is rejected then the evidence is considered to be sufficiently strong to say the water body does not meet water quality standards. Only waters where it is demonstrated that standards are not met would be placed on the section 303(d) list. For this alternative, a Type I error would be to erroneously list a "clean" water body. A Type II error would be to fail to list a water segment with a real water quality problem. The water segments placed on the section 303(d) list would be those water bodies where there is sufficient information to reject the null hypothesis and accept the alternate hypothesis.

   With most statistical tests, this form of null hypothesis would result in greater control over the potential (Type I) error of inadvertently listing a water segment that should not be listed because there is not a real water quality problem. With this form of null hypothesis, the error of failing to identify and list a truly polluted water body is a Type II error. Direct control of Type II error is difficult to achieve unless the amount of evidence is increased (i.e., more samples taken), Type I errors are increased, the effect size (or critical exceedance rate) is increased, or pollution levels are lowered (USEPA, 2002a). A disadvantage of this null hypothesis is that there may be reduced incentives to increase sample sizes because more data may indicate that water quality standards are not being met and the water should be listed.

To mitigate which error should be controlled, statistical errors could be balanced so the tests performed would control both types of statistical error (Smith et al., 2001; Commenter 51). Taking a balanced error approach would protect against the error of incorrectly adding water bodies to the section 303(d) list and would protect against the unnecessary expenditure of funds developing TMDLs when the water segment does not have a water quality problem. At the same time, an error balancing approach would guard against missing real water quality problems that might go undetected.

With an error balancing approach, direct control of Type II error would be addressed by taking into account the amount of evidence available and the effect size (USEPA, 2002a). If errors are balanced in this way, this alternative may increase incentives to increase sample sizes because the collection of more data may increase the possibility that waters would be removed from the list.

This alternative is the preferred alternative because it would give SWRCB and the RWQCBs the greatest control over the error of incorrectly adding water bodies to the section 303(d) list and, therefore, helps protect against the unnecessary expenditure of funds developing TMDLs when the water segment does not have a water quality problem.

2. <u>The form of the null hypothesis is: The water segment does not meet water quality standards</u>. To place waters on the section 303(d) list, the form of the null and alternate hypothesis would be:

   H_0: The water segment <u>does not</u> meet water quality standards.
   H_a: The water segment meets water quality standards.

   To remove waters from the section 303(d) list, the hypotheses would be:

   H_0: The water segment <u>does not</u> meet water quality standards.
   H_a: The water segment meets water quality standards.

   For listing, if H_0 is rejected then the evidence is sufficiently strong to say the water body meets water quality standards. The section 303(d) list would include all the waters where H_0 is not rejected. Using this form of the null hypothesis, a Type I error would be failing to list a polluted water body. A Type II error would be incorrectly listing a non-polluted water body.

Under this alternative, the RWQCBs and SWRCB would again have direct control over Type I error; but in this case, Type I error would be the likelihood of failing to list a water body that should be identified as impacted. As a result, this alternative is conservative in the sense that the baseline condition (the water body does not meet water quality standards) becomes the de facto decision when there is insufficient evidence to refute it (USEPA, 2000b). Consequently, while waters that do not meet standards would be placed on the section 303(d) list, the potential to place waters on the list with inconclusive data would be great. If the null hypothesis is rejected, the accepted alternate hypothesis represents those waters that meet water quality standards.

This alternative gives the SWRCB and the RWQCBs the greatest control over the error of incorrectly missing water segments that should be on the section 303(d) list. Using this form of the null hypothesis controls the error of not identifying real water quality problems that can have impacts on aquatic life or human health. In addition, this alternative may encourage additional monitoring (USEPA, 2003b).

A disadvantage of this alternative is that TMDLs would likely be required for waters where they are not needed. However, if statistical errors are balanced, as described in Alternative 1, these problems would be mitigated and the difference between Alternative 1 and this alternative would be reduced (Smith et al., 2001).

Recommendation: Alternatives 1. See Policy sections 3 and 4.

Issue 6B: ***Choice of Statistical Tests for the Evaluation of Water Quality Data***

Issue: Based on the need to use statistical analysis to help develop the section 303(d) list and selection of an initial null hypothesis to anchor those analyses, what statistical test(s) should be used to evaluate water quality sample data?

Issue Description: A number of statistical tests can be used to evaluate water quality sample data and assess compliance with water quality standards. All of these tests have their strengths and weaknesses. For the purpose of assessment of standards attainment a statistical test used to analyze water quality data should have as many of the following desirable traits as possible:

- ♦ Accurate with relatively small sample sizes.
- ♦ Easy to calculate.
- ♦ Easy to understand and interpret.
- ♦ Relevant and applicable to data from different types of distributions.
- ♦ Accurately handles the characteristics of water quality data. In particular, deals successfully with magnitude, frequency, and spatial and temporal variations in water quality values.
- ♦ Applicable to water quality objectives, water quality criteria, and the array of evaluation guidelines that may be available.

Descriptions of statistical concepts that may assist in understanding statistical analysis of data have been summarized by USEPA (2000a, 2000b, and 2002a).

Baseline: In previous section 303(d) listing processes, RWQCBs performed little or no statistical or quantitative analyses on water quality data. In the development of the 2002 section 303(d) list, most RWQCBs and SWRCB used the USEPA raw score approach.

Alternatives: Ten alternatives are presented in this issue paper. For convenience, brief summaries of the statistical tests are presented in Table 13. The table includes the statistical test, the test's major assumptions, major limitations, and reference.

TABLE 13: COMPARISON OF STATISTICAL AND QUANTITATIVE TESTS AVAILABLE FOR SECTION 303(D) ANALYSES

Statistical Test	Assumptions	Disadvantages	Reference
1. USEPA "Raw Score" Method	Random sampling Independent sampling	High Type I error	USEPA, 1997c
2. One Sample Student's t-test for the Mean	Random sample Independence of data values Data approximately normally distributed	Greatly influenced by outliers Difficulty using "less-than" data (i.e., values below the detection limit)	USEPA, 2000a; USEPA, 2002a
3. Wilcoxon Signed Rank (One-Sample) Test for the Mean	Random sample Independence of data values Data symmetric continuous distribution	Repeated data values produce misleading result	USEPA, 2000a; USEPA, 2002a
4. The Chen Test (Modified One-Sample t-test for the Mean)	Random sample Independence of data values Data are from a skewed data set	Difficulty using "less-than" values	USEPA, 2000a; USEPA, 2002a
5. One-sample Proportion Test	Random sample Independence of data values	Difficult to use with small sample sizes	USEPA, 2000a
6. Percent Lower Confidence Limits	Random sample Independence of data values Data approximately normally distributed or lognormally distributed	Influenced by outliers Difficulty using "less-than" data Not widely used	Gibbons, 2001
7. Exact Binomial Test (Fixed Significance Level)	Random sample Independence of data values Data is dichotomous (only two possible answers) Exceedance probability remains constant Population of samples is infinite	Does not consider absolute data magnitude High Type II error ($N < 20$) Loss of information (raw values changed to nominal ["yes"/"no"] information)	USEPA, 2002a; Lin et al., 2000
8. Exact Binomial Test (Balanced Alpha and Beta Errors)—Acceptance Sampling by Attributes	Same as for the Exact Binomial Test (Fixed Significance Level)	Does not consider absolute data magnitude Error rates can be balanced at any desired level Loss of information (raw values changed to nominal ["yes"/"no"] information)	USEPA, 2002a; Smith et al., 2002; Gibra, 1973

Statistical Test	Assumptions	Disadvantages	Reference
9. Bayesian Version of Binomial Test; Bayesian Test using a normal distribution	Same as for Exact Binomial Test Same as for other parametric tests assuming the normal distribution	Prior information about likely violation rates required. Difficult/complex calculations	Smith et al., 2001; Ye and Smith, 2002
10. Exact Hypergeometric Test	Random sample Independence of data values Data is dichotomous Exceedance probability remains constant Population of samples is finite	Does not consider absolute data magnitude Limited to use when samples are made from finite populations	USEPA, 2002a

1. Use of the USEPA "Raw Score" Method. This procedure involves evaluation of data collected from a water segment for constituents of concern and comparing results against applicable criteria. The test statistic is the number of sample results that are greater than an applicable criterion in some critical percentage of the samples (USEPA, 1997c). This critical exceedance rate has traditionally been established based on USEPA guidance [e.g., 10 percent exceedance rate for conventional pollutants (USEPA, 1997c); <25 percent depending on the pollutant (SWRCB, 2003a)]. Under this procedure, if more than the critical percentage of samples exceeds the standard, the water body is deemed not to meet water quality standards for that pollutant and the water body in question is placed or remains on the section 303(d) list.

   This is a rigid and absolute test: any exceedance above the critical exceedance percentage is cause for listing, whether values come from a small or large sample. The approach also does not consider the absolute magnitude of the measurements being assessed. Since sample sizes are rarely multiples of ten, actual sample ratios must be rounded off.

   The disadvantages of this type of test is that the associated Type I error rate is high in comparison with certain other types of tests (e.g., the exact binomial; see Issue 6D). As Figure 15 shows, with the cut-off exceedance rate set at ten percent, the Raw Score Approach results in no less than a 20 percent Type I error rate (Smith et al., 2001). Usually the rates are much higher (e.g., to 60%) and these error rates are not reduced by larger sample sizes. If Type I error is of concern this test results in unacceptably high false positive error rates.

   The advantages of this approach are that it is very simple to calculate and understand; the chance of making a Type II (false negative) error is significantly lower than for some other tests (Figure 16). The lower Type II error is at the expense of high Type I error (listing when a problem does not exist). Using this test, it is less likely to fail to reject a false null hypothesis.

The Raw Score Approach does not explicitly manage error rates and it has been suggested that the approach be replaced with other statistical approaches (Smith et al., 2001). USEPA does not recommend this approach in the CALM Guidance (USEPA, 2002a) but does recommend its use in limited circumstances in guidance for developing the 2004 section 303(d) list (USEPA, 2003b).

2. One-Sample t-Test. Student's t-Test is a parametric test with the primary assumptions being random, independent sampling and approximate normality of the data (USEPA, 2000a). It is frequently used to compare means from two samples. However, a variation may be used to compare a mean from one sample to a set criterion. In this case, the mean (or arithmetic "average") of sample values is compared to a regulatory threshold value. If the sample mean were equal to or below the critical value, an action (e.g., listing) would not take place. If the mean were found to be above the action level, the water body would be listed.

   Sample data are used to calculate the sample mean and standard deviation. A "t" statistic is then calculated and compared to a tabular value for the correct sample size. The tabular results tell whether or not to reject the null hypothesis (i.e., that as a whole the sample is significantly different—below or above—a critical value).

   This test and its results are well understood and relatively easy to calculate and interpret. It is "robust" against moderate deviations from normality. As for most statistical tests, larger sample sizes improve this test's reliability and like other tests related mathematically to the mean, variance, and standard deviation, this test is sensitive to outlier values.

   Because the mean is greatly influenced by outliers, this may not always be a reliable statistic. All alternatives dealing with the mean have similar disadvantages, related to limitations of dealing with a measure of central tendency. All measures of central tendency may not be informative of the range and distribution of the sample. These estimators (sample statistics) are helpful primarily when the sample distribution is symmetrical and not subject to significant outliers.

   Also, the t-test does not deal reliably with sample values below the detection limit. Although the test operates reasonably well with non-normal data, as for all parametric tests the normality of the sample data should be assessed. Confirming assumptions of this test would add another step to the section 303(d) analytical process and require increased workloads for RWQCBs. Although recommended by USEPA, it is unknown if any state uses this statistical test in the section 303(d) listing and delisting processes.

3. <u>One-Sample Wilcoxon Signed Rank Test.</u> Using this nonparametric test, raw data values are transformed into *ranks* and can be used to test hypotheses about the mean or median of a population (USEPA, 2000a, 2002a). The sample data are not assumed to be from a normal distribution. To use this test, sample data are assumed to have been collected randomly from a symmetric continuous population of values. A detailed explanation of the test and an example calculation using the method is presented by USEPA (2000a, 2002a). Although recommended by USEPA, it is unknown if any state uses this statistical test in the section 303(d) listing and delisting processes.

   Symmetry is an important assumption, and should be satisfied for this test to work properly. If sample values do not give a symmetrical frequency distribution, which may happen frequently with water quality data, then this test may be inappropriate. The t-Test is more resistant to inaccuracies due to deviations from its assumptions then is this nonparametric test.

   Reliability of the test is reduced if there are ties in the results or if there are values below quantitation.

4. <u>Chen Test.</u> This is a derivation of the t-Test designed to compare the sample mean against a critical value when data is "skewed;" i.e., most values are small but a few large outliers are contained in the sample (USEPA, 2000a). The null hypothesis should be that the sample mean is less than or equal to the critical value. The alternative hypothesis is then that the sample mean is greater than the critical value. A detailed explanation of the test and an example calculation using the method is presented by USEPA (2000a, 2002a). No state uses this statistical test in the section 303(d) listing and delisting processes.

   This test assumes a "right-hand" skewed sample distribution (with a long, right "tail") and randomly sampled values. Skewness can be calculated to confirm that this test is applicable.

   If sampled water quality data is skewed, this test is more reliable and/or appropriate than other tests of the sample mean discussed above. Under the proper conditions, it is not particularly Type I or Type II error prone.

   Confirming "skewness" in non-obvious cases would require additional data analysis. If the data is not skewed, then other tests are more appropriate. Similar to the t-Test, the Chen test has problems dealing with non-detected sample findings.

5. One-sample Proportion Test (Z-test). This test addresses proportions or percentiles above or below a critical value (USEPA, 2000a) and is used to test either the hypothesis that the proportion of sample values is equal to or less than some critical proportion, or that it is greater than that critical value. A detailed explanation of the test and an example calculation using the method is presented by USEPA (2000a, 2002a). It is unknown if any state uses this statistical test in the section 303(d) listing and delisting processes.

   The Z-test assumes randomly collected sample data. It is equivalent to the Sign Test for the median when proportions are equal to 50 percent. This test is valid for data from any underlying distribution. The only assumption is for random sampling. This test remains accurate even when non-erroneous outliers are present.

   The major disadvantage is that the test cannot be performed easily using small sample sizes. In order to perform this test easily, both sample size times the proportion of non-exceedances and sample size times the proportion of exceedances must be greater than or equal to five. For example, if the critical exceedance rate is ten percent, sample size must be greater than 50. For smaller sample populations, calculations are complex.

   In general, calculations for this test are more complicated than the exact binomial test.

6. Percent Lower Confidence Limit on the Percentile of the Pollutant Concentration. A statistical approach has been proposed to identify waters that do not meet standards using the percent lower confidence limit on an upper percentile of the pollutant concentration to determine if the water quality standard is exceeded (Gibbons, 2001). Calculations of confidence intervals allows creation, based on sample data, of an interval that either does or does not encompass some critical value (i.e., the pertinent water quality standard). The results allow workers to be confident that the true (water segment) exceedance probability falls in an interval calculated from the sample data. From these results, investigators can determine whether to list or not list a water body.

   If performed correctly, the results should be identical to those from hypothesis testing. Lower one-sided confidence limit testing is the same as testing the null hypothesis that a water body meets water quality standards. The approach proposed by Gibbons (2001) could be used to derive normal, lognormal, and nonparametric lower confidence limits. As with other tests, the tests are sensitive to distribution, independence, and randomness assumptions.

Advantages of the method include: (1) appropriate for a variety of different concentration distributions (i.e., normal, lognormal, nonparametric), (2) directly incorporates the magnitude of the measured concentrations in the test of the hypothesis that a percentage of the true concentration distribution exceeds the standard, and (3) explicit statistical power characteristics that describe the probability of detecting a true exceedance, conditional on the number of samples, the concentration distribution, and the magnitude of the exceedance.

This nonparametric approach is used by the State of Nebraska for listing decisions and the parametric tests are used for setting priorities on water segments (Kansas Department of Health and Environment, 2002).

7. Exact Binomial Test (Fixed Significance Level). The Exact Binomial Test is intended to be used for analyzing *dichotomous data*, which is appropriate for assessing compliance with water quality standards (USEPA, 2002a; Lin et al., 2000; Smith et al., 2001). For binomial analysis of data related to section 303(d) listings, raw numeric data must be transformed into nominal ("named") information; specifically "yes" the data point attains the water quality objective or criterion or "no" it does not. A detailed explanation of the test and an example calculation using the method is presented by USEPA (2000b, 2002a).

Procedure for Listing with a Fixed Significance Level

The exact binomial test is based on a default assumption that the true, but unknown, exceedance rate, r, is less than or equal to the regulatory exceedance rate, r_1. The tested one-sided hypotheses are the null hypothesis, H_o: $r \leq r_1$**,** versus the alternate hypothesis, H_a: $r > r_1$**.**

To find the minimum number of measured exceedances to place waters on the section 303(d) list (*klist)*, let *klist* = 0 initially. Then calculate α (for a discussion of alpha and beta, see Issue 6D) from the probability (P) of the cumulative binomial distribution:

$$\alpha = P(k \geq klist \mid r_1, N) = \sum_{k=klist}^{N} \left(\frac{N!}{k!(N-k)!} \right) r_1^{\,k} (1 - r_1)^{(N-k)} \quad (1)$$

Where α is Type I error (probability of making false positive errors),
k is the number of exceedances in a sample,
klist is minimum number of exceedances to list, and
N is the total number of samples.

The cumulative binomial distribution in Equation (1) can also be calculated using the incomplete beta function (Abramowitz and Stegun,

1972) or the Excel® function BINOMDIST() that returns the binomial probabilities as follows:

$$\alpha = \mathrm{I}(r_1, klist, N - klist + 1)$$

$$= \text{BINOMDIST}(N\text{-}klist,\ N,\ 1\text{-}r_1,\ \text{TRUE})$$

The incomplete beta (I) and Excel® functions are provided (here and elsewhere in this issue paper) so these values may be confirmed using readily available programs. The incomplete beta and BINOMDIST() functions are used to calculate the cumulative binomial distribution.

If α is greater than the desired significance level then add one to *klist* and repeat until α is less than or equal to the desired significance level. Consequently, *klist* is a function of three input values: N, r_1, and the significance level.

Under the null hypothesis, the expected number (i.e., the average value) of exceedances is the product r_1N. If observed exceedance k equals or exceeds *klist*, the null hypothesis is rejected. The logical outcome of rejecting the null hypothesis is that the water body is not meeting water quality standards and should be placed on the section 303(d) list.

Procedure for Delisting with a Fixed Significance Level

A "reversed" null hypothesis is used for delisting a water body. The default assumption is that the true, but unknown, exceedance rate, r_1, is greater than or equal to the regulatory exceedance rate, H_o: $r \geq r_1$, versus the alternate hypothesis, H_a: $r < r_1$.

To find the maximum number of measured exceedances to remove a water from the section 303(d) list (*kdelist)*, let *kdelist* = 0 initially. Then calculate α from the probability of the cumulative binomial distribution:

$$\alpha = P(k \leq kdelist \mid r_1, N) = \sum_{k=0}^{kdelist} \left(\frac{N!}{k!(N-k)!} \right) r_1^{\,k} (1 - r_1)^{(N-k)}$$

$$= 1 - \sum_{k=kdelist+1}^{N} \left(\frac{N!}{k!(N-k)!} \right) r_1^{\,k} (1 - r_1)^{(N-k)} \quad (2)$$

$$= 1 - \mathrm{I}(r_1, kdelist + 1, N - (kdelist + 1) + 1) = 1 - \mathrm{I}(r_1, kdelist + 1, N - kdelist)$$

$$= \text{BINOMDIST}(kdelist,\ N,\ r_1,\ \text{TRUE})$$

If α is less than the desired significance level then add one to *kdelist* and repeat until α is less than or equal to the desired significance level. The null hypothesis is rejected if $k \leq kdelist$, and the water body is considered to meet water quality standards and removed from the section 303(d) list.

Note that for delisting with small sample sizes, α may be larger than the desired significance level even when *kdelist* = 0. The minimum sample size required for delisting is equivalent to the sample size required for an upper one-sided non-parametric tolerance limit (Owen, 1962):

$$N = \frac{\ln(\alpha)}{\ln(1 - r_1)} \qquad (3)$$

In practice, *N* is rounded up to the nearest integer. For example, using a nominal significance level of 0.1 and an exceedance rate of 0.1 the minimum sample size required is ln(0.1)/ln(1-0.1) = 21.9. Rounded up, a minimum of 22 samples would be required for delisting.

Another Excel® function CRITBINOM() can be used to calculate *klist* or *kdelist* if the significance level is fixed. This procedure is described more fully in the draft FED (SWRCB, 2003c).

This statistical procedure is relatively quick and easy, especially because it is readily available in EXCEL® software programs. The binomial test provides a relatively low chance of committing a Type I error (rejecting a true null hypothesis) (Figure 15). Since section 303(d) listing issues can be boiled down to “measurements do or do not meet water quality standards”, the use of the binomial test, intended for dichotomous information, seems appropriate. Many states have used this test, including Arizona (Arizona DEP, 2000), Florida (Florida DEP, 2002), Nebraska (Nebraska DEQ, 2001), Texas (TNRCC, 2002), and Washington (Washington Department of Ecology, 2002).

This test allows the user the flexibility of choosing (1) the critical exceedance rate, (2) the desired statistical "confidence" (Type I error rate), and (3) the minimum sample size allowed. The binomial test has been described as a modest improvement beyond USEPA’s raw score method (Shabman and Smith, 2000).

In binomial testing, specific and sometimes critical information concerned with the absolute magnitude of sample values is not addressed in the test. This could be addressed somewhat in establishing priority for TMDL development by interpreting measurement magnitude as a percentage

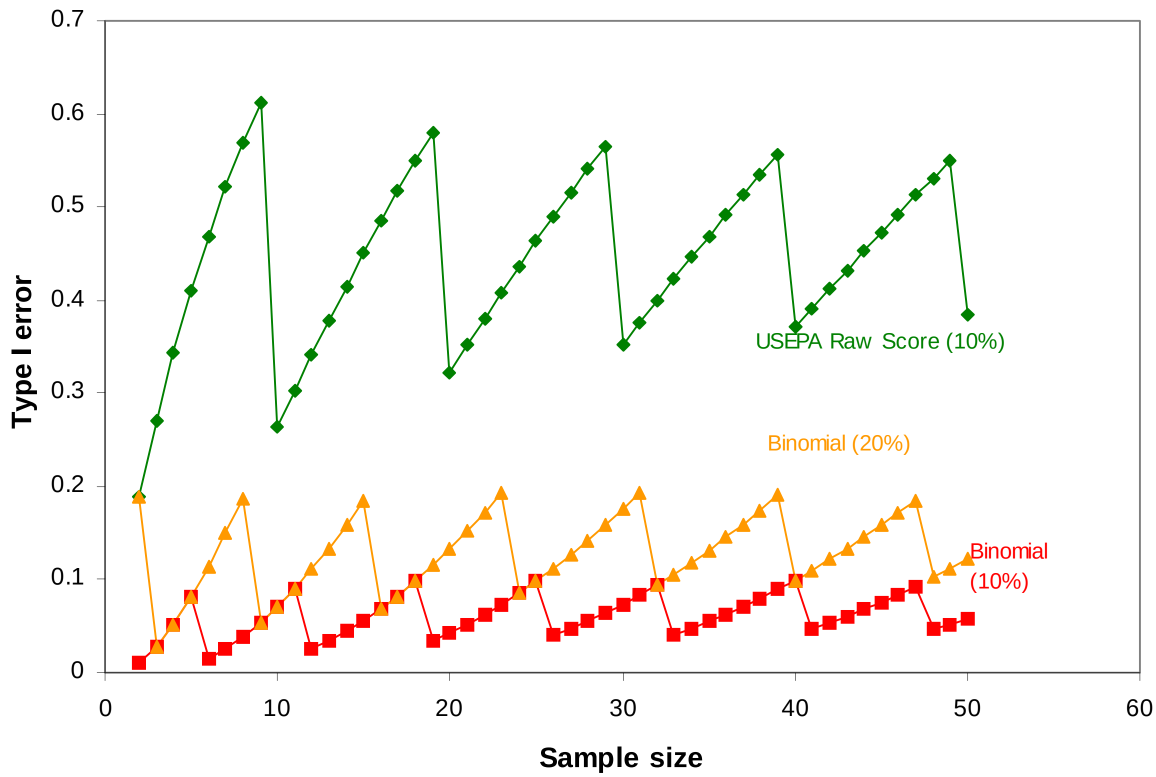


FIGURE 15: TYPE I ERROR RATES FOR EXACT BINOMIAL TEST (WITH 10% AND 20% TYPE I ERROR RATES AND 10% EXCEEDANCE FREQUENCY) AND THE USEPA RAW SCORE METHOD

above the standard. Another way to address magnitude is to use an alternative procedure for listing and delisting using a situation-specific weight of evidence approach.

The chance of making a Type II error (i.e., not rejecting a false null hypothesis) is greater using the binomial test than for some other procedures, especially with samples sizes less than 20 (Figure 16). In nonparametric statistical procedures in general, there is little control over Type II error rates (USEPA, 2002a). Error rates using this fixed level of confidence is analyzed further in Issue 6D, Alternative 2).

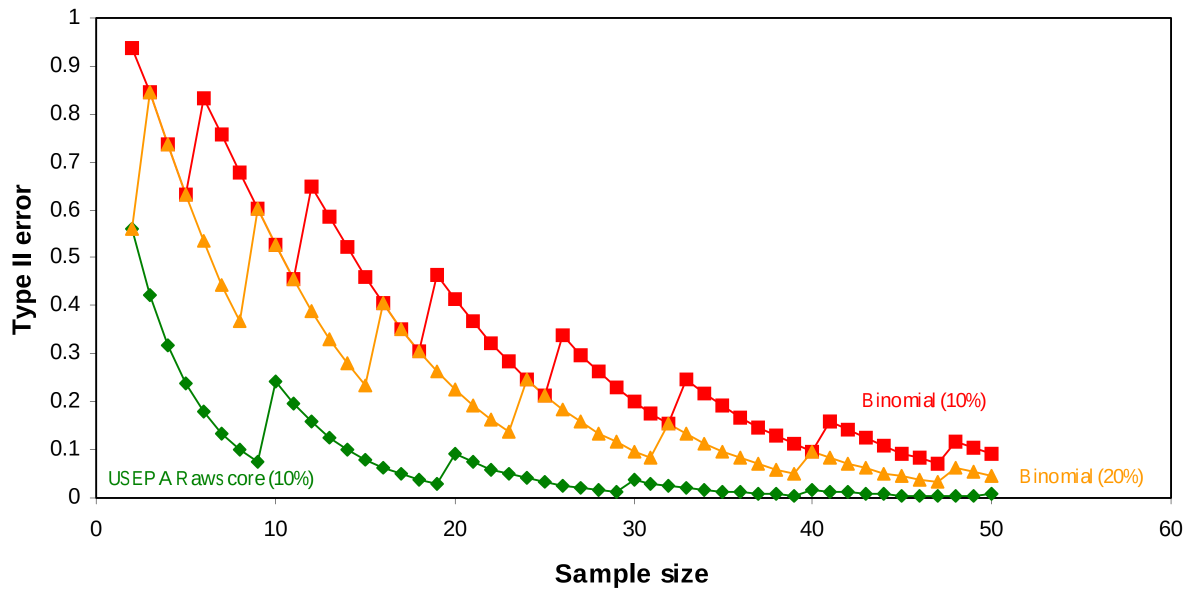


FIGURE 16: TYPE II ERROR RATES FOR EXACT BINOMIAL TEST (WITH 10% AND 20% TYPE I ERROR RATES AND 10% EXCEEDANCE FREQUENCY) AND THE USEPA RAW SCORE METHOD

8. Exact Binomial Test (Balanced Alpha and Beta Errors)—Acceptance Sampling by Attributes. The exact binomial test as described in the previous alternative, like most statistical hypothesis testing procedures, will control the maximum α rate at a value below the nominal significance level for most sample sizes. In contrast, the magnitude of β (beta) depends on several factors, including α, the population variance, the effect size, and sample size. Generally, α varies inversely with β, and control of β is traditionally sought through the appropriate selection of sample size (Gibra, 1973) or through the use of a more powerful statistical test (Helsel and Hirsch, 2002).

This alternative looks at the possibility of balancing alpha and beta errors. One way to balance errors is to use *acceptance sampling by attributes*: i.e., random samples are evaluated to be either above or below the applicable water quality standard using the binomial test (Gibra 1973). A water body is listed if the number of exceedances k in N samples equals or exceeds a critical value *klist*. Likewise, a water body is delisted if $k \leq$ *kdelist* in a sample of N. This process is called a *single acceptance sampling plan* since the decision is based on a single sample of size N (Gibra, 1973).

Procedure for Listing

For listing water bodies, the probability of rejecting the null hypothesis is calculated using the probability of the cumulative binomial distribution and selected values of *r* (i.e., alternate exceedance rates) within the interval [0,1]:

$$P(reject\ H_0) = P(k \geq klist \mid klist, N)$$

$$= \sum_{k=klist}^{N} \left(\frac{N!}{k!(N-k)!} \right) r^k (1-r)^{(N-k)} \tag{4}$$

$$= \mathrm{I}(r, klist, N - klist + 1)$$

= BINOMDIST(*N*-*klist*, *N*, 1-*r*, TRUE)

This probability equals α when the null hypothesis is true and power (1 - β) when the null hypothesis is false. Under the standard hypothesis, α is the probability of incorrectly listing a clean water body while β is the probability of incorrectly failing to list a contaminated water body.

The probability of *not rejecting* the standard null hypothesis is the complement of Equation (4):

$$P(not\ reject\ H_0) = 1 - P(reject\ H_0) = P(k \leq klist - 1 \mid klist, N)$$

$$= \sum_{k=0}^{klist-1} \left(\frac{N!}{k!(N-k)!} \right) r^k (1-r)^{(N-k)} \tag{5}$$

$$= 1 - \mathrm{I}(r, klist, N - klist + 1)$$

= BINOMDIST(*klist-1*, *N*, *r*, TRUE)

This probability equals the confidence coefficient (1-α) when the null hypothesis is true and β when the null hypothesis is false.

Using the example of *N* = 25, Figure 17 illustrates these probabilities as a function of alternate exceedance rates for the standard null hypothesis. This graph simultaneously depicts alpha or power (via Equation 4) and confidence or beta (via Equation 5). The Figure shows the theoretical probability of rejecting the null hypothesis on the vertical axis versus *r* on the horizontal axis is known as a power curve. The mathematical complement of a power curve is an operating characteristics (OC) curve.

An OC curve is a power curve flipped along the horizontal axis by subtracting the power curve probability from unity.

Procedure for Delisting

For delisting water bodies, the probability of rejecting the reverse null hypothesis is calculated using the probability of the cumulative binomial distribution and selected values of *r* within the interval [0,1]:

$$
\begin{aligned}
P(reject\ H_0) &= P(k \le kdelist \mid kdelist, N) \\
&= \sum_{k=0}^{kdelist} \left(\frac{N!}{k!(N-k)!} \right) r^k (1-r)^{(N-k)} \\
&= 1 - \mathrm{I}(r, kdelist+1, N-kdelist) \qquad (6) \\
&= \text{BINOMDIST}(kdelist, N, r, \text{TRUE})
\end{aligned}
$$

Again, this probability equals α when the null hypothesis is true and power (i.e., 1 - β) when the null hypothesis is false. However, under the reverse hypothesis **the nature of the errors are reversed**: α is now the probability of incorrectly failing to list(delisting) a water body that does not meet standards while β is the probability of incorrectly listing (not delisting) a water body that does meet standards.

The probability of *not rejecting* the reverse null hypothesis is the complement of Equation 6:

$$
\begin{aligned}
P(not\ reject\ H_0) &= 1 - P(reject\ H_0) = P(k \ge kdelist+1 \mid kdelist, N) \\
&= \sum_{k=kdelist+1}^{N} \left(\frac{N!}{k!(N-k)!} \right) r^k (1-r)^{(N-k)} \\
&= \mathrm{I}(r, kdelist+1, N-kdelist) \qquad (7) \\
&= \text{BINOMDIST}(N\text{-}kdelist\text{-}1, N, 1\text{-}r, \text{TRUE})
\end{aligned}
$$

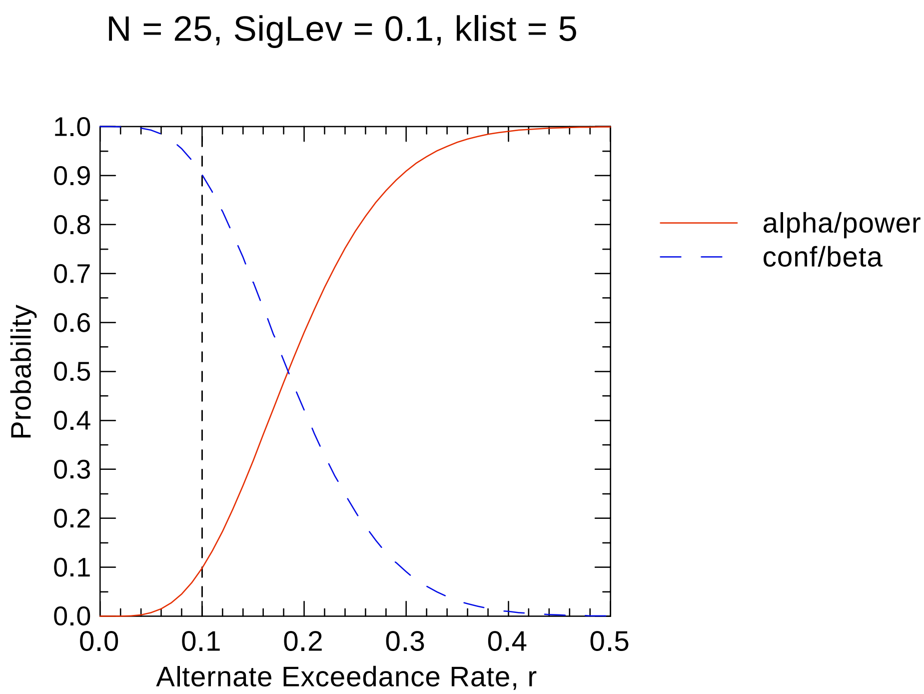


FIGURE 17: PROBABILITIES OF REJECTING (SOLID LINE) AND NOT REJECTING (DASHED LINE) THE STANDARD NULL HYPOTHESIS HO: $r < r_1 = 0.1$ WHEN USING THE BINOMIAL MODEL.

Alpha error is the solid line to the left of the vertical dashed line; power is the line to the right. Beta error is the solid line to the right of the vertical dashed line; confidence is the line to the left. This graph assumes a sample size of 25, a significance level of 0.10, and klist = 5.

This probability is confidence ($1-\alpha$) when the null hypothesis is true and β when the null hypothesis is false.

Again, using the example of $N = 25$, Figure 18 illustrates these probabilities as a function of alternate exceedance rates for the standard null hypothesis.

N = 25, SigLev = 0.1, kdelist = 0

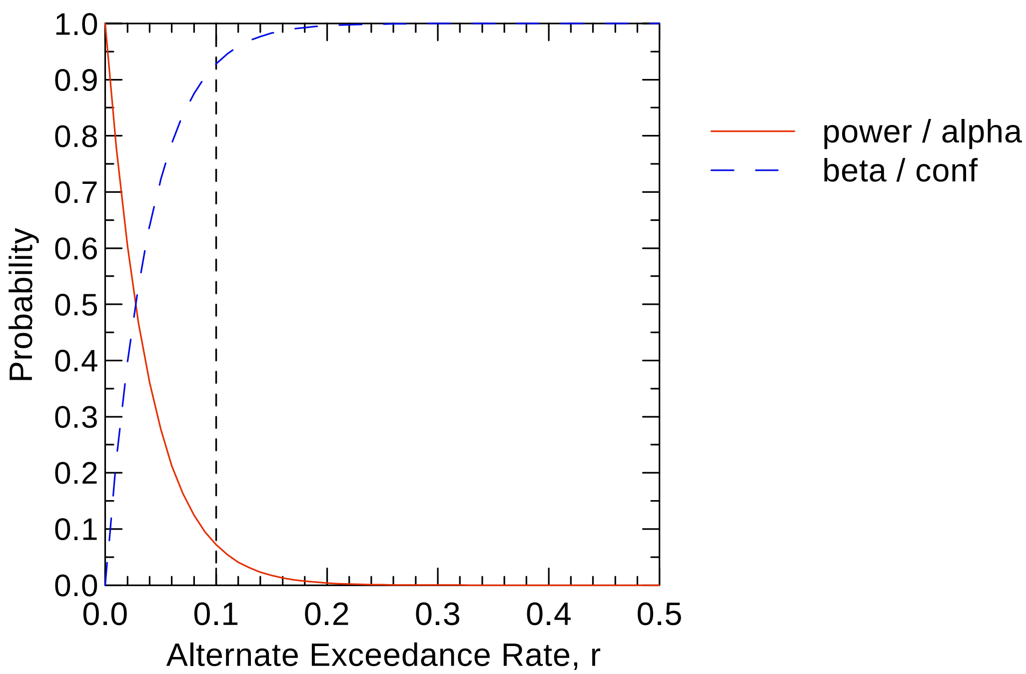


FIGURE 18: PROBABILITIES OF REJECTING (SOLID LINE) AND NOT REJECTING (DASHED LINE) THE REVERSE NULL HYPOTHESIS HO: $r > r_1 = 0.1$ WHEN USING THE BINOMIAL MODEL.

Alpha error is the solid line to the right of the vertical dashed line; power is the line to the left. Beta error is the dashed line to the left of the vertical dashed line; confidence is the line to the right. This graph assumes a sample size of 25, a significance level of 0.10, and kdelist = 0.

Balancing Errors

Alternatives to controlling only the α rate are possible (Lehmann, 1958). Mapstone (1995) argued against adhering to a fixed and arbitrary α, advocating instead for the consideration of economic, environmental, social, and political consequences of both α and β decision-making errors. In the absence of further information, Mapstone recommended that decision errors should be weighted equally, i.e., $\alpha = \beta$. In addition, he recommended that decision-makers define a level of impact essential to detect – an effect size. Furthermore, Mapstone suggested that the effect size is perhaps the most critical aspect of environmental impact decision-making and is a biological (or chemical, physical, aesthetic, economic, etc.) decision, not simply a statistical decision. This issue is addressed in Issue 6C.

The effect size is variously called the *gray region* within the Data Quality Objectives (DQO) process (Millard and Neerchal, 2001) or the *indifferent zone* (Gibra, 1973) within the acceptance sampling process. For section 303(d) listing and delisting, the effect size represents the range of true exceedance rates where the consequences of decision errors are relatively minor.

USEPA (2002a) applied the error balancing approach of Smith et al. (2001) to the section 303(d) listing process. To balance errors, *klist* and *kdelist* are determined in a manner different than described in the previous alternative (No. 7) (Saiz, 2004).

Balanced Error Approach for Listing

Figure 19 is a magnification of the lower portion of Figure 17. Examination of Figure 19 reveals that an alternate exceedance rate value r_2 exists such that $\alpha = \beta$. This can be envisioned as a horizontal line passing through the α curve and the β curve with vertical lines indicating r_1 and r_2. In fact, an infinite number of alternate exceedance rate pairs (r_1, r_2) exist that will balance α and β at varying levels for a given N and *klist*. As the balanced error level decreases the effect size (r_2 - r_1) increases since r_1 must decrease and r_2 must increase. Holding r_1 or r_2 constant will affect the magnitude of α and β and the degree to which these errors can be balanced.

The approach taken by USEPA (2002a) for listing is to first define N, r_1, and r_2. Next, *klist* is determined iteratively as the value that minimizes the absolute difference between α and β. The minimized quantity $|\alpha - \beta|$ can be expressed using Equation (6) for α and Equation (7) for β:

$$|\alpha - \beta| = |\ \mathrm{I}(r_1, klist, N - klist + 1) - [1 - \mathrm{I}(r_2, klist, N - klist + 1)]| \quad (8)$$

where $r_1 < r_2 < 1$. An equivalent procedure is to first define N, r_1, and the effect size (r_2 - r_1).

This minimization calculation is analogous to the minimum squared deviation technique used in statistical curve fitting of data. Errors will balance perfectly when the minimized quantity is zero. However, because of the discrete nature of the binomial probability distribution only approximate balancing of α and β is possible, especially with smaller sample sizes.

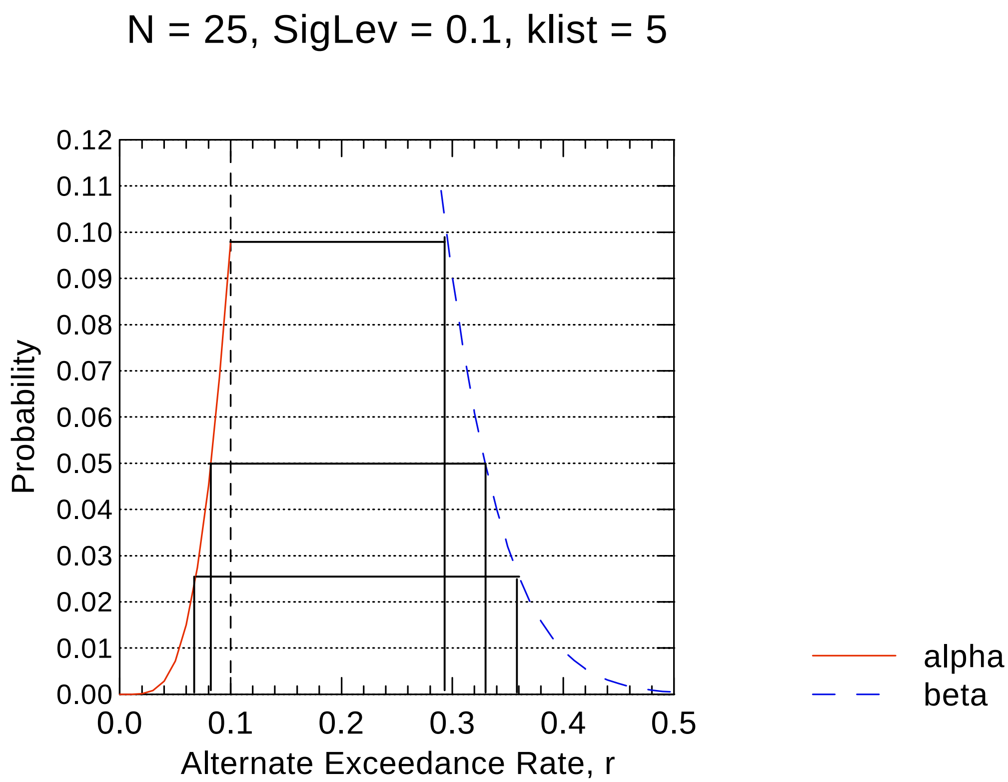


FIGURE 19: VISUAL REPRESENTATION OF EFFECT SIZE ($\alpha = \beta$)

Lowering the balanced error level (vertical lines) increases the effect size (horizontal lines). Three possible exceedance rate pair (r_1,r_2) realizations are shown. This graph assumes a sample size of 25, a significance level of 0.10, and *klist* = 5.

Balanced Error Approach for Delisting

For delisting, the USEPA (2002a) approach is to again define N, r_1, and r_2, but this time r_2 is a value less than r_1. *kdelist* is determined as the k value that minimizes the absolute difference between α and β. The minimized quantity $|\alpha - \beta|$ can be expressed using Equation (4) for α and Equation (5) for β:

$$|\alpha - \beta| = |\ [1 - \mathrm{I}(r_1, kdelist + 1, N - kdelist)] - \mathrm{I}(r_2, kdelist + 1, N - kdelist)| \quad (9)$$

where $r_2 < r_1 < 1$.

The balanced error approach is useful because it considers both types of decision-making errors, α and β, rather than only α when analyzing data.

Another objective is to maintain these balanced error rates at or below an acceptable magnitude. A pre-defined maximum acceptable error for both α and β will allow the determination of acceptable sample sizes to use for listing and delisting. This issue is addressed in Issue 6D.

As discussed in Alternative 7, specific and sometimes critical information concerned with the absolute magnitude of sample values is not addressed in the binomial test. This could be addressed by allowing a situation-specific weight of evidence approach if the magnitude of measurement needs to be considered.

At present, no other state uses this approach for listing or delisting.

This alternative is the preferred alternative because the exact binomial test is intended to be used for *dichotomous data*, which is appropriate for assessing compliance with water quality standards; by balancing errors, the economic, environmental, social, and political consequences of <u>both</u> α and β decision-making errors are more adequately considered.

9. <u>Bayesian Procedures for Parametric or Nonparametric Statistical Tests</u>. This procedure is more sophisticated than the previously discussed tests. In the Exact Binomial Test, for example, the chance of exceeding the water quality standard is treated as fixed and the data are regarded as random. The Bayesian procedure treats the probability of exceeding a standard as a random variable with an associated distribution (Smith et al., 2001). For section 303(d) listing purposes, some form of prior information about the water body and its levels of pollutants would be required in order to choose the initial form of the distribution, called the *prior distribution*. Once new data are obtained, the prior distribution is updated, and the available information is used to compute a resulting distribution of likely standard exceedances (Ye and Smith, 2002).

   The Bayesian Procedure may require relatively sophisticated analysis and statistical understanding to calculate the test statistics manually.

   This procedure may work well for small sample sizes. It provides flexibility when previous information about the situation being studied is available. Using the parametric test, this model takes magnitude into account and controls much more than, for example, the USEPA raw score and exact binomial procedures. Type I and Type II error rates are intermediate between those for binomial (lowest for Type I; highest for Type II) and USEPA raw score (highest for Type I; lowest for Type II) procedures for samples sizes to 50 (Ye and Smith, 2002). Likewise, if more than one data point is significantly above an objective, with the remaining data well below the objective, the water body may still be recommended for listing by the Bayesian procedure.

This procedure has not been used for listing decisions. Apparently, no other states have yet adopted this procedure. One problem is that prior information is required that may not be available. In some instances it may require data from a normally distributed population.

10. Hypergeometric Test. The hypergeometric test is equivalent to the binomial test except that samples are assumed to be from a finite population and samples are not replaced (Sokal and Rohlf, 1995). Like the exact binomial test, this statistical model is also appropriate for binary results (e.g., either "yes" or "no"). This test has been suggested for use in comparing sample data to standards if standards are assessed on the exceedant day basis, like the USEPA acute and chronic criteria (USEPA, 2002a). It is unknown if any state uses this statistical test in the section 303(d) listing and delisting processes.

    Assumptions of the exact hypergeometric test, as for the exact binomial

    test, are that the sample data are binary (only two outcomes possible), the chance of an exceedance remains constant, and sampling is independent and random.

    This procedure is most appropriate for sampling *with replacement* from a population of finite size but if a small number of samples are taken from large populations, these populations can be considered essentially infinite (Sokal and Rohlf, 1995). As is almost always the case, water quality data are sampled from a continuous, *infinite* population of values (from a lake, river segment, etc.). As the sample size increases, the hypergeometric model approximates the binomial model (Sokal and Rohlf, 1995). As a result, for the most part, the exact binomial test appears to be more appropriate for evaluating water quality sample data.

Recommendation: Alternative 8. See Policy sections 3, 4, and 6.1.5.8.

Given the range of data sets that will be reviewed and the types of data that have been reviewed in previous section 303(d) list processes, acceptance sampling by attributes (the exact binomial test and error balancing) should be used as the base analysis of data.

The use of acceptance sampling by attributes is assumed in the selection of critical exceedance rate (Issue 6C), confidence and power levels (Issue 6D), and minimum sample size (Issue 6E).

Issue 6C: ***Critical Rates of Exceedance of Water Quality Standards***

Issue: What is the "critical rate of exceedance" of a water quality standard in each sample that would trigger the listing of a water body on the section 303(d) list?

Issue Description: In establishing a statistical approach for assessing if water quality standards are exceeded it is important to establish the level or levels of standards exceedance that are acceptable or unacceptable. This *critical exceedance rate* (*r)* is the estimate of the actual proportion of samples that exceed an applicable water quality criterion ("the proportion of exceedances"). This variable may range from zero (0 percent), i.e., any exceedance is justification for listing the water body, to one (100 percent). Rates from less than 1 percent to as high as 25 percent are discussed in Table 14.

An *r* value can also be used as an indication of the persuasiveness of the number of exceedances in a sample population. If the number of exceedances is greater than *r*, it increases confidence that the water quality standard is exceeded and that the exceedance is not due to uncontrolled sampling or analytical errors. Since errors vary from one sample to another, the critical exceedance rate is only an indirect representation of that uncertainty.

According to USEPA (2002a), sources of uncertainty include: (1) natural variation in the population; (2) temporal and spatial variability; (3) measurement error; and (4) laboratory (analytical) error. With these sources of uncertainty possible, a critical exceedance rate of greater than zero is indicated. If a critical exceedance rate cannot be chosen, it is virtually impossible to use any statistical approach.

Implicit in selecting *r* is also the selection of a meaningful effect size. Mapstone (1995) recommended that decision-makers define a level of impact essential to detect – an effect size. Furthermore, Mapstone suggested that the effect size is perhaps the most critical aspect of environmental impact decision-making and is a biological (or chemical, physical, aesthetic, economic, etc.) decision, not simply a statistical decision. For section 303(d) listing and delisting, the effect size represents the range of true exceedance rates where the consequences of decision errors are considered relatively minor.

Baseline: Previously, RWQCBs used *r* to judge when a water body was not meeting water quality standards. However, this process was implemented without the use of statistical analysis. Instead, RWQCBs used *r* values from 10 to as high as 95 percent. This resulted in region-to-region inconsistencies in the listing of water bodies.

TABLE 14: CRITICAL EXCEEDANCE RATES PROPOSED BY USEPA

Critical Exceedance Rate	Source	Notes
≤1-in-3 years	USEPA, 1997c	fully supports beneficial uses for acute criteria
0.09% (1 out of 1,095)	USEPA, 2002a	using hypergeometric distribution equivalent to a 1-in-3 year exceedance frequency for acute criteria
0.36% (1 out of 274)	USEPA, 2002a	using hypergeometric distribution equivalent to a 1-in-3 year exceedance frequency (4-day averages) for chronic criteria
>1-in-3 years to <10%	USEPA, 1997c	partially supports beneficial uses for acute criteria
5% (plus a 15% effect size)	USEPA, 2002a	for toxicant criteria, equivalent to a 1-in-3 year exceedance frequency
<10%	USEPA, 1997c; USEPA, 2002a	for bacteria criteria
<10%	USEPA, 1997c; USEPA, 2002a	fully supports beneficial uses for conventional pollutants
10%	USEPA, 2003	for chronic criteria for acute criteria (if justified) for conventional pollutants (if justified) using either binomial or "raw score" tests
>10%	USEPA, 1997c	for acute criteria no support of beneficial uses measurement error should be accounted for
>10% (plus a 15% effect size)	USEPA, 2002a	for conventional pollutants
>10% to <25%	USEPA, 1997c USEPA, 2002a	partially supports beneficial uses for conventional pollutants
>25%	USEPA, 1997c; USEPA, 2002a	for conventional pollutants does <u>not</u> support beneficial uses

Alternatives:

1. Provide no guidance on the choice of critical exceedance rate to the RWQCBs. Under this alternative, the RWQCBs would continue to use various *r* values in their analyses of sample data to develop the section 303(d) list. Values would vary region-by-region, and could even vary decision-by-decision within a single region.

   The possibility of uncertainty affecting analyses of sampled information varies widely. This alternative provides the maximum level of flexibility to RWQCBs for matching *r* with likely levels of statistical uncertainty.

   Under this alternative, *r* may not always match a perceived or anticipated overall level of possible error in gathering, analyzing, and reporting sample data. Region-by-region listing or delisting inconsistencies would not be addressed under this alternative.

2. Test water quality sample data against a single *r* of 25 percent. Under this alternative, a 25 percent value would be used in statistical analysis of sample data. Therefore, a ratio of exceedances close to 25 percent or more would have to be observed in samples to conclude the water body was failing to meet water quality standards. USEPA has used the 25 percent critical exceedance rate for conventional pollutants (Table 14) as an indication that beneficial uses are not supported (USEPA, 1997c).

   High exceedance rates would most likely be observed in cases where very large errors in collection and analysis of data are possible or very large natural variability is found. Unfortunately, exact knowledge of sample and laboratory error is rarely known on an individual sample basis.

   Many states use this exceedance rate to determine if water bodies are not supporting beneficial uses for conventional pollutants (Table 15).

3. Use a single *r* of 15 percent. Under this alternative, it would be assumed that the variability and error associated with sampling and analysis of data would sum to a sample exceedance rate of 15 percent. Therefore, at least 15 percent of samples observed would exceed the applicable criterion before considering whether the water body is not meeting standards and should be listed. USEPA (2002a) has recommended a 15 percent effect size when analyzing chemical data. At least one state uses 15 percent in analyzing data for section 303(d) purposes (Table 15).

TABLE 15: CRITICAL EXCEEDANCE RATES PREVIOUSLY USED BY SEVERAL STATES

Critical Exceedance Rate	State	Reference
USEPA (1997b) guidance	Alabama	Alabama Department of Environmental Management, 2002
10%—bacteria 4%—bacteria, marine beaches from April 1 through October 31 25% or less depending on the conventional or toxic pollutant	California	SWRCB, 2003a
85th percentile—chronic chemical standards 50th percentile—iron 15th percentile—DO, pH	Colorado	Colorado Water Quality Control Division, 2001
10%—water quality criteria	Florida	Florida Department of Environmental Protection, 2002
11%—conventional pollutants	Georgia	Georgia Environmental Protection Division, 1998; as quoted by Community Watershed Project
10%—Numeric and narrative water quality standards	Idaho	Idaho Department of Environmental Quality, 2003
10%—chronic standards; bacteria; chloride; sulfate; parameters used to assess irrigation and livestock watering, food procurement 2 exceedances in 30-36 samples—acute standards 0%—nitrate drinking water standard 50%—other drinking water parameters	Kansas	Kansas Department of Health and Environment, 2002
10% pH	Maryland	Maryland Department of the Environment, 2003
2 exceedances in 3 year period—Toxicity-based standards $\leq$10%--Conventional pollutants $\leq$10%--Fecal coliform	Minnesota	Minnesota Pollution Control Agency, 2004
10% of measurements for acute and chronic standards; 25% exceedance of acute standards; 1-50% exceedance of chronic standards	Montana	Montana Department of Environmental Quality, 2002

Critical Exceedance Rate	State	Reference
11% of measurements for conventional pollutants; 50% exceedance of standard		
>10%—fecal coliform 11%—water quality criteria >10%—Agricultural water supply beneficial use	Nebraska	Nebraska Department of Environmental Quality, 2001
>10%—bacteria, clarity, phosphorus, chlorophyll-a >10%—drinking water assessments	New York	New York State Department of Environmental Conservation, 2002
11%—DO, pH 10%—heavy metals, priority pollutants, chlorine, ammonia 25%—turbidity, total phosphorus, total nitrogen, chlorophyll-a	North Carolina	South Carolina Department of Health and Environmental Control, 2002
10%—bacteria, DO, pH Minimum of 2 exceedances—toxics	Oregon	Oregon Department of Environmental Quality, 2003
10%—conventional pollutants, metals and organics (acute and chronic criteria 25%—bacteria (single sample criterion)	Texas	Texas Natural Resource Conservation Commission, 2002
11%—conventional pollutants 2 exceedances in 3-year period—toxics	Virginia	Virginia Department of Environmental Quality, 2002
No more than one exceedance--Drinking water Exceed only once or was not exceeded in < 10% of the samples if the criterion was exceeded at least two times—aquatic life Exceeded in > 40% of the samples --Chronic criteria More than one violation -- Acute criteria	Utah	Utah Department of Environmental Quality, 2004
2 or more exceedances in a 3-year period—toxics 10% or exceeds geometric mean—bacteria One 7-day average exceeds standard—DO, temperature 10%—dissolved gas, pH, nitrogen, phosphorus, turbidity, hardness	Washington	Washington Department of Ecology, 2002

4. Use a single r of 10 percent. Past USEPA guidance (USEPA, 1997c; USEPA, 2002a) recommends making non-attainment decisions for conventional pollutants where more than 10 percent of samples exceed applicable water quality standards. This guidance provides a simple "rule of thumb" to evaluate data sets of limited size for assessment purposes, to account for measurement error, and the potential that small data sets may not be fully representative of receiving water conditions.

   This r has traditionally been applied nationally (Table 15) in previous listing cycles, most notably with the USEPA "raw score" methodology. Other states using a statistical approach (often the exact binomial test) use the 10 percent critical value (e.g., Florida DEP, 2002).

5. Use separate r values, as recommended in the CALM Guidance (USEPA, 2002a), for toxic pollutants and another one for conventional pollutants in order to balance decision errors. The Policy would specify separate ranges of exceedance frequencies for toxic pollutants and conventional pollutants.

   In order to avoid conflicting exceedance frequencies for listing and delisting, the r values should be selected carefully. It is possible, and undesirable, to assign r_1 and r_2 values that would result in conflicting decision rules for listing and delisting. Under such starting values, a set of observed exceedances will exist that simultaneously result in a decision to list under the standard null hypothesis and a decision to delist under the reverse null hypothesis for a given N.

   For example, given $N = 25$ and for listing $r_1 = 0.10$ and $r_2 = 0.25$, but for delisting $r_1 = 0.40$ and $r_2 = 0.25$. Using the balanced error approach leads to *klist* = 5 or more exceedances and *kdelist* = 6 or less exceedances. A water body listed with 5 or 6 exceedances in a sample of 25 could be simultaneously listed and delisted. Generally, the balanced error approach should result in a *kdelist* value that is at least one exceedance less than *klist*.

   To avoid this problem, the following relationship should be established: r_1 (listing) = r_2 (delisting) and r_2 (listing) = r_1 (delisting). In this case, the r_1 and r_2 starting values results in the equality of the minimized error quantities. Equating these quantities means that *kdelist* will always be one less than *klist*. Thus, α for listing becomes exactly equal to β for delisting and vise-versa. This reversal and equality of errors for listing and delisting is desirable because conflicting decisions based on which null hypothesis is chosen (standard versus reversed) will then be eliminated. The CALM Guidance (2002a) applied the error balancing approach

(Smith et al., 2001) to the section 303(d) listing process noting that balanced decision error rates are less affected by switching the null and alternative hypothesis.

Estimating Critical Exceedance Frequencies and Effect Size

Water quality standards exceedances can be influenced by natural variability (including sample frame selection, sampling unit definition, and numbers of samples), measurement error (including sample collection, sample handling, and analysis), and not due to a real violation of the standard. Natural variability can be substantial but is rarely explicitly known. Measurement error is more readily quantified when well-run monitoring programs set limits on the amount of acceptable measurement error. Typical allowable variation for the measurement of conventional parameters, metals, and organic chemicals range from 10 to 50 percent (e.g., Puckett, 2002; Stephenson et al., 1994), 40 percent for toxicity measurements (Stephenson et al., 1994), and up to three orders of magnitude for bacteria measurements (Puckett, 2002). These types of potential measurement errors introduce doubt into the decision to list waters.

While it cannot be precisely known how much error is included in the decision to list, the decision becomes unclear when the *r* values and effect size approach acceptable measurement error. Consequently, with a small number of samples exceeding standards, at some point the decision to list becomes "too close to call." As the *r* value (the gray area where the decision may be too close to call) decreases, fewer sample exceedances are required to place waters on the list. Conversely, for delisting, as *r* decreases, the number of samples that show standards are met increases.

The *r* values should only be used in statistical analysis after an assessment is made of whether each measurement attains or does not attain water quality standards. The water quality standard's averaging period (if any) should be addressed in this preliminary step of determining if a single sample measurement exceeds the water quality objective or criterion (Issue 4A). The *r* values and effect size should only be applied to determine the number of samples needed to place waters on the section 303(d) list. This value should *never* be used to assess if the standard is met a percentage *of the time* because the *r* value assesses only the strength of the decision to list or delist based on the sample population (i.e., grab samples) available.

It has been questioned whether a set *r* (say 10 percent) can be used to interpret water quality objectives expressed as: "the instantaneous concentration of the pollutant shall not be greater than ___ μg/L, at any time." These types of standards pose several challenges in assessing waters to be placed on the section 303(d) list. It is reasonable to not treat every single sample as representing the true ambient condition of the water segment because an individual sample is not a definitive assessment of whether the water segment is attaining applicable water quality standards. It is necessary to account for natural or sampling variability in the assessment because (1) error is introduced into the analysis of samples or (2) short-term or sporadic excursions of the water quality standard in some samples does not reflect the best assessment of the true condition of the water segment (USEPA, 2003e).

In general, aquatic organisms can tolerate higher concentrations of pollutants for short periods than they can for complete life cycles (USEPA, 1991f). It is debatable whether short-term and sporadic excursions from the water quality standard can occur without resulting in nonattainment of the water quality standard. At least one USEPA Region has stated:

> "[US]EPA's best information at this time is that the extent to which such a 'true' exceedance could occur without impairing designated uses depends on the nature and toxicity of the pollutant and on the extent to which the pollutant is naturally variable in the environment without impairing designated uses." (USEPA, 2003e)

In most Basin Plans, natural or controllable sources of pollution are recognized as contributing to the variability of some pollutants in the State's waters. All major federal, State, and local monitoring programs in California recognize the variability inherent in sampling and analysis of samples. Attainment assessments for "not to be exceeded" standards do not recognize such variation and uncertainty. Consequently, perfect assessment of attainment for a "not to be exceeded" standard assumes a monitoring effort that continually measures the water quality objective at all points in the water segment. No monitoring efforts measure all points at all times; actual monitoring involves sampling the water segment and estimating the characteristics of the entire water segment based on the characteristics of the sample. Therefore, water quality objectives set as "not to be exceeded" maxima should be subject to statistical analysis that accounts for variability. Statistical analysis does not allow for a single sample to determine if water quality standards are attained.

In these "not to exceed" cases, the *r* value is only used to quantify the strength or persuasiveness of the data used to interpret this type of standard. The *r* value should *not* be used to justify allowing the standard to be exceeded some percentage *of the time*, as this would be an inappropriate interpretation of the water quality objective.

For conventional pollutants (pH, temperature, dissolved oxygen, etc.), CALM Guidance (USEPA, 2002a; Table 4-3 in the reference) recommends a statistical guideline of acceptable exceedance frequency of 10 percent (on average) and unacceptable exceedance frequency of 25 percent in any given sample. This approach includes a specification of maximum effect size of 15 percent. Effect size is the maximum magnitude of exceedance frequency that would be tolerated. USEPA (1997c) recommends listing for bacteria at a 10 percent exceedance frequency.

If this recommendation were used in listing decisions, waters with less than 10 percent exceedance would not be listed while waters with exceedance frequency above 25 percent would always be placed on the section 303(d) list. Waters that fall between these two values would sometimes be listed. As described by USEPA (2002a), the use of the exact binomial test with a population exceedance rate of 25 percent (which includes a 15 percent effect size) "indicates severe problems and represents the minimum violation (rate) we would almost always want to detect" (Smith et al., 2001). This interpretation is consistent with CWA section 305(b) guidance (USEPA, 1997c) and is in the low range for expected measurement error.

Chronic water quality criteria (as presented in the CTR) are always expressed as average concentrations over at least several days and are expressed with exceedance frequencies over three-year periods on the average. USEPA's chronic water quality criteria for toxics in freshwater environments are expressed as 4-day averages. On the other extreme, USEPA's human health water quality criteria for carcinogens are calculated based on a 70-year lifetime exposure period. As stated in the CTR, the allowable frequency of exceedance is one time in a three-year period on the average.

For toxics (including acute and chronic criteria for toxic pollutants, etc.), CALM Guidance (USEPA, 2002a; in table 4-3 of the reference) recommends a statistical guideline of acceptable exceedance frequency of 5 percent (on average) and unacceptable exceedance frequency of 20 percent in any given sample. This approach again includes a maximum effect size of 15 percent. If this recommendation were used in listing decisions, waters with less than 5 percent exceedance for these parameters would not be listed while waters with exceedance frequency above 20 percent would always be placed on the section 303(d) list. Waters that fall between these two values would sometimes be listed. This interpretation is at the lower end of the allowable measurement error of major monitoring programs.

At present, no other state has implemented these specific exceedance frequencies for placing waters on the section 303(d) list.

6. Use separate *r* values for conventional pollutants as recommended by USEPA (2002a). Establish *r* values for toxicants at a level that is more conservative than the USEPA recommended values. As for alternative 5, the Policy would specify separate ranges of exceedance frequencies for toxicants and conventional pollutants. As described and justified in alternative 5 for conventional pollutants, waters with less than 10 percent exceedance frequency would not be listed while waters with exceedance frequency above 25 percent would always be placed on the section 303(d) list (USEPA, 2002a).

   For toxicants (including acute and chronic criteria for toxic pollutants, etc.), CALM Guidance (USEPA, 2002a; in table 4-3 of the reference) recommends a statistical guideline of acceptable exceedance frequency of 5 percent (on average) and unacceptable exceedance frequency of 20 percent in any given sample. This approach again includes a maximum effect size of 15 percent. At the September 8, 2004 SWRCB workshop, testimony was received stating that these exceedance frequencies are not stringent enough to assure that problem waters would be placed on the section 303(d) list.

   Toxicants have significant potential to adversely affect aquatic life and potentially public health when present at levels above those defined in the water quality standards. Therefore, to be most protective of water quality, listing decisions for toxicants should be based on standards exceedances for these substances at relatively low frequencies, even if on limited occasions, rather than on the more prolonged persistence required for other pollutants. Using a lower bound of 3 percent, for example, is well below the typical allowable variation for metals, organic chemicals, and toxicity (see alternative 5). Using a 3 percent exceedance frequency is more environmentally conservative and provides additional assurance waters will be listed when measurement variation is moderate.

   If this recommendation were used in listing decisions, waters with less than 3 percent exceedance for these parameters would not be listed while waters with exceedance frequency above 18 percent would always be placed on the section 303(d) list. Waters that fall between these two values would sometimes be listed. As described in alternative 5, this interpretation is well below allowable measurement error of major monitoring programs.

   This alternative represents the preferred alternative because the range of values, in the absence of site-specific values, is pragmatic, balanced, fair, and within the limits of the water quality regulatory process. Based on the monitoring efforts implemented in California (e.g., NPDES, SWAMP, USEPA, etc.), the data sets available (SWRCB, 2003a), past practices of the SWRCB and many RWQCBs, and the consequence of a section 303(d) listing; the 3 percent-18 percent and 10 percent-25 percent *r* values are reasonable in the absence of a site-specific values.

At present, no other state has implemented these specific dual exceedance frequencies for placing waters on the section 303(d) list.

7. Use a single *r* value of less than 5 percent. Under this alternative, the critical maximum limit of exceedances seen in any sample would be less than five percent. Several states use very low exceedance rates for toxic chemicals (Table 15). The justification for these low exceedance rates is discussed by USEPA (2002a) in the CALM guidance. Generally, very low exceedance frequencies are justified by the requirement that USEPA acute and chronic water quality criteria only allow for a one-in-three year exceedance frequency. To work within this frequency, states typically assume there is no variability in sampling or analysis and, therefore, do not use statistical analysis.

   To distinguish very rare occurrences of standard exceedances with statistical tests requires very large sample sizes because the exceedance frequency is so small. USEPA has estimated that over 900 samples in a three-year period are needed to assess if these standards are attained (USEPA, 2002a). The difficulty associated with the once-in-three-years assessments occurs because the standard as presented in the guidance allows only one extremely rare event (e.g., one exceedant day out of 1,095 days for acute criteria or one exceedant period out of 274 four-day periods for chronic criteria), but no more. With these types of critical exceedance frequencies false negative (Type II) error are very high unless sample size requirements are increased.

   If modestly-sized data sets are to be used to assess compliance with USEPA acute and chronic criteria and variability of measurements are to be considered in the assessments, then the attainment assessments become similar in practice to determinations of compliance with "not to be exceeded" standards discussed in Alternative 4. USEPA has acknowledged that a higher critical exceedance frequency can be used for acute and chronic criteria (USEPA, 2003b; USEPA, 2002a) and for "not to exceed" standards if justified.

Recommendation: Alternative 6. See Policy sections 3 and 4. The form of the testable hypotheses becomes:

1. For Listing Toxics:
   H_o: $p \leq 0.03$
   H_a : $p > 0.18$
2. For Delisting Toxics
   H_o: $p \geq 0.18$

$H_a : p < 0.03$

3. For Conventional Pollutants and Bacteria

$H_o: p \leq 0.10$

$H_a : p > 0.25$

4. For Delisting Conventional Pollutants and Bacteria

$H_o: p \geq 0.25$

$H_a : p < 0.10$

Where p is the estimate of the true proportion of samples that exceed the numeric water quality standard. The proportion of samples exceeding the standard is the number of samples exceeding divided by the total number of samples.

Issue 6D: **Selection of Statistical Confidence and Power Levels**

Issue: When a statistical test is used to evaluate numeric sample data, what minimum level of statistical confidence and power should be selected for section 303(d) list decision-making?

Issue Description: Statistical hypothesis testing is primarily about choosing between likely hypotheses that lead to better decision-making. A good deal of statistical theory is devoted to quantifying the reliability of such decisions. An appropriate statistical test or value can be used to choose the hypothesis that best fits the observed facts and to increase confidence in the findings. Statistical confidence is the probability of not committing a Type I error (listing when we should not). The power of a hypothesis test is the probability of not committing a Type II error (not listing when we should).

For the purposes of analyzing statistical confidence and power, the null hypothesis is: water quality standards are met (as recommended in Issue 6A). The alternative hypothesis is, then, water quality standards are not met. Decisions on whether the water body should be listed depend on which hypothesis, the null or alternative, is "rejected" at a certain level of confidence and power.

In statistics, the likelihood of making false-positive errors is assigned a shorthand symbol α. Alpha values range from zero (or 0%) to one (or 100%) chance of making a Type I error. The converse of alpha, the non-error rate, is defined as one minus alpha (or $1 - \alpha$), and ranges from a one (100%) to zero (0%) chance of not making a Type I error. This non-error rate gives the *confidence* in the test results. The greater the confidence in a statistical test result (i.e., the lower the α value), the more likely that a Type I error (rejection of a true null hypothesis) will not be made.

Similarly, the likelihood of making false-negative errors is assigned a shorthand symbol β. Beta values range from zero (or 0%) to one (or 100%) chance of making a Type II error. The converse of beta, the non-error rate, is defined as one minus beta (or $1 - \beta$), and ranges from a one (100%) to zero (0%) chance of not making a Type II error. This non-error rate gives the *power* of the test results. The greater the power in a statistical test (i.e., the lower the β value), the more likely that a Type II error (acceptance of a false null hypothesis) will not be made. When other variables, such as sample size and critical exceedance rate are held stable, decreasing α increases β, and vice versa.

Confidence levels have no direct bearing on Type II error, the error of failing to reject an untrue null hypothesis. A confidence of 99 percent, for example, helps ensure that approximately 99 times out of 100 a true null hypothesis will not be judged falsely. However, setting such a high confidence level in test calculations does not prevent, and may actually promote, a higher error rate of judging a false null hypothesis to be true (Type II error).

Type I and Type II errors are both undesirable. However, a policy that provides a moderately high degree of confidence can be adopted for both listing and delisting decisions. Further discussion of control of Type II error is addressed in the determination of recommended form of the null hypothesis (Issue 6A), choice of the statistical test (Issue 6B), critical exceedance rate (Issue 6C), and sample size (Issue 6E).

Baseline: Previously, the RWQCBs and the SWRCB did not select or determine a level of statistical confidence in section 303(d) listing decisions.

Alternatives:

1. Provide no guidance on the choice of statistical confidence or power to the RWQCBs. Under this alternative, RWQCBs would be able to choose whatever confidence level (and Type I error rate) or power level (and Type II error rate) which seem appropriate. Confidence and power might vary from one decision to the next, or from region-to-region.

   This alternative would grant the RWQCBs great flexibility in section 303(d) list decision-making and would allow establishment of confidence levels depending on the circumstances of each listing decision. However, to make decisions based on statistical tests without bias, confidence and power levels should be determined before tests are performed.

   Assuming that the RWQCBs use the same statistical procedure to analyze sample data, this alternative could result in inconsistent listing decisions (e.g., the same number of exceedances in two samples of the same size could result in listing in one region and no listing in another region).

2. Use any confidence level less than ninety percent (i.e., $[1-\alpha] <= 0.90$). Under this alternative a confidence level of less than or equal to 90 percent would be used by RWQCBs and power

(Type II error) would not be controlled. This less certain confidence level (e.g., 75 to 90 percent) could be used for placing waters on the section 303(d) list. Emerging and more subtle problems (e.g., problems characterized by fewer exceedances) are more likely to be identified with a lower confidence level (Williamson, 2001). However, the risk is an increase in Type I errors, i.e., waters will be identified more frequently as exceeding standards when in fact they may not be exceeding standards. Additional monitoring or confirmation of the problem before a TMDL is developed would help identify and eliminate such mistakes. The State of Florida uses an 80 percent confidence level for placement of waters on its Planning List (i.e., those waters where additional monitoring is needed before the decision to place waters on the section 303(d) list can be made).

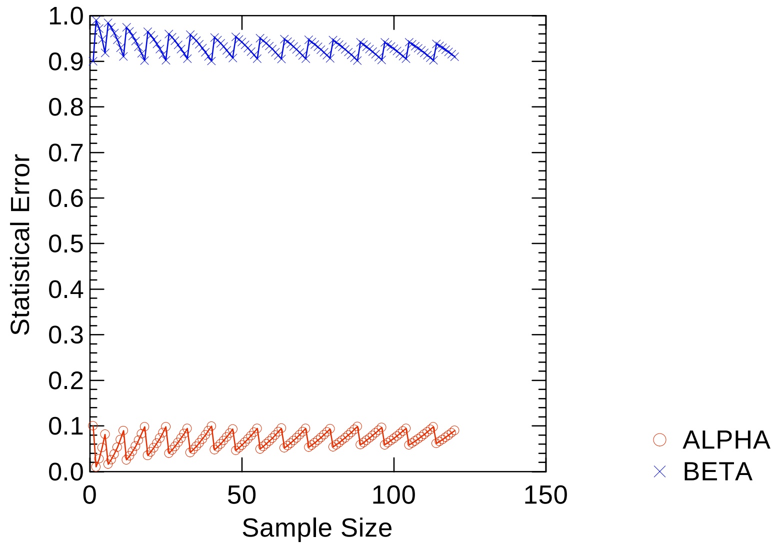
Scientists and decision-makers normally look for a high degree of confidence (i.e., a low α) in order to reject a null hypothesis. Any statistical conclusion that has a confidence level of less than 90 percent is considered not acceptable by most statisticians (Lin et al., 2000). Many states have selected 90 percent confidence for placement and removal of waters from the section 303(d) list (e.g., Arizona DEQ, 2000; Florida DEP, 2002; Texas, 2002; and Washington DEP 2002).

As used in the draft Listing Policy (SWRCB, 2003c), the binomial test effectively controls α, but not β. Figure 20 shows maximal statistical error rates associated with the draft Listing Policy for sample sizes up to 120. Type I error (α) is controlled at levels less than or equal to 0.10 for all sample sizes shown. The β error rate, however, is consistently greater than 0.90. In addition, larger sample sizes do not appreciably lower maximal β rates. Rates for β of 0.2 or less are generally desirable but are not achieved using this conventional hypothesis testing approach.

The top graph of Figure 20 emphasizes that when deciding not to list a water body (i.e., accepting the null hypothesis of H_o: $r \leq 0.1$) there is a high probability ($\beta > 0.90$) of "missing" a water body that should, in fact, be listed. This decision error is greatest when the true alternate exceedance rate is very close to, but greater than, the hypothesized exceedance rate of $r = 0.10$.

In contrast, the lower graph of Figure 20 emphasizes that when deciding to keep the water body on the section 303(d) list (i.e., accepting the null hypotheses of H_o: $r \geq 0.1$) there is a high probability ($\beta > 0.90$) of incorrectly failing to remove a water body from the section 303(d) list. Again, this decision error is greatest

LIST WHEN H_O: R ≤ 0.10 IS REJECTED



DELIST WHEN H_O: R > 0.10 IS REJECTED

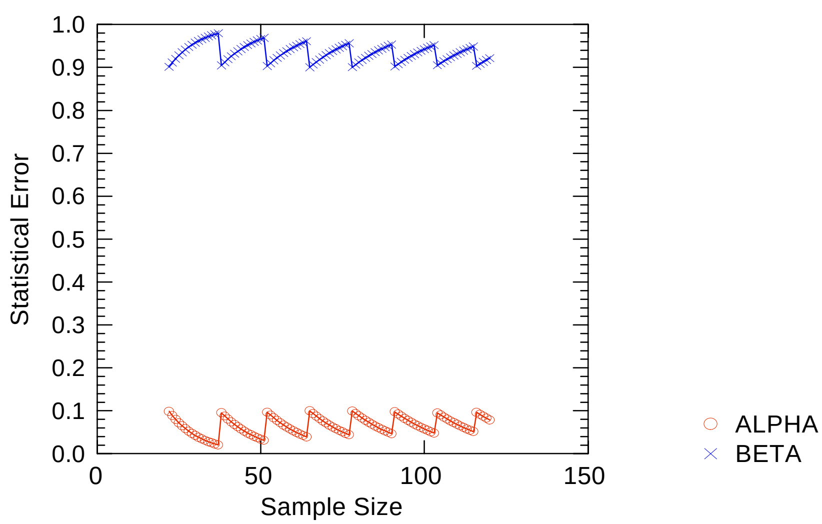


FIGURE 20: STATISTICAL DECISION-MAKING ERROR RATES FOR EXCEEDANCE FREQUENCIES USED IN THE DRAFT SWRCB POLICY (DECEMBER 2, 2003 VERSION).

when the true exceedance rate is very close to, but less than, the hypothesized exceedance rate of $r = 0.10$.

This alternative would allow section 303(d) decision making to proceed with greater than a one-in-ten chance of making a Type I error. In scientific research, confidence levels of at least 90, 95, or even 99 percent (i.e., $\alpha \leq 0.10, 0.05, \text{ or } 0.01$) are traditionally desirable. Using this alternative, the probability of missing real water quality problems is great.

3. Balance confidence level at 80 percent (i.e., $[1 - \alpha] = 0.80$) and power at 0.80 (i.e., $[1 - \beta] = 0.80$). Use a higher degree of confidence and power (90 percent) when removing toxicants from the list. The 80 percent confidence and 80 percent power levels are recommended under this alternative in order to balance the two types of errors (Types I and II) when sample sizes are expected to be relatively small (e.g., <30). A higher degree of certainty (i.e., 90 percent confidence and power) would be required when considering removing a toxicant from the section 303(d) list.

   The binomial test, like most statistical hypothesis testing procedures, will control the maximum α rate at a value below the nominal significance level for most sample sizes. In contrast, the magnitude of β depends on several factors, including α, the population variance, the effect size, and sample size. Generally, α varies inversely with β, and control of β is traditionally sought through the appropriate selection of sample size (Gibra, 1973) or through the use of a more powerful statistical test (Helsel and Hirsch, 2002).

   Alternatives to controlling only the α rate are possible. Mapstone (1995) argued against adhering to a fixed and arbitrary α, advocating instead for the consideration of economic, environmental, social, and political consequences of both α and β decision-making errors. In the absence of further information, Mapstone recommended that decision errors should be weighted equally, i.e., $\alpha = \beta$.

   If errors are made in the section 303(d) process, they could be costly. For example, if a TMDL is developed and implemented and the originally identified problem does not exist, the costs could run into the millions of dollars to address a non-problem. Conversely, if a real water quality problem is missed, the unidentified problem could have devastating impacts on beneficial uses of water unchecked by actions to control the problem. The loss of a beneficial use could also cost millions of dollars.

Each of these errors may be avoided by assessing the water quality situation more completely. In other words, if monitoring data were available to better assess water quality conditions then Type I and Type II errors could be minimized. The cost of minimizing these errors is the cost of performing the monitoring. The costs for monitoring many parameters addressed by the Listing Policy are presented in Tables 16 (toxicants) and 17 (conventional pollutants).

Depending on the parameter and the number of exceedances, monitoring costs range from just over $2,700 to nearly $68,000 per site to meet the minimum requirements for listing under the provisions of the Policy. For removing toxicants from the section 303(d) list the costs range from just under $38,000 to nearly $119,000.

The balanced error approach considers both types of decision-making errors, α and β, rather than only α. Another objective is to maintain these balanced error rates at or below an acceptable magnitude. Although USEPA (2002a) suggested that a moderate acceptable magnitude for balancing errors is 15 percent, the choice of values for α and β rates is a policy decision (Millard and Neerchal, 2001). Nevertheless, a pre-defined maximum acceptable error for both α and β will allow the determination of acceptable sample sizes to use for listing and delisting.

Appropriate sample sizes required to achieve the desired error rates are illustrated in Figures 21 and 22. If the effect size is 15 percent and both α and β rates at or below 0.20 then 16 samples for toxicants (Figure 21) and 26 samples for conventional pollutants (Figure 22) are needed. For removing toxicants from the list, if both α and β error rates at or below 0.10, then at least 28 samples are required. If the CALM Guidance-recommended balanced errors of 0.15 are used, then 29 samples for toxics (assuming a 5 percent and 20 percent exceedance frequency) and 33 samples for conventional pollutants are needed. At the USEPA-recommended α and β, monitoring costs would be approximately 21 percent to 45 percent greater (Table 16).

Use of the higher error rate (20 percent) is appropriate because the basis for the listing will be reviewed and corroborated by subsequent analyses performed in the course of developing the TMDL. In this situation, higher error rates are acceptable because the listing only initiates the planning process that may lead to implementation of more expensive management measures (Hahn and Meeker, 1991). Based on comments received at the September 8, 2004 SWRCB workshop, toxic pollutants can have large impacts on water quality and are of great public concern so it may be desirable to require more certainty (e.g., a lower, more restrictive error rate of 10 percent) when removing toxic pollutants from the section 303(d) list. This increased certainty however comes at a greater cost for monitoring but the costs are balanced by the assurance that when waters are removed from the list, a statistically valid and larger sample would be available to support the delisting. The cost of monitoring for toxicant delistings is 43 percent to 93 percent greater than the costs of monitoring for placement of the toxicant on the list (Table 16). Considering the environmental and social consequences as presented at the September 8, 2004 workshop, using this approach would reduce the chances for removing pollutants from the list before standards are truly achieved.

Figure 23 directly compares the selected balanced error sampling plans with the December 2003 Listing Policy (Alternative 2). By using the balanced error approach both α and β decrease appreciably with increasing sample size (N). Lowered α and β rates using the balanced error approach contrast sharply with the higher β error rates expected when using the traditional statistical tests such as the binomial test without balanced error rates.

For conventional pollutants (i.e., r_1 = 10 percent, r_2 = 25 percent), with sample sizes under 60, the balanced error plans require fewer exceedances to list a water body and allow more exceedances when delisting a water body. When sample size is greater than 60, a greater number of exceedances are needed to place a water on the section 303(d) list. This greater number of allowable exceedances may be an incentive for additional monitoring. The incentive for increase toxicant monitoring is the need for increased certainty when toxicants are considered for delisting.

This alternative is the preferred alternative because the errors are sufficiently low to identify water quality problems while at the same time balancing the potential costs of monitoring of conventional pollutants and toxicants (at sample sizes greater than 28) to identify real water quality problems. This proposal does not balance the costs of monitoring for toxicants at small sample sizes but, rather, requires that more information be used to support removal of these pollutants from the list. The error balancing

TABLE 16: ESTIMATED COSTS OF SAMPLING AND ANALYSIS FOR TOXICANTS USING 20 PERCENT ALPHA AND BETA FOR LISTING DECISIONS AND USING 10 PERCENT FOR DELISTING DECISIONS

Sample Type	Low Cost per Sample	High Cost per Sample	Listing				Delisting	
			2 samples (Low Range)	16 samples (Low range)	2 samples (High Range)	16 samples (High Range)	28 samples (Low Range)	28 samples (High Range)
Water Chemistry								
Metals w/WQ parameters	$1,364	$2,026	$2,728	$21,824	$4,052	$32,416	$38,192	$56,728
Organic w/WQ parameters	$1,722	$2,371	$3,444	$27,552	$4,742	$37,936	$48,216	$66,388
Tissue chemistry								
Metals w/WQ parameters	$1,354	$2,609	$2,708	$21,664	$5,218	$41,744	$37,912	$73,052
Organic w/WQ parameters	$1,992	$2,990	$3,984	$31,872	$5,980	$47,840	$55,776	$83,720
Sediment chemistry								
Metals w/WQ parameters	$1,241	$1,795	$2,482	$19,856	$3,590	$28,720	$34,748	$50,260
Organic w/WQ parameters	$1,992	$2,990	$3,984	$31,872	$5,980	$47,840	$55,776	$83,720
Toxicity Tests								
Water								
Saltwater w/WQ parameters 1 species to 3 species	$1,931	$3,904	$3,862	$30,896	$7,808	$62,464	$54,068	$109,312
Freshwater w/WQ parameters 1 species to 3 species	$2,130	$4,235	$4,260	$34,080	$8,470	$67,760	$59,640	$118,580

Sample Type	Low Cost per Sample	High Cost per Sample	Listing				Delisting	
			2 samples (Low Range)	16 samples (Low range)	2 samples (High Range)	16 samples (High Range)	28 samples (Low Range)	28 samples (High Range)
Sediment-water interface Saltwater w/WQ parameters 1 species	$2,096	$2,481	$4,192	$33,536	$4,962	$39,696	58,688	$69,468
Sediment Freshwater w/WQ parameters, sediment grain size 1 species, Low (Acute), High (Chronic)	$2,388	$3,031	$4,776	$38,208	$6,062	$48,496	$66,864	$84,868
Saltwater w/WQ parameters and sediment grain size, 1 species, Low (survival test), High (survival and growth test)	$2,400	$4,088	$4,800	$38,400	$8,176	$65,408	$67,200	$114,464

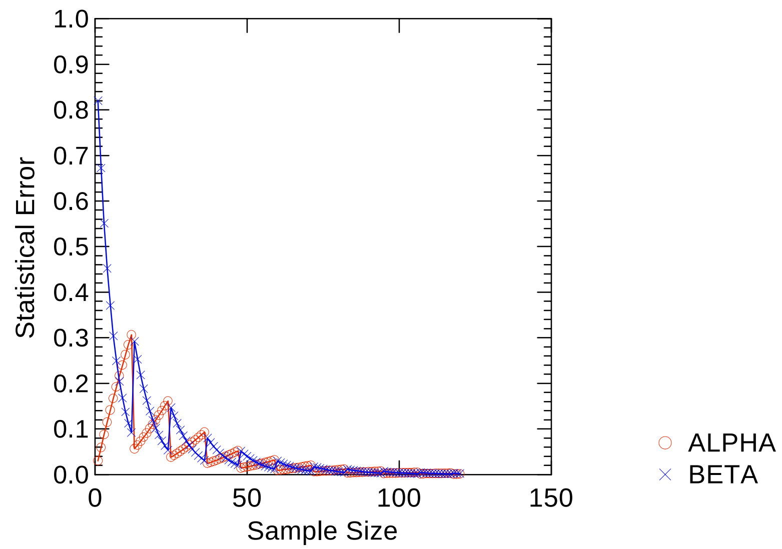
1. WQ Parameters include: DO; pH; temperature; conductivity; turbidity
2. Each sample type includes: sampling ranging from $788 (low) -$988 (high) per sample, chemical analysis or testing cost; water quality parameter and identification of pollutant when stated. For all bacteria and virus measurements five replicate samples are included for each sample.
3. Twenty percent of the cost for each sample type was added to cover the cost of data quality assurance.
4. Estimated costs per sample were based on the November 2000 Report to Legislature (SWRCB, 2000b) and SWAMP costs (SWRCB, 2003b).
5. Three samples are the absolute minimum number of samples needed to support a listing.

TABLE 17: ESTIMATED COSTS OF SAMPLING AND ANALYSIS FOR CONVENTIONAL POLLUTANTS USING 20 PERCENT ALPHA AND BETA

Sample Type	Low Cost per Sample	High Cost per Sample	5 samples (Low Range)	26 samples (Low range)	5 samples (High Range)	26 samples (High range)
Conventional Pollutants and Nutrients ortho-Phosphate, nitrate + nitrite, chloride; sulfate; nitrate (separate); nitrite (separate); ammonia; total P; TKP; chorophyll-a; alkalinity; TSS; TDS; hardness; TOC; DOC; DO; pH; temperature; conductivity; turbidity	$1,636	$2,068	$8,180	$42,536	$10,340	$53,768
Total/Fecal coliform bacteria	$1,186	$1,918	$5,930	$30,836	$9,590	$49,868
Enterococcus bacteria	$1,096	$1,738	$5,480	$28,496	$8,690	$45,188
Cryptosporidum/ Giardia	$1,306	$1,738	$6,530	$33,956	$8,690	$45,188
Enteric viruses	$1,456	$1,918	$7,280	$31,538	$9,590	$49,868
Coliform in shellfish	$1,000	$1,276	$5,000	$26,000	$6,380	$33,176

1. Costs for conventional pollutants alone could be less than reported because fewer exceedances are required.
2. Each sample type includes: sampling ranging from $788 (low) -$988 (high) per sample, chemical analysis or testing cost; water quality parameter and identification of pollutant when stated. For all bacteria and virus measurements five replicate samples are included for each sample.
3. Twenty percent of the cost for each sample type was added to cover the cost of data quality assurance.
4. Estimated costs per sample were based on the November 2000 Report to Legislature (SWRCB, 2000b) and SWAMP costs (SWRCB, 2003b).
5. Five samples are the absolute minimum number of samples needed to support a listing.

List when H_o: $r \leq 0.03$ is rejected



Delist when H_o: $r \geq 0.18$ is rejected

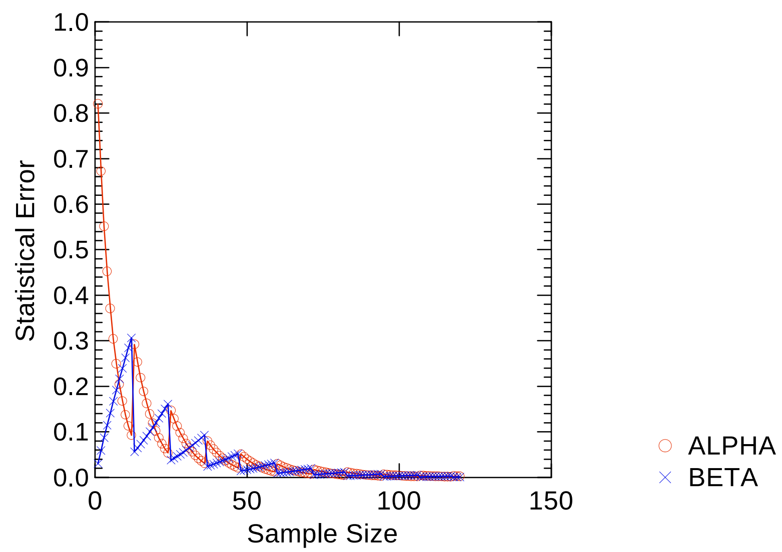
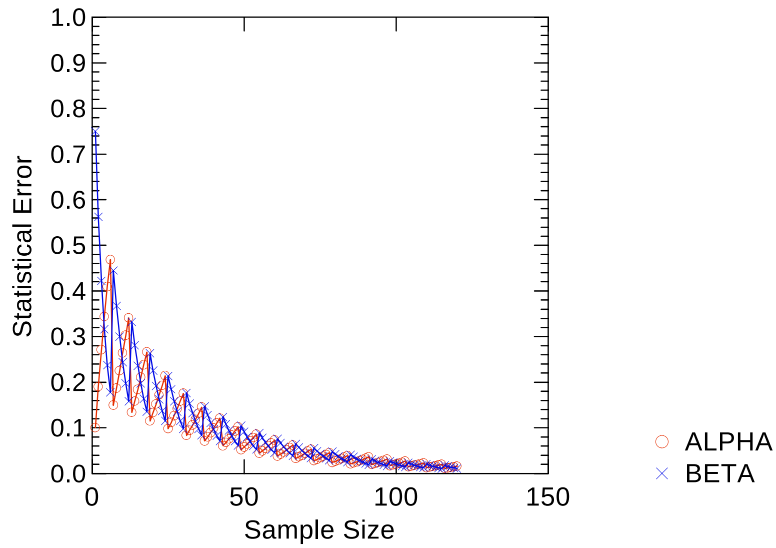


FIGURE 21: BALANCED ERROR RATES ASSOCIATED WITH THE SAMPLING PLAN FOR R_1 = 3 PERCENT AND R_2 = 18 PERCENT WITH EFFECT SIZE = 15 PERCENT.

LIST WHEN H_O: R $\leq$ 0.10 IS REJECTED



DELIST WHEN H_O: R $\geq$ 0.25 IS REJECTED

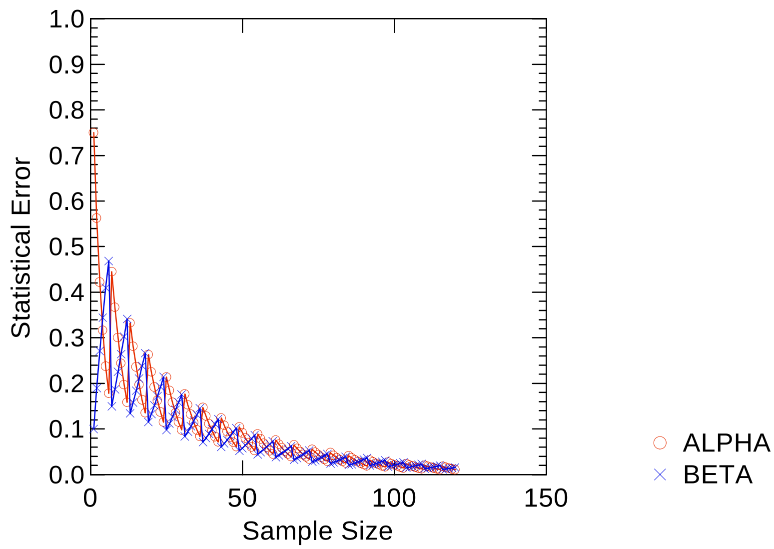
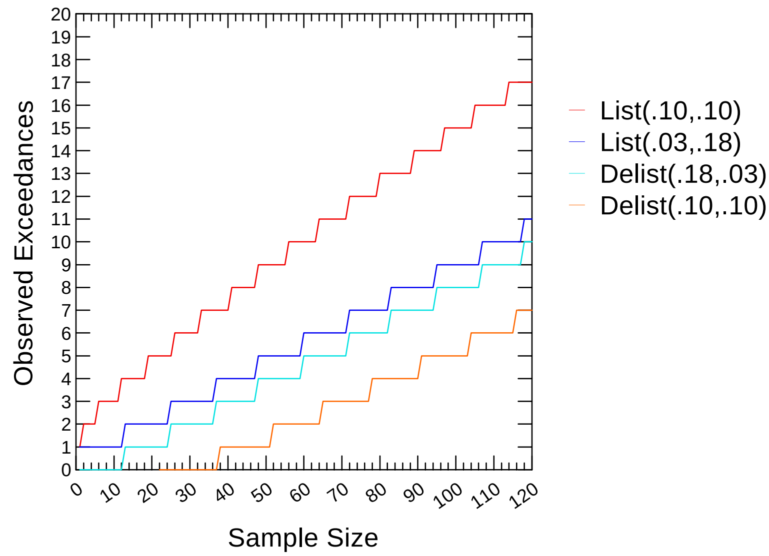


FIGURE 22: BALANCED ERROR RATES ASSOCIATED WITH THE SAMPLING PLAN FOR R_1 = 10 PERCENT AND R_2 = 25 PERCENT WITH EFFECT SIZE = 15 PERCENT.

Alternative 2 vs. Alternative 3



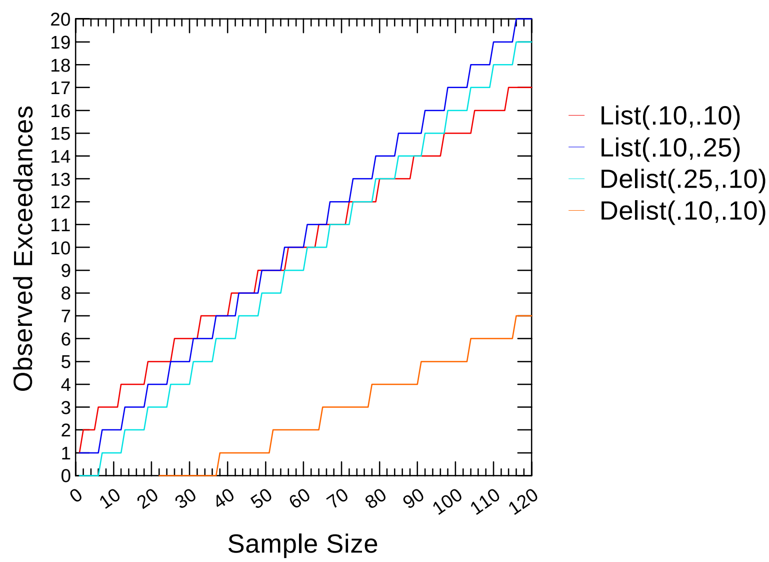


Figure 23: Comparison of December 2003 Version of Listing Policy versus Balanced Error Sampling Plans. Notation used is List(R_1, R_2) or Delist(R_1, R_2).

approach is an equitable way to decide whether a water body should be listed or delisted. Listing when sample size is lower than 16 for toxicants or 26 for conventional pollutants is discussed in Issue 6E.

4. A confidence level greater than ninety percent (i.e., [1 - α] > 0.90). Scientists and decision-makers normally look for a high degree of confidence (i.e., a low α) in order to reject a null hypothesis.

   This alternative decreases the likelihood of making a Type I error (e.g., to 5%, 1%, etc.). Many scientific, medical, or social researchers demand these levels of confidence for their investigations.

   Using a larger value raises the statistical bar, making it harder for data to be judged adequate. Because accurate water quality data are difficult to collect in great numbers, these standards may be too high. Also, as confidence is increased, power (1 - β; the rate of not making a Type II error) increases (if sample size is held constant). All of the limitations described in Alternative 2 when just Type I error is controlled applies to this alternative.

Recommendation: Alternative 3. See Policy sections 3 and 4.

Issue 6E: ***Minimum Sample Size***

Issue: What minimum sample size is required for section 303(d) listing and delisting?

Issue Description: If critical exceedance rate, effect size, Type I error, Type II error, and variance are held constant, the sample size has a large effect on expected errors. *Minimum* sample size allowed is critical to decision-makers because this value is an effective way to help control errors associated with making decisions based on sampled data.

Baseline: RWQCBs used minimum sample sizes ranging from one to ten samples.

Alternatives:

1. Provide no guidance in the choice of the sample size in the binomial distribution model. This alternative would grant RWQCBs the greatest flexibility in making section 303(d) list recommendations. The RWQCBs could choose to use the widest range of data sets submitted by public and agency sources. Information from resource-strapped data contributors would not necessarily be excluded.

   However, region-by-region listing methodology inconsistencies would not be addressed under this alternative. If very small sample sizes are used, error rates even if balanced, could be very high (i.e., greater than 20 percent).

2. Set a minimum sample size to control error rates at a specified level. USEPA guidance (2002a) identifies acceptable Type II error at 20 percent or less. Assuming a Type I error of 0.2 and a Type II error level of 0.2 (20 percent), the minimum sample size to place waters on the section 303(d) list would be set at 21 for toxics and 26 for conventional pollutants (Figures 21 and 22). Smaller sampling sizes could be used with this Type II error but the critical exceedance rate would have to be increased (USEPA, 2002a). For example, acceptable Type II error for a sample population of 10 requires a critical exceedance rate of at least 40 percent.

   Using a minimum sample size (such as 21 samples) would exclude numerous data sets used in previous listing cycles and would not be consistent with recent USEPA guidance (USEPA, 2003b). However, such a relatively large sample size could result in the data taking on a normal distribution. Investigators could then analyze the data with parametric statistical tests that may offer advantages over the somewhat less powerful binomial test.

3. Require a minimum sample size of 20 for measurements of chemicals in water and 10 for measurements of sediment, tissue, water toxicity, and

bacteria. For delisting, use minimum sample size dictated by critical exceedance rate and confidence level used in the statistical test. Smaller sample sizes are more prone to yield erroneous decisions to list (USEPA, 2003b). Even so, several states require the use of 10 or 20 samples to support listing decisions. Florida (Florida DEP, 2002), for example, requires at least 20 samples before a water segment is considered for placement on the section 303(d) list. Other states, such as Nebraska (2001) or Montana (2002) allows smaller sample sizes if the measurements integrate biological response or chemical concentration. While smaller sample sizes have a higher potential for error, this may be acceptable because the measurements are either integrative of environmental effect or exposure (toxicity or sediments), or the potential is higher that the measurement (tissue or bacteria) is indicative of potential human health impact.

Selection of a relatively small minimum sample size would allow RWQCBs to accept and use a larger number of data sets submitted for evaluation. Citizen monitoring groups and others with limited sampling budgets could still contribute information to section 303(d) listing efforts.

4. Do not require an absolute minimum number of samples. Use the number of samples that exceed water quality standards. Under this alternative, SWRCB would allow smaller sample sizes to be used if the frequency of sample exceedances is large, i.e., the number of exceedances is equal to or greater than the minimum number of samples identified using the balanced error approach with the exact binomial test (please refer to Issues 6A through 6D).

    One of the balanced error sampling plans (listing using 3 percent and 18 percent) requires 16 or more samples to keep both error types below 20 percent. Using this approach, two exceedances in 16 samples is the minimum exceedance needed to list a water body. If a decision rule is established to list if two or more exceedances are observed for any sample size less than 16, independent of the statistical sampling plan as recommended in Issue 6D, the α levels are always low and there is a small chance of incorrectly listing a clean water body (Figure 24).

    At the September 8, 2004 SWRCB workshop, comments were received stating that the use of small numbers of samples should be consistent with the provisions of water quality standards. USEPA interprets the California Toxics Rule (40 CFR 131.38(c)(2)(iii)) to mean that waters must be listed if there are two or more independent excursions of acute or chronic water quality standards within any 3 consecutive year time frame. Assuming two samples are representative of the three year time frame on average and are

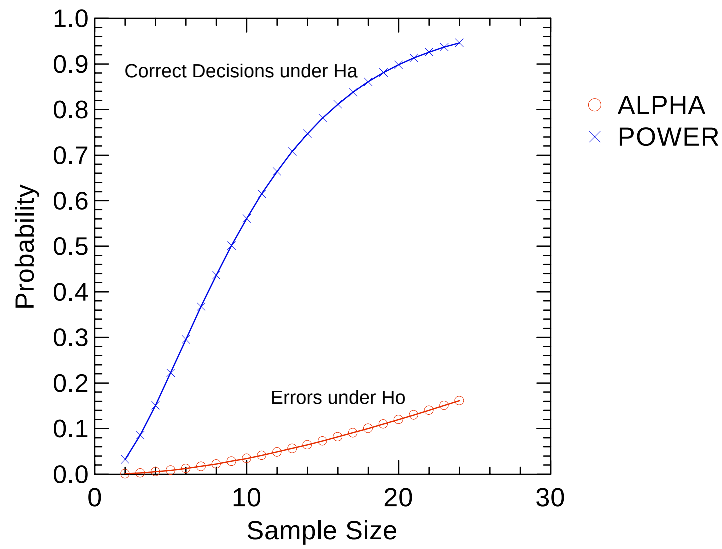


FIGURE 24: LISTING WITH TWO EXCEEDANCES

representative of the spatial characteristics identified for listing, then the Policy should allow a toxicant to be placed on the section 303(d) list if there are two exceedances in at least two samples.

The burden of proof is greater when using this rule, as compared to the balanced statistical sampling plan (as discussed in the previous issue papers). With smaller sample sizes, α levels are always low and there is a small chance of incorrectly listing a clean water body. However, β errors are high with these smaller sample sizes and there is a large chance of failing to list water bodies that are not meeting water quality standards.

The β errors comes from having small sample sizes that contain 0 or 1 exceedance, when we do not list with the decision rule (i.e., do not reject the null of $r \leq 0.03$). If listing occurs with two or more exceedances, a β error cannot be committed because the null hypothesis is always rejected. Therefore, with two or more exceedances in sample sizes between two and 16, inclusive, the only possible outcomes are α errors or a correct decision (i.e., power = 1- β). The correct decision rate depends on the alternative hypothesis proposed, in this case H_a: $r > 0.18$. For listing with two or more exceedances with $N = 2$ to 16, α errors are low, but power increases from <0.8 percent to 80 percent with increasing sample size.

The same relationship holds for the balanced error approach using 10 percent and 25 percent. The decision rule would be to list if five or more exceedances were observed in sample sizes between 5 and 25.

Using this approach, small sample populations are not excluded because the frequency of the observed excursions are high enough to support reliable attainment determination as long as the samples are spatially and temporally representative.

If these minimum sample sizes and minimum exceedance rates are used, it is likely that the number of decisions to list would be less than in 2002 (Figure 25). This alternative satisfies USEPA guidance (USEPA, 2003b) requiring rigid sample sizes not be used and that small data sets be included in deciding to place waters on the section 303(d) list.

Recommendation: Alternative 4. See Policy sections 3 and 4.

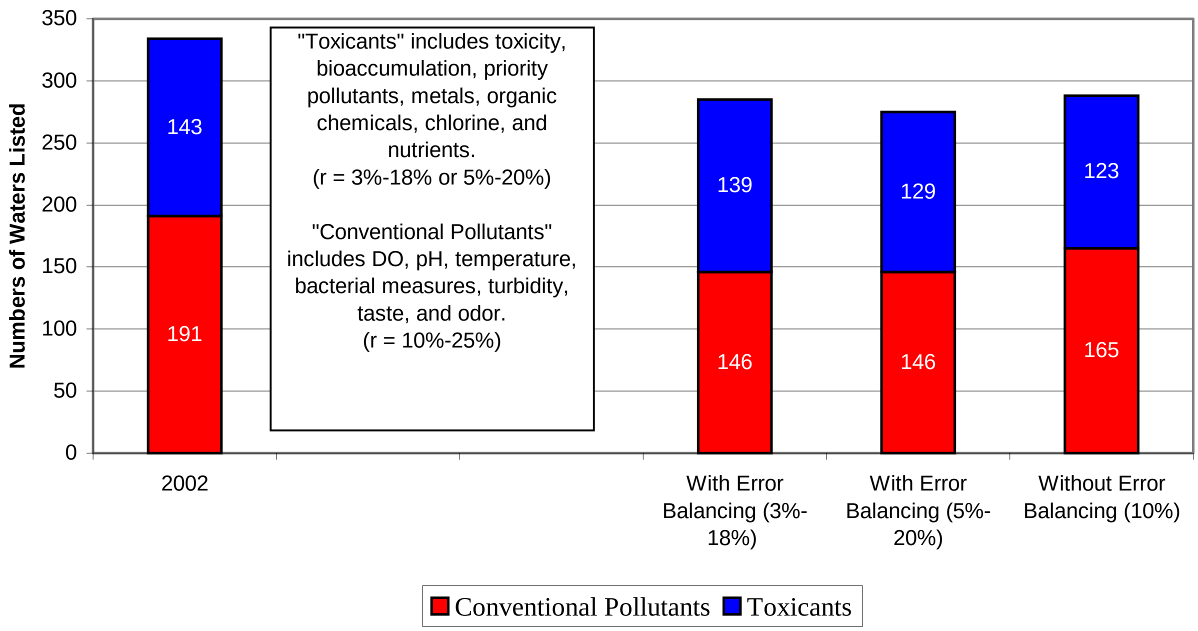


FIGURE 25: GRAPHICAL COMPARISON OF THE NUMBER OF DECISIONS TO PLACE WATERS ON THE SECTION 303(D) LIST.

Figure 25 was developed from the data and information analyzed during the development of the 2002 section 303(d) list (SWRCB, 2003a). The figure was develop using the following assumptions:

1. The "With Error Balancing (3%-18%)" bar incorporates the recommendations presented in Issues 6B, 6C, 6D, and 6E.
2. The "With Error Balancing (5%-20%)" bar incorporates the recommendations presented in Issues 6B; 6C, Alternative 4; and 6E. Errors are balanced at 20 percent.

3. The “Without Error Balancing (10%)” bar represents the recommended approach in the draft FED (SWRCB, 2003c) and Issue 6D, Alternative 2.
4. Sometimes the same data set is compared to multiple evaluation guidelines.

Figure 25 illustrates that 285 out of 334 listing decisions using acceptance sampling by attributes using the recommended *r* values and error balancing would support decisions to list. This suggests a possible 14.7 percent reduction in numbers of decisions to list waters as compared to the 2002 listing process.

Issue 6F: ***Quantitation of Chemical Measurements***

Issue: How should data measurements below the quantitation limit for the chemical measurement be interpreted?

Issue Description: One of the most difficult problems in the analysis of water quality data is the incorporation of measurements below analytical detection (nondetects) into statistical analysis. Water quality data often include observed measurements that are below or less than the quantitation limit (QL) of the analytical instruments. Measurements below the QL lies somewhere between zero and the detection limit. For some constituents, established water quality objectives or criteria lies below the QL.

Baseline: In 2002, the RWQCBs used several methods to evaluate nondetect data.

Alternatives:

1. Provide no guidance for interpreting data below the QL. The RWQCB would be given significant flexibility under this alternative. Guidelines would establish in the Policy for interpreting data below the QL. However, one of the goals of the Policy is to establish consistent guidelines for interpreting data. If guidelines were not established, different methods would likely be used statewide to analyze data that falls below the QL.

2. Provide general guidance to interpret values below the QL. Under this alternative, the Policy would present general guidance on interpreting analytical data that are below the QL. In order to obtain consistency statewide, general guidelines should be established.

   The following general guidelines could be used for interpreting data below the QL. If the exact binomial test is used with data below detection, it is not necessary to quantify the value. For detection levels below the water quality objective should always be judged as meeting water quality standards and the nominal value used would not be affected by the magnitude of the measurement. For measurements below quantitation and above the water quality objective, it cannot be determined if standards are attained and therefore a fundamental assumption of the binomial test is violated (i.e., there would be more than two outcomes). These measurements should not be evaluated using this test. The concepts for this approach are presented in Figures 26 and 27.

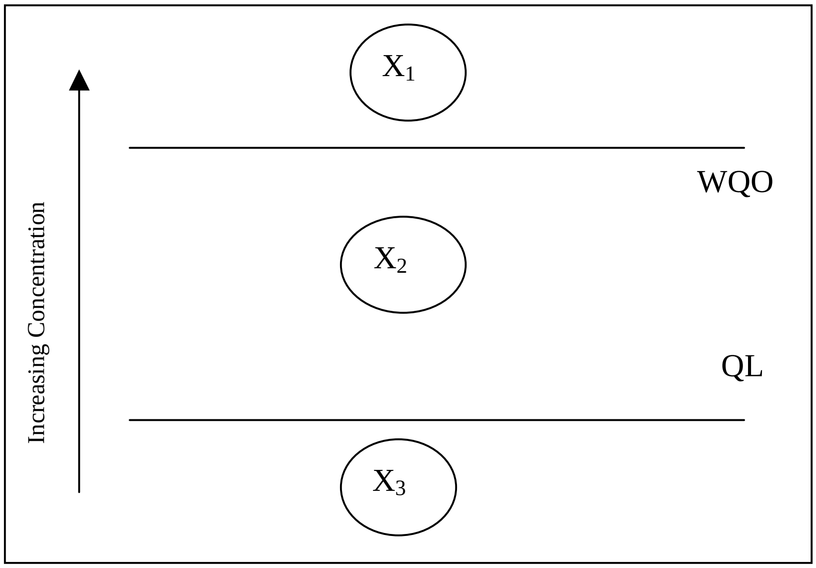


FIGURE 26: INTERPRETING DATA WHEN MEASUREMENTS ARE LESS THAN OR EQUAL TO THE QUANTITATION LIMIT (QL) AND THE WATER QUALITY OBJECTIVE IS GREATER THAN THE QL.

In Figure 26, X_1, X_2 and X_3 should be interpreted in the following manner (consistent with Gibbons and Coleman, 2001).

X_1: This value should be used in the analysis if the measured value is greater than the water quality objective and QL. If the data point is greater than the QL, the data can be quantitatively analyzed with suitable precision and accuracy. Additionally, if the data point is above the water quality objective, the water quality objective has been clearly exceeded. Therefore, the data point presents a valid assessment of the sample.

X_2 : This value would meet the water quality objective if the measured value is below the water quality objective and above the QL; there is a higher level of confidence that the measured value is the true value. If the data point lies above the QL, the data point is considered valid to use in assessments. However, since the value is below the water quality objective, it is not exceeded and the standard is met.

X_3: This value would meet the water quality objective because the data are less than or equal to the QL and the water quality objective is greater than the QL.

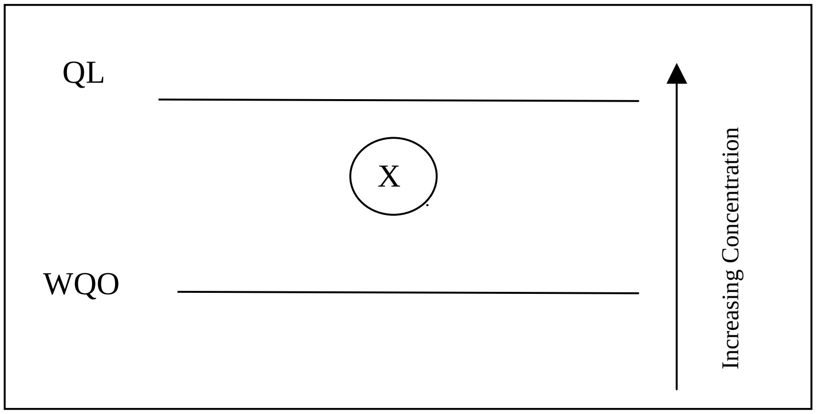


FIGURE 27: INTERPRETING DATA WHEN MEASUREMENTS ARE LESS THAN OR EQUAL TO THE QL AND THE WATER QUALITY OBJECTIVE IS LESS THAN THE QL.

In the circumstance presented in Figure 27, X should be interpreted in the following manner (consistent with Gibbons and Coleman, 2001). When the sample value is less than the QL but is greater than the water quality objective, the results should not be used in the statistical analysis. If the data value falls below the QL it is only an estimate of the true value. Therefore, it is unknown whether the estimated data value exceeded the water quality objective.

This alternative is the preferred alternative because it provides a consistent method for the incorporation of measurements below analytical detection (nondetects) into statistical analysis.

3. Use USEPA general guidance to interpret non-detects. USEPA (1998d) presents some general guidelines to evaluate data that include values below the detection limit (Table 18). However, there is no general procedure that is applicable in all cases.

TABLE 18: USEPA GUIDANCE ON INTERPRETATION OF MEASUREMENTS BELOW DETECTION

Percentage of Non-detects	Statistical Analysis Methods
< 15%	Replace non-detects with detection limit divided by 2, detection limit, or a very small number
15% - 50%	Trimmed mean, Cohen’s adjustment, Winsorized mean and standard deviation.
>50% - 90%	Use tests for proportions

The suggested procedures depend on the amount of data below the detection limit. For relatively small amounts of data below detection limits, replacing the non-detects with a small number or half the detection limit (DL/2) and proceeding with the analysis may be satisfactory. For moderate amounts of data below the detection limit, a more detailed adjustment (e.g., Cohen's adjustment, trimmed mean, Winsorized mean and standard deviation) is appropriate.

Cohen's method provides adjusted estimates of the sample mean and standard deviation that accounts for data below the detection limit. The adjusted mean are based on the statistical technique of maximum likelihood estimation of the mean and variance so that non detects that are below the detection limit but may not be zero are accounted for. Trimming discards the data in the tails of a data set, in order to develop an unbiased estimate of the population mean. For environmental data, nondetects usually occur in the left tail of the data, therefore, trimming can adjust the data set to account for nondetects when estimating a mean. Winsorizing replaces data in the tails of the data set with the next most extreme data value. In situations where relatively large amounts of data are below the detection limit, one needs only to consider whether the chemical was detected; the detection limit is subjective. The Test of Proportions is suggested if more than 50 percent of the data are below the detection limit but at least 10 percent of the observations are quantified. Therefore, if the parameter of interest is a mean, consider switching the parameter of interest to some percentile greater than the percent of data below the detection limit.

This alternative allows for flexibility in interpreting data below the QL. This could lead to inconsistencies in dealing with nondetect data and also potential misinterpretation of the data and inappropriate decision making because many statistical tests are influenced greatly by the number of measurements below detection.

Recommendation: Alternative 2. See Policy section 6.1.5.5.

Issue 7: Policy Implementation

In order to implement the provisions of the California Listing Factors, California Delisting Factors, and statistical analysis, several issues must be addressed in order for the process to be transparent and the listing approach consistent. These factors include:

A. Evaluation of existing listings

B. Defining existing readily available data and information

C. Soliciting data and information and approval of the list

D. Documentation of data and information

E. Data quality requirements

F. Spatial and temporal representation

G. Data age requirements

H. Determining water body segmentation

I. Natural sources of pollutants

Issues related to these topics are presented in Issues 7A through 7I.

Issue 7A: ***Review of the Existing Section 303(d) List***

Issue: What steps should the SWRCB and RWQCBs take to implement the Policy?

Issue Description: The Policy will ultimately define the factors to place and remove waters from the section 303(d) list. There are more than 1,800 water segment and pollutant combinations on the 2002 section 303(d) list that were included prior to the Policy's implementation. The State should review waters currently on the section 303(d) list for consistency with the Policy. However, the resources available to complete this task will limit the review of all listings before the next section 303(d) list is due.

Baseline: Since the inception of the California section 303(d) list, the SWRCB has used previous lists as the basis for the development of the biennial section 303(d) list. The 2002 section 303(d) list was no exception. The 1998 section 303(d) list formed the basis for the 2002 list submittal.

The SWRCB in 1998 and USEPA in 1999 approved the 1998 amendments to the list. At that time, the SWRCB and USEPA evaluated all the existing and readily available water quality-related data and information to make the listing decisions. For many of the listed water bodies, the SWRCB and RWQCBs did not receive new data or information. Therefore upon consideration of the 2002 list, the SWRCB had no new evidence with which to reexamine the 1998 section 303(d) list conclusions. In the absence of evidence that called the 1998 listing decisions into question, decisions based on the previous record, were included on the list.

Alternatives:

1. <u>Incorporate a requirement to revise the existing section 303(d) list so it is consistent with the Listing/Delisting Policy.</u> Under this alternative, the Policy would be applied to all existing listings of water segment-pollutant combinations on the 2002 section 303(d) list. If completed in one listing cycle, this alternative would be a monumental task. However, it is unlikely the SWRCB and RWQCBs would be able to complete this task within the next two years. There are not enough staff resources available to complete the extensive data and information review that would be required. To reduce the impact of a reevaluation, it would be necessary to divide the re-analysis into several parts, completed over a number of listing cycles.

   Listings that have yet to be reassessed would be carried forward on to the new section 303(d) list until all the reassessments are complete. After all waters have been reassessed, the updated version of the list would be used as the basis for subsequent lists. Future reassessment of waters should only be completed if new data and information become available.

This alternative would be staff resource intensive and could cause a delay in development of TMDLs.

2. Do not require that the entire section 303(d) list be reviewed. Only change the existing list if new data and information are available and indicate a change is needed. This alternative represents the baseline process. The advantage of this alternative is that the list could be reviewed within existing resources with minimal impacts on staff. The major disadvantage is that inconsistencies with the Policy would remain on the section 303(d) list until new information is available. Under this alternative, it cannot be determined when the State will completely reevaluate the section 303(d) list because of uncertainties in developing new data and information.

   In order to improve consistency in the re-evaluation of the section 303(d) list, the Policy could include a process for interested parties to request the reassessment when new information or a new data evaluation is available. Using the guidance provided in the Policy, an interested party would make a request to the appropriate RWQCB to reassess a listing. The interested party would describe the reason that the listing is inappropriate, provide evidence that the data and information for the original listing is inadequate, and provide the data and information necessary for the RWQCB to conduct the reassessment.

   This alternative would have minimal impact on RWQCB staff resources.

3. Reevaluate existing listings on the section 303(d) list as resources allow with no requirement for new data and information. (Combination of Alternatives 1 and 2). Water segments and pollutants on the section 303(d) list could be reevaluated, as resources allow, if the listing was based on faulty data or if data and information indicates that the waters would not meet listing or delisting requirements of the Listing Policy. This alternative assumes that the listing and delisting provisions of the Policy are applied (e.g., minimum samples sizes needed for removing waters from the section 303(d) list (Issue 6D)).

   An interested party would be able to request an existing listing be reassessed (whether new data are available or not) under the provisions of the Policy. To reduce the workload involved in evaluating the existing listings the request for reevaluation would include an assessment of all the readily available and existing data and information. In requesting the reevaluation, the interested party would be required to describe the reason(s) the listing is inappropriate, state the reason the Policy would lead to a different outcome, and provide the data and information necessary to enable the RWQCB and SWRCB to conduct the review.

The most recently completed section 303(d) list would form the basis for any subsequent lists.

The steps to complete a reevaluation would be:

- Evaluation of all readily available data and information to assess a water segment.
- In performing the reassessment the RWQCBs or SWRCB would use the California Delisting Factors to assess each water segment-pollutant combination.

This alternative is the preferred alternative because with the limited resources available, this alternative presents the most feasible means of reevaluating existing listings.

4. Do not state in the Listing Policy when or if existing listings are to be reevaluated. Under this alternative the Listing Policy would be silent on whether existing listings would be reevaluated. The advantage of this alternative is that RWQCB and SWRCB may not be impacted by requests for evaluation of previously listed waters. A disadvantage is that if the Policy is silent on this point and makes no provision for reviewing historical listings, RWQCBs may or may not view it as obligated or authorized to conduct such a review. This interpretation may lead to the continued development of TMDLs that may not be necessary. This last point may be mitigated by requiring a full reevaluation of listings as the first step in TMDL development.

Recommendation: Alternative 3. See Policy section 4.

Issue 7B: ***Defining Existing Readily Available Data and Information***

Issue: How should the SWRCB define existing readily available data and information?

Issue Description: Federal regulation requires the SWRCB and RWQCBs to assemble and consider all existing readily available data and information that will be useful in determining whether water quality standards are being met (40 CFR 130.7). To date, each RWQCB has used its judgment in identifying which data and information to use in its listing process.

The RWQCBs and SWRCB in the process of evaluating whether water quality standards are being met have traditionally relied on data and reports documenting specific environmental characteristics pertaining to the physical, chemical and biological conditions of each RWQCBs water bodies and watershed systems. The data and information reviewed has consisted of submittals as a result of the RWQCBs and SWRCB solicitation, selected data possessed by the RWQCBs and the SWRCB, and other sources.

Baseline: During the 2002 section 303(d) listing process, the RWQCB and SWRCB solicited all data and information from state and federal agencies and from the public to support updates of the section 303(d) list.

Alternatives:

1. <u>Only specify the possible sources of data and information; do not specify the major types of data.</u> Sources of existing and readily available information could include all data and information from federal, state, regional and local agencies, institutions, environmental and volunteer groups, private and public organizations, watershed groups, regulated dischargers, and private individuals. Data from SWAMP as well as other statewide ambient monitoring programs implementing appropriate QAPPs could also be used.

   The advantage of this alternative is that the RWQCBs and SWRCB are not burdened with evaluating reports that may not yield any new or unassessed data and information. The disadvantage is there may be inconsistencies in the amounts and types of information used in the listing process.

2. <u>Specify the types of data and information that will be solicited by the SWRCB and RWQCBs.</u> Under this alternative the RWQCBs would be required to review a set number of data and information sources. These sources of readily available data and information could include all data and information, preferably on paper or in electronic form, and from all available sources but at a minimum include:

- The most recent CWA section 303(d) list;
- The most recent CWA section 305(b) report;
- The most recent drinking water source assessments;
- Municipal Separate Storm Sewer System (MS4) monitoring reports;
- Information on water quality problems in documents prepared to satisfy Superfund and Resource Conservation and Recovery Act requirements;
- Data and information regarding fish and shellfish advisories, beach postings and closures, or other water quality-based restrictions;
- Reports regarding fish kills, cancers, lesions or tumors;
- Dilution calculations, trend analyses, or predictive models for assessing the physical, chemical, or biological condition of streams, rivers, lakes, reservoirs, estuaries, coastal lagoons, or the ocean.
- Water quality data and information from SWAMP or any other ambient monitoring programs;
- Data and information documenting water quality problems; and
- Existing and readily available water quality data and information reported by regional, local, state and federal agencies (including discharger-monitoring reports); citizen monitoring groups; academic institutions; and the public. Federal agencies would be actively solicited. These agencies could include: U.S. Department of Agriculture, NOAA, and U.S. Fish and Wildlife Service.

The disadvantage of this alternative is that RWQCBs and the SWRCB would be required to review reports that may not yield any new or unassessed data and information.

This alternative represents the preferred alternative because inconsistencies or questions about the amounts and types of information used in the listing process would be reduced.

Recommendation: Alternative 2. See Policy section 6.1.1.

Issue 7C: ***Process for Soliciting Data and Information and Approval of the List***

Issue: How should the SWRCB and the RWQCBs solicit readily available data and information and approve the CWA section 303(d) list?

Issue Description: Assembling all existing and readily available data and information is central in developing and revising the section 303(d) list. The RWQCBs have access to a number of sources of data. However, many federal, state, and local agencies, as well as the interested public, may have data and information that could be useful in developing the section 303(d) list. In the past, each listing cycle was initiated by the RWQCBs by soliciting interested parties for any readily available data and information regarding the water quality conditions in the surface waters of each region. This has been traditionally accomplished through public notices and local newspaper ads and letters from the RWQCBs to interested parties.

After existing data and information have been evaluated the approval process is initiated. Through a series of public hearings, each RWQCB assembles and approves a recommended section 303(d) list for submittal to the SWRCB. Subsequently, the SWRCB carries out a final review of the candidate regional lists and assembles a statewide list for final approval and submittal to USEPA. The final approval of the statewide list is accomplished through several public hearings, workshops and a board meeting where the final statewide CWA section 303(d) list is approved.

Baseline: For the 1998 section 303(d) list, SWRCB and the RWQCBs staff prepared guidance for the water quality assessment update for reviewing new monitoring information, soliciting information from state and federal agencies, and inviting the public to participate. RWQCBs' staff used the guidelines as the basis for the 1998 listing and delisting of water bodies, prioritizing and scheduling TMDLs, and public noticing procedures.

The development of the 2002 section 303(d) list was initiated by the RWQCBs request for readily available data and information in March 2001. After review of the data and information gathered, each RWQCB compiled their own list of water quality limited segment recommendations for submittal to the SWRCB. Each RWQCB submitted staff reports and lists to SWRCB, along with copies of public submittals, data and information, and documents referenced in the submittal. All documents were made available in the administrative record for public comment.

In May 2002, the SWRCB initiated a second data and information solicitation. The SWRCB staff reviewed the RWQCBs recommendations and developed fact sheets for each proposal to add water bodies, delete water bodies, and/or change the section 303(d) list. The 1998 section 303(d) list served as the basis for the 2002 section 303(d) list. Listings from 1998 were not reviewed or evaluated, nor were fact sheets developed unless new data was submitted.

Beyond the general information solicitation, state and federal agencies such as DFG, DHS, the National Marine Fishery Service (NMFS), and USGS were solicited for any new information. The SWRCB held three public hearings, a workshop, and Board meeting.

Alternatives:

1. Only the RWQCBs should solicit readily available data and information and manage the approval process for section 303(d) listing recommendations. The RWQCBs would initiate the listing process by soliciting all readily available information. The data and information request would cover all new and current information regarding water quality conditions of a water body or watershed, within the boundary of a particular region, since the last listing. The readily available data and information would consist of any data and/or written reports documenting specific environmental characteristics pertaining to the physical, chemical, and biological conditions of the region's water bodies and watershed systems. This would be the only data and information solicitation during the listing process.

   For the approval process, each RWQCB would develop a section 303(d) list and be responsible for holding public hearings to consider each proposed water body. After receiving testimony, each RWQCB would develop responses to all comments on the lists from the public and approve recommendations for each list. After, each RWQCB has approved their lists; they would submit them to the SWRCB. The SWRCB would assemble and approve the final section 303(d) list without review or change to any RWQCB recommendation. Once the final section 303(d) list has been approved by the SWRCB, the section 303(d) list would be submitted to USEPA for approval.

   Under this alternative, the RWQCBs will hold primary responsibility in making water body-pollutant recommendations pertaining to the section 303(d) list. This procedure has been conducted in the past and has lead to many inconsistencies in interpreting the data statewide.

2 Only the SWRCB should solicit readily available data and information for listing recommendations for transmittal to the RWQCBs and manage the list approval process. The SWRCB would initiate the listing process by soliciting all readily available data and information by following the procedures outlined in Alternative 1. Once the data was received, it would be sent to the RWQCBs. The major disadvantage of this alternative would be that much data and information available to the RWQCBs would not be

available to the SWRCB and, therefore, would not be included in the administrative record.

Once the RWQCBs received the data and information sent by the SWRCB, fact sheets would be assembled with the pertinent information for each potential water body-pollutant combination. All RWQCB-prepared fact sheets would be subsequently sent to the SWRCB for review and evaluation. The SWRCB would make recommendations for each water body-pollutant combination and assemble the statewide lists. The SWRCB would hold public hearings and workshops to hear testimony from the public. Written responses to public comments would be addressed by the SWRCB. The SWRCB would approve the list and submit the section 303(d) list to USEPA for approval.

Under this alternative, the RWQCBs would be limited in their participation in the section 303(d) listing process. The RWQCBs would only participate in assembling fact sheets and not participate in the recommendation process. Input from the RWQCBs is critical in the listing recommendation process, because they are the experts in their regions in regards to the condition of their water bodies. Without the RWQCBs expertise, the likelihood of making an inappropriate decision could be potentially high.

3. Both the SWRCB and RWQCBs would issue a combined data and information solicitation and manage the approval process. Under this alternative, both the SWRCB and RWQCBs would initiate the listing process by simultaneously actively soliciting all readily available data and assessment information on the quality of the surface waters of the state.

   In general, readily available data and information should include information from any interested party, including but not limited to: private citizens; public agencies; State and federal governmental agencies; non-profit organizations; and businesses possessing data and information regarding the quality of a region's waters. The solicitation would focus on absolutely all data and information that might be available. The Boards may place emphasis on recent data and information generated since the last listing. Readily available data and information would consist of any data and information in electronic and/or written reports documenting specific environmental characteristics pertaining to the physical, chemical and biological conditions of a region's water bodies and watershed systems.

   This alternative provides the best combination of regional and statewide data solicitation. Each RWQCB would focus on locating data and information for its region without the burden of soliciting information from agencies that may be statewide in scope. Data from state and federal agencies would be more efficiently solicited by the SWRCB.

Information solicited should contain the following:

- The name of the person or organization providing the information;
- The name of the person certifying the completeness and accuracy of the data and information and a statement describing the standards exceedance;
- Mailing address, telephone numbers, and email address of a contact person for the information provided;
- A paper copy and an electronic copy of all information provided. The submittal must specify the software used to format the information and provide definitions for any codes or abbreviations used;
- Bibliographic citations for all information provided; and
- If computer model outputs are included in the information, provide bibliographic citations and specify any calibration and quality assurance information available for the model(s) used.

Data solicited should contain the following:

- Data in electronic form, in spreadsheet, database, or ASCII formats. The submittal should use the SWAMP data format and should define any codes or abbreviations used in the database.
- Metadata for the field data, i.e., when measurements were taken, locations, number of samples, detection limits, and other relevant factors.
- Metadata for any GIS data must be included. The metadata must detail all the parameters of the projection, including datum.
- A copy of the quality assurance procedures.
- A paper copy of the data.
- Data from citizen volunteer water quality monitoring efforts require the name of the group and indication of any training in water quality assessment completed by members of the group. Data submitted by citizen monitoring groups should meet the data quality assurance procedures as detailed in section 6.1.4.
- For photographic documentation, adhere to the guidelines detailed in section 6.1.4.

The RWQCBs would evaluate all readily available data and information. They would assemble fact sheets with the pertinent information for each potential water body-pollutant combination. Public hearings would be held by RWQCBs to consider each proposed listing decision. The RWQCBs would provide written response to comments. The RWQCB would approve all recommendations for the section 303(d) list. Each RWQCB would submit to the SWRCB, all fact sheets along with a copy of the supportive documentation (e.g., data and information) for the recommendation, and all documentation and response to comments presented during the hearing process.

The SWRCB would review each RWQCBs water body fact sheet and recommendation to ensure that the Policy guidelines were followed. After review of the fact sheets and documentation, the SWRCB would add their recommendation to each water body fact sheet for the section 303(d) list. The section 303(d) list would then be made available to the public for review and comment. The SWRCB would hold workshops to consider all testimony presented by the public. The SWRCB would provide written responses to comments from the public and approve the list at a SWRCB meeting. Subsequent to SWRCB approval, the section 303(d) list would be submitted to USEPA for approval as required by the CWA. The supporting water body fact sheets would also be sent to USEPA as documentation of the recommendations for the section 303(d) list.

RWQCBs should consider the listing recommendations at workshops or hearings. This would provide an opportunity for the public to give comments on decisions and the RWQCB the opportunity to respond to those comments. This would allow RWQCBs to address contentious issues before they reach the SWRCB. A second review of each RWQCB fact sheet recommendation by the SWRCB would provide consistency in the listing recommendations statewide.

This alternative is the preferred alternative because it would allow for more consistency in the development of the section 303(d) list.

Recommendation: Alternative 3. See Policy section 6.1.2.1, 6.2, and 6.3.

Issue 7D: ***Documentation of Data and Information***

Issue: How should data and information be documented?

Issue Description: Evaluation of data and information for the listing of waters on the section 303(d) list is often complex. For listing decisions to be transparent, the assessment of data and information should be documented using a consistent format that allows the RWQCBs, SWRCB, and the public to understand the reasons for the proposed listings.

Documentation of proposed listings has varied widely. Some RWQCBs prepare fact sheets that support each listing proposal, while other RWQCBs summarize the rationale for listing in staff reports. The information provided to the SWRCB from the RWQCBs has varied considerably in content and format.

Baseline: For the 2002 303(d) list, SWRCB staff developed fact sheets for each water body and pollutant recommended by the RWQCBs for the section 303(d) list. All pertinent information needed to make the listing decision was outlined on each fact sheet.

Alternatives:

1. <u>Each RWQCB should be allowed to document their recommendations in a manner that they choose.</u> This alternative represents the status quo. RWQCB staff assembles the analysis of data and information in a manner that best informs each RWQCB of the recommendations for placement on the section 303(d) list. One advantage of this approach is that each RWQCB could tailor the documentation of their recommendations to the staff resources that are currently available. This approach would also likely result in no or minimal changes in RWQCB workload. The major disadvantage is that it would be difficult for the SWRCB staff to assemble the needed information in a consistent manner.

2. <u>Use a standard format for the documentation of data and information.</u> Under this alternative RWQCB would be required to submit summaries of the data and information used to support recommendations for the listing and delisting of waters in the categories recommended for the section 303(d) list. Depending on the amount of documentation, the development of fact sheets for each water segment and pollutant may increase the workload of the RWQCB and SWRCB staff. To minimize potential impacts on staff resources, fact sheets should only be prepared in circumstances where data and information are available. If the data show that standards are met, individual water body fact sheets could be used to summarize data for the many pollutants that meet standards.

   The fact sheets should contain the following summary information:

A. Region
B. Type of water body (bay and harbors, coastal shoreline, estuary, lake/reservoir, ocean, rivers/stream, saline lake, tidal wetlands, freshwater wetland)
C. Name of water body segment (including Calwater watershed)
D. Pollutant or type of pollution that appears to be responsible for standards exceedance
E. Medium (water, sediment, tissue, habitat, etc.)
F. Water quality standards (copy applicable water quality standard, objective, or criterion from appropriate plan or regulation) including:
   1. Beneficial use affected
   2. Numeric water quality objective/water quality criteria plus metric single value threshold, mean, median, etc.) or narrative water quality objective plus guideline(s) used to interpret attainment or non-attainment
   3. Antidegradation considerations (if applicable to situation)
   4. Any other provision of the standard used
G. Brief Watershed Description (e.g., land use, precipitation patterns, or other factors considered in the assessment)
H. Summary of data and or information
   1. Spatial representation, area that beneficial use is affected or determined to be supported, including a map, any site specific information, and reference condition.
   2. Temporal representation
   3. Age of data and or information
   4. Effect of seasonality and events/conditions that might influence data and/or information evaluation (e.g., storms, flow conditions, laboratory data qualifiers, etc.)
   5. Number of samples or observations
   6. Number of samples or observations exceeding guideline or standard
   7. Source of or reference for data and/or information
I. For numeric data include:
   1. Quality assurance assessment
J. For non-numeric data include:
   1. Types of observations
   2. Perspective on magnitude of problem
   3. Numeric indices derived from qualitative data
K. Potential source of pollutant or pollution (the source category should be identified as specifically as possible)
L. Program(s) addressing the problem, if known and any conditions of the enforceable program list met
M. Data evaluation as required by sections 3 or 4 of the Policy
N. Recommendation
O. TMDL schedule (developed only for the section 303(d) list as required by section 5 of the Policy).

This alternative is the preferred alternative because it provides a means to adequately document the data quality, guideline selection, and data quantity processes required by the Policy.

Recommendation: Alternative 2. See Policy section 6.1.2.2.

Issue 7E: ***Data Quality Requirements***

Issue: What data quality should be required?

Issue Description: A wide range of data has been used for section 303(d) listing and delisting of water bodies. Knowing the quality of data is essential in determining the strength of the recommendation to list a water body.

The quality of the data used in the development of the section 303(d) list should be of sufficient high quality to determine water quality standards attainment. Quantitative data are of little use unless accompanied by descriptions of sample collection, the analytical methods used, Quality Control (QC) protocols, and the degree to which data quality requirements are met.

Quality Assurance (QA) is an integrated system of management activities involving planning, implementation, documentation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected. QA consists of two separate but interrelated activities: QC and quality assessment. QC refers to the technical activities employed to ensure that the data collected are adequate, given the monitoring objectives to be tested. Quality Assessment activities are implemented to quantify the effectiveness of the QC procedures. QC is the overall system of technical procedures that measure the attributes and performance of a process, item, or service against defined standards.

To ensure that high quality data is produced in monitoring efforts, provisions are described in a Quality Assurance Project Plan (QAPP). A QAPP describes in comprehensive detail the necessary QA, QC, and other technical activities that must be implemented to ensure that the results of the work performed satisfy the stated performance criteria.

Baseline: In previous section 303(d) listing cycles, a large array of information and data were accepted. The quality of the data and information used was generally unknown. In 2002, if the RWQCB provided information on the quality of the data, it was recorded in the fact sheet.

Alternatives:

1. <u>Use all data of any quality or of unknown quality to make decisions to list/delist waters.</u> Data from major monitoring programs in California are considered to be of adequate quality. These major programs include SWAMP, the Southern California Bight Projects managed by SCCWRP, USEPA EMAP, SFEI-RMP, and the BPTCP. These monitoring programs/organizations follow and adhere to an established QA program.

However, there are many organizations, both private and public, that have monitoring programs, but the RWQCBs may not be familiar with the quality of their data. Data and information available from organizations and/or parties that did not submit data in previous listing cycles must also be considered. If all data and information are used to make listing decisions, the quality of the data needs to be determined to confidently make a judgment as to whether an impairment truly exists. These unknowns and/or concerns can be clarified with the development of data quality guidelines.

Data without rigorous QC can be useful in combination with high quality data and information. If data collection and analysis is not supported by a QAPP, or its equivalent, or if it is not known if the data is supported by a QAPP, then the data and information would not be used by itself to support listing or delisting of a water segment. These data would only be used to corroborate other data and information with an appropriate QAPP.

2. The SWRCB should provide general guidance on the quality of data that is acceptable for use in the section 303(d) listing process. The development of data quality guidelines would bring clarity and transparency to the process of using available data to determine if a water body segment warrants listing. Even though all data and information will be used, data supported by a QAPP should provide the needed data quality assurance that previous listing cycles lacked. Data that are supported by a QAPP pursuant to the requirements of 40 CFR 31.45 are acceptable for use in developing the section 303(d) list. QAPPs drafted in accordance with the provisions of the SWAMP Quality Management Plan also satisfy this requirement. Additional information about QAPP preparation is available from USEPA (2002d). If a QAPP is not available it would be also acceptable to use available information that is equivalent to the information contained in a QAPP.

   The QAPP (or its equivalent) should contain a discussion of the QA/QC practices associated with the following:

   - Short description of the monitoring project.
   - Sample collection program.
   - Sample preservation and transportation.
   - Field measurements.
   - Laboratory measurements.
   - Generated data handling.
   - Past data selection (if used).
   - Corrective actions.
   - Summary report at project end.

Data supported by a QAPP and/or from the major monitoring programs in California are acceptable for use in developing the section 303(d) list. If a discharger monitoring report has been determined to be adequate for assessing compliance with WDRs, no further review of the QAPP is necessary.

Numeric data are considered credible and relevant for listing purposes if the data set submitted meets the minimum QA/QC requirements outlined below. A QAPP should be available containing, the following elements:

- Objectives of the study, project, or monitoring program;
- Methods used for sample collection and handling;
- Field and laboratory measurement and analysis;
- Data management, validation, and recordkeeping (including proper chain of custody) procedures;
- Quality assurance and quality control requirements;
- A statement certifying the adequacy of the QAPP (plus name of person certifying the document; and
- A description of personnel training.

A site-specific or project-specific sampling and analysis plan for numeric data should also be available that contains:

- Data quality objectives or requirements of the project;
- Rationale for the selection of sampling sites, water quality parameters, sampling frequency and methods that assure the samples are spatially and temporally representative of the surface water and representative of conditions within the targeted segment of time of sampling; and
- Information to support the conclusion that results are reproducible.

The RWQCBs should make a determination in the fact sheets on the availability of a QAPP or equivalent, adequacy of data collection and analysis practices, and adequacy of the data verification process including the chain of custody, detection limits, holding times, statistical treatment of data, precision and bias, etc. If any data quality objectives or requirements in the QAPP are not met the reason for not meeting them and the potential impact on the overall assessment should be clearly documented because these issues may have a large bearing the usefulness of the data.

Data without rigorous QC (such as photographic documentation) could be used to corroborate other data and information with an appropriate QAPP or if justified as part of the situation-specific weight of evidence. For these narrative and qualitative submittals to be most useful, the submission should:

- describe events or conditions that indicate impacts on water quality;
- provide linkage between the measurement endpoint (e.g., a study that may have been performed for some other purpose) and the water quality standard of interest;
- be scientifically defensible;
- provide analyst's credentials and training; and
- be verifiable by the SWRCB or RWQCB.

For photographic documentation, the submission should:

- identify the date;
- mark the location on a general area map;
- either mark the location on a USGS 7.5 minute quad map along with quad sheet name or provide location latitude/longitude;
- provide a thorough description of the photograph(s);
- describe the spatial and temporal representation of the photographs;
- provide the linkage between a photograph-represented condition and a condition that indicates an impact on water quality;
- provide the photographer's rationale for the area photographed and camera settings utilized; and be verifiable by SWRCB and RWQCB.

This alternative is the preferred alternative because it includes procedures to ensure that data collected are of adequate quality to make decisions to place or remove waters from the section 303(d) list.

Recommendation: Alternative 2. See Policy section 6.1.4.

Issue 7F: ***Spatial and Temporal Representation***

Issue: How should spatial and temporal characteristics of the water bodies be addressed by the Policy?

Issue Description: Water quality assessment includes monitoring to define the condition of the water body, detect trends, and provide information to establish cause and effect relationships. Important aspects of an assessment are the interpretation and reporting of monitoring results and recommendations for future actions. One of the main components in the assessment of water quality is spatial and temporal representation of the water body segment.

In California, there are many water body types (e.g., lakes, rivers, coastal, estuaries and bay,) with varying degrees of climatic, geologic and/or geographic characteristics where pollutants (natural or unnatural) can have widely different effects on the aquatic and ecological environment. In addition, physical conditions (e.g., flow patterns, flow rate, depth, currents, storm event, wind, temperature, sunlight, etc.) can vary widely within a water body, as well as from one water body to the next. When collecting data and information from a water body, one needs to consider whether the data and information is representative of the water body segment during the assessment period.

Baseline: In previous section 303(d) listing cycles, spatial and temporal representation were considered on a case-by-case basis.

Alternatives:

1. RWQCBs should interpret spatial and temporal data on a case-by-case basis. Under this alternative, the RWQCBs would have significant flexibility in considering spatial and temporal factors in evaluating data for a water body segment.

   The advantage of this alternative is the RWQCBs would be able to consider the various kinds of physical conditions in the assessment of water body. A disadvantage is that the lack of general guidance could lead to inconsistencies among RWQCBs, depending on the expertise and experience of the staff preparing the water body listing assessment.

2. The Policy should establish specific guidance in considering spatial and temporal representation in the evaluation of data and information. Specific guidelines would be outlined in the Policy to consider spatial and temporal factors in evaluating data from the water body segment. One advantage is that more specific guidance could lead to greater consistency among RWQCBs.

3. The Policy should establish general guidance when considering spatial and temporal representation in the evaluation of data and information. Under

this alternative, the Policy would provide general guidance on evaluating data so that it is spatially and temporally representative of a water segment. The general guidance could focus on those factors that are necessary to meet the minimal assumptions of virtually any statistical test, namely that the sampling be temporally and spatially independent and that sampling is random (in the sense that the measurements are not biased).

To the extent possible, all samples used in the listing process should statistically represent the segment of the water body or collected in a consistent targeted manner that represents the segment of the water body.

In order to limit spatial dependence of samples, measurements collected within 200 meters of each other shall be considered the same station or location. This value is used by other states to represent a small water segment (e.g., Florida DEP, 2002). However, samples less than 200 meters apart may be considered to be spatially independent samples but these findings should be justified in the water body fact sheet. Samples from mixing zones should not be included as part of the data set because, in these areas, standards are allowed to be exceeded for short periods of time.

Samples should also be temporally representative of characteristics of the water body. For example, measurements used in the section 303(d) assessment should be temporally independent to satisfy the requirements of most statistical tests. If the majority of samples were collected on a single day or during a single short-term natural event (e.g., a storm, flood, and wildfire), the data should not be used as the primary data set supporting the listing.

In general, to make sure standards exceedances are recurrent, measurements should be available from two or more seasons or from two or more events when effects or water quality objectives exceedances would be clearly manifested. Sampling representation can be either over short or long periods of time or can be from multiple sources; in either case, the measurements should be combined. Measurements from ephemeral waters, during a specific season, or during human-caused events (except spills) should also be used to assess significant pollutant-related exceedances of water quality standards. Timing of the sampling should include the time of day in which the sample was taken and the critical season for the pollutant and applicable water quality standard, to the extent possible. To be transparent, the water quality fact sheet should describe the significance of the sample timing.

Water body specific information should also be reported when assessing the spatial and temporal representativeness of the available measurements. One of the most important factors is that listing decisions are supported by actual data from the segment. While this may be self-evident, there have been circumstances when waters with no monitoring data were listed because they had the same visual characteristics, as other waters with monitoring data that showed standards were not met. To avoid these situations, data used to assess water quality standards attainment should be actual data that can be quantified and qualified. Information that is descriptive, estimated, modeled, or projected should only be used as ancillary lines of evidence for listing or delisting decisions. At a minimum, data should be measured at one or more sites in a water segment to justify listing the water.

If applicable information is available, environmental conditions in a water body or at a site should also be taken into consideration. Water quality is affected greatly by season, events such as storms, the occurrence of wildfires, land use practices, etc. In addition, there are a variety of factors that affect measurements of water quality conditions including: (1) depth of water quality measurements, (2) flow, (3) hardness, (4) pH, (5) the extent of tidal influence (if coastal), and (5) other relevant sample- and water body-specific factors. Information related to these factors should be included in the fact sheet if it is available so interested parties can more clearly understand their influence.

This alternative is the preferred alternative because it would provide general statewide consistency in evaluating spatial and temporal representation of water body segments. Another advantage is that RWQCB would still have considerable flexibility to use professional judgment in assessing what the available data and information represent.

Recommendation: Alternative 3. See Policy sections 6.1.2.2, 6.1.4, 6.1.5, 6.1.5.1, 6.1.5.2, and 6.1.5.3.

Issue 7G: ***Data Age Requirement***

Issue: Should older data be used to support decisions to place or remove waters from the section 303(d) list?

Issue Description: An underlying assumption of the listing process is that the data and information assessments represent current conditions in States waters. If very old data are used to make assessments, it is possible that the data do not represent current water quality conditions. Another confounding factor is that as sampling and analysis methods improve, older data may be less relevant or not comparable to newer data and information.

For each data set, RWQCBs and SWRCB must determine how much of the data collected is relevant to the decision to list or not list the water body. If data are representative, it is likely that the decision will be correct. Unrepresentative data will likely result in incorrectly placing or not placing a water body segment on the section 303(d) list. This could result in the unnecessary expenditure of public resources or missing a problem completely.

Many states require that the data and information used to justify a listing decision be reasonably current, credible, and scientifically defensible. The range of older data allowed in these programs is generally from 5 to 10 years.

Baseline: All data and information of any age were used in the development of the 2002 section 303(d) list.

Alternatives:

1. Establish guidance on the age of data acceptable for listing. Under this alternative, the Policy would provide general guidance on the age of the data used in the listing decisions in order to provide some assurance that the data used are reasonably representative of water quality conditions.

   Some states use data and information that is no more than five years old, with older data being used on a case-by-case basis (e.g., Arizona); while others allow for older data to be used (e.g., Florida allows data to be 7.5 years old). As with California, some states use any available data and information because little data or information is available on many state waters.

   A disadvantage of requiring the use of recent data only is that some data takes years to make its way through the peer review process and the results may not be available until the age requirement has past. For example, peer review and reporting of USGS data may take years to get through the review process. If data age requirements were too short otherwise high quality data would not be available to be used in the section 303(d) process.

General guidelines could be provided in the Policy on the age of the data but the RWQCBs should have flexibility in determining the circumstances of when to include older data and information. When reviewing the data (both newer and older), the RWQCBs should take into consideration temporal factors that could assist in determining whether the water quality problem is persistent or recurrent. Seasonal or year-to-year variations in the transport of the pollutant should be considered when reviewing the data and information.

Generally, listing decisions could be limited to using only the most recent ten-year period of data and information for water chemistry and sediment chemistry information. Data older than ten years would then only be used on a case-by-case basis. Older data could be used in conjunction with newer data, to demonstrate trends or if the conditions in the water body have not changed. In the interest of making listing decisions transparent, the reason(s) for using older data could be described in the water body fact sheet. In any case, older data should meet all data quality requirements presented in the Policy.

2. Use data and information, regardless of age, to determine which data should be used in the section 303(d) list assessments. The use of all data and information, regardless of age, ensures that all readily available data and information is used. However, older data may not represent current water quality conditions or may reflect the result of less precise laboratory analytical procedures. Under this alternative, no preference is given to current information so older, perhaps unrepresentative, data may bias the decision-making process.

   Older possibly unrepresentative data could identify a water body segment as not meeting standards, when standards are in fact met, or may identify a water body segment as meeting standards, when in fact, standards are not met.

   Using older data and information can provide context for newer data, such as characterizing trends or checking for compliance with antidegradation provisions, provided precautions are taken to avoid inappropriate interpretation of the data. Older data can be used to represent current conditions if it can be established that the water body has not changed over time. Conversely, if data are available before and after a change in the water body setting (e.g., a cleanup has been implemented or new permit conditions exist), it may be appropriate to base assessments on only the most recent data. Older data may be very useful in reevaluating previous listing decisions if guidelines or numeric objectives are enacted or revised subsequent to the previous listing cycle and reassessment based on those data yield different findings of attainment of water quality standards.

If the Policy allows the use of all data, whatever the age, it becomes incumbent upon the RWQCBs to use their judgment to assess the reliability and quality of the data. All data should meet the data quality and quantity requirements as specified in the Policy.

This alternative represents the preferred alternative because all data and information should be used to make section 303(d) listing decisions. If older data are all that is available it should be used to decide if the water should be listed or delisted.

Recommendation: Alternative 2.

Issue 7H: ***Determining Water Body Segmentation***

Issue: How should water body segments be identified?

Issue Description: Basin Plans list water bodies within each region and establish water quality objectives to protect beneficial uses from degradation. In some instances, beneficial uses and water quality objectives apply to entire hydrologic units or areas; in other cases, Basin Plans identify water bodies individually by name, dividing some rivers into segments. For each watershed, water body and segment, beneficial uses are designated. In some Basin Plans, assigned beneficial uses of an identified water body are extended to all of its unlisted tributaries.

In developing the section 303(d) list, the evaluation of available data determines whether exceedances of water quality standards have occurred. Information on monitoring strategy, number of samples and the spatial representation of the samples determine the extent of the water quality impact within the water body. Together, this information determines if water quality impacts extend to whole watersheds, specific tributaries, whole water bodies, or specific sub-segments of a water body.

In order to make credible decisions about the extent of the water quality limited segment, a balance is needed between: (1) considering all grab samples to be representative of merely the cubic foot of water from which they were taken, and (2) assuming each grab sample is representative of conditions over hundreds of stream miles or thousands of lake acres (USEPA, 2003b).

Baseline: Identification of water quality limited segments during previous section 303(d) listing cycles varied between RWQCBs. Generally, RWQCBs based their listings on their Basin Plan surface water segmentation classifications by either listing according to hydrologic unit, area, and sub-area or by listing on the basis of water body type and name. Some RWQCBs added water body segments not identified in Basin Plans. Other RWQCBs established listings throughout watersheds even if the data indicated only a portion of the water body or segment was impacted.

Alternatives:

1. Use adopted Basin Plan water body listings to determine where water quality standards are not being met. Allow identification of new segments if warranted. Under this alternative, RWQCBs would list water bodies or segments in accordance with the segmentation approach used in the Basin Plans but would be allowed to further divide waters if warranted. In the absence of an adequate segmentation system, the RWQCBs would be encouraged to use professional judgment to define distinct reaches based on hydrology (e.g., stream order, tributaries, dams, or channel characteristics) and relatively homogeneous land use.

If available data suggest that a pollutant may cause an excursion above a water quality objective, the RWQCB should, if the information are readily available, identify land uses, subwatersheds, tributaries, or dischargers that could be contributing the pollutant to the water body. The RWQCBs would be encouraged to identify stream reaches or lake/estuary areas that may have different pollutant levels based on significant differences in land use, tributary inflow, or discharge input. Based on these evaluations of the water body setting, RWQCBs would aggregate the data by appropriate reach or area.

Another important factor is the area impacted in each segment. While CWA section 303(d) and associated federal regulations do not require estimation of the extent of the impacted water segment, this information is useful in determining the scale of the reported standards exceedance in the water quality limited segment. The length or area of estimated impact should be based on the data used to establish the listing and the extent should be limited to the length or area represented by these data.

Consequently, water segments should not be placed on the section 303(d) list unless data support this finding. Data should be measured at one or more sites in the water segment in order to place the water body on the section 303(d) list. Segments should only be placed on the list if the listing is backed by data.

This would reduce controversies regarding extent (miles or acres) estimates where impairment may be occurring because the data would be evaluated in the context of the measurements or samples, land use, and nature of the pollutant source.

This alternative is the preferred alternative because by establishing segments in this way, confusion would be avoided regarding applicable designated beneficial uses, the name of the segment, and the size and boundaries of the affected segment.

2. <u>List entire segments or watersheds if any data in the watershed show impacts.</u> The primary purpose of listing water bodies under section 303(d) is to identify water body segments within a region where water quality standards are not met. If waters are found to not meet standards in one part of a watershed it is possible that other parts of the watershed are similarly impacted. A conservative approach would be to list all segments of a watershed, even if data are available showing a small part of the watershed is impacted.

   Using watershed classification to list water bodies for designating beneficial uses and water quality objectives might provide broad comprehensive protection to the waters within each RWQCBs jurisdiction. Broad protection of water quality was originally generated by the CWC section 13240 that requires RWQCBs to "adopt water quality control plans for *all areas* within the region." [*emphasis added*], and is buttressed by an interpretation of the definition of waters of the United States to mean that the standards of tributary waters are at least as stringent as the standards established for the waters to which they are tributary. When the Basin Plans were established, each RWQCB designated beneficial uses for most waters within the region. However, it was not possible to survey the beneficial uses of all waters of the state or even list all waters of the state. In order to provide full protection to unnamed water bodies, the Basin Plans typically include a statement which generally applies the beneficial uses of any specifically identified water body to all of its tributaries.

Such extension of protection of designated beneficial uses to all waters within a region is appropriate but the application of the same approach when developing the section 303(d) list is questionable. Identification of water quality limited segments is based on an assessment of site-specific monitoring data that documents a site within a water body segment where standards may not be attained.

Site-specific data documenting water quality impacts cannot apply to entire watersheds unless the monitoring data covers an entire watershed. The extension of documented water quality impacts to entire watersheds because beneficial uses are deemed applicable to the entire watershed, is not warranted unless it can be shown that the data are representative of the entire watershed.

Recommendation: Alternative 1. See Policy section 6.1.5.4.

Issue 7I: ***Natural Sources of Pollutants***

Issue: How should SWRCB address natural sources of pollutants under CWA section 303(d)?

Issue Description: Basin Plans address water quality problems caused or exacerbated by human activities. Natural processes can also cause water quality problems, which usually cannot be controlled. Many Basin Plans contain language distinguishing between controllable water quality factors that result in degradation of water quality and those factors that are not controllable. Controllable water quality factors are those actions, conditions, and circumstances resulting from human activities that may influence the quality of the waters of the state and may be reasonably controlled. Uncontrollable factors include those conditions caused by natural processes.

Baseline: During the 2002 section 303(d) listing process, a number of Lahontan RWQCB (Region 6) water bodies not meeting water quality standards for a particular pollutant originating from natural sources were removed from the 303(d) list.

Alternatives:

1. Place water bodies not meeting water quality standards due to natural sources on the section 303(d) list. Under this alternative, there would be no guidance regarding impacts relative to natural sources. This would provide the RWQCBs with the flexibility to add, remove, or not list waters depending on whether standards are exceeded and without regard to sources or types of pollutants. Water bodies recommended for section 303(d) listing in the future or existing listings recommended for removal from the list due to natural sources would require review and approval by the SWRCB.

   Once listed, the water body would be prioritized and scheduled for possible TMDL development. This could result in an attempt to control a pollutant loading originating from a natural uncontrollable source. Pollutants originating from natural sources are beyond the SWRCB and the RWQCB capabilities to correct.

   This alternative is the preferred alternative because water quality standards would be interpreted as they exist in plans and regulations and would not be judged relative to the feasibility of TMDL development or source of pollutants.

2. Do not place water bodies exceeding water quality standards due to natural sources on the section 303(d) list. Under this alternative, water bodies not meeting water quality standards due to natural sources would

not be listed on the section 303(d) list. Any waters previously listed would be removed from the section 303(d) list during subsequent listing cycles.

Under this alternative, it would have to be demonstrated that natural conditions or processes cause a segment of a water body to be considered a water quality limited segment. Documentation must address the natural source(s) of the substance and explain why human causes can be ruled out as the cause of the water quality limited segment. Human-caused sources (i.e., “waste” as defined in CWC section 13050(d) or “pollution” as defined in CWC section 13050(l) and 40 CFR 130.2(c)) can generally be ruled out where the excursions beyond objectives would occur in the absence of the human caused sources.

For example, the densities of fecal and total coliform in urban runoff can come from natural and human sources. It is not possible to determine *a priori* without site-specific study if the source is not a result of human activity. Consequently, it is appropriate for these waters to be listed and the portion of the contamination due to natural sources is determined during the development of the TMDL.

Another example is metal concentrations in some saline and geothermal waters. Because of its geological history, the Lahontan Region has a number of water bodies with concentrations of salts and/or toxic trace elements such as arsenic, which exceed drinking water standards or criteria for protection of freshwater aquatic life and wildlife. These waters include inland saline (desert playa) lakes and geothermal springs. Past state and federal guidance led to listing of a number of Lahontan Region waters which are "impaired" only by natural sources. As documented in the 2002 section 303(d) list staff report (SWRCB, 2003a), saline and geothermal waters are unique ecosystems with their own degree of physical, chemical, and biological integrity, and support aquatic life and wildlife adapted to extreme environmental conditions. These waters should not be judged as not meeting water quality standards on the basis of freshwater aquatic life criteria.

For the above reasons, water body-pollutant combinations would not be placed on the section 303(d) list if the excursion beyond standards occurs in the absence of any human-caused sources. Even though standards are not met in this instance, a TMDL is not required.

Waters could be recommended for listing even though a portion of the identified pollutant(s) are probably of natural origin because there is a high potential for human-caused sources to contribute to the excursion above standards.

Recommendation: Alternative 1.

Issue 8: Priority Ranking and TMDL Completion Schedule

Issue: How should priority ranking and TMDL scheduling be established for water quality limited segments?

Issue Description: CWA section 303(d) requires that states develop a priority ranking of listed water bodies to assist in guiding TMDL development. Federal regulation further requires that the priority ranking specifically include the identification of waters targeted for TMDL development within the next two years.

In 1998, the SWRCB and RWQCB ranked water bodies as high, medium, or low priority for TMDL development. A general set of criteria associated with the importance and extent of the beneficial use threatened, degree of impairment, potential for beneficial use recovery, public concern and available information was applied. Once priority ranking was established, TMDL scheduling was based on considerations of available resources, watershed management initiative concerns, and attainability of the TMDL schedule. The TMDL development schedule was further divided into three separate categories. Level 1 waters were targeted for TMDL development over the next two years; Level 2 waters were targeted for TMDLs to be initiated over the next five years; and Level 3 waters were tentatively scheduled for TMDL completion over a period of 13 years. As a result of this priority ranking and scheduling approach, not all-high priority waters were targeted for TMDL development within two years.

Baseline: In the 2002 listing process, factors such as importance and extent of beneficial uses threatened, degree of impairment, potential for beneficial use recovery, public concern, and available information were considered. However, the resources available within the next two years were used to determine if a water body should be ranked as high priority for TMDL development. The approach taken during the 2002 listing process linked priority ranking with TMDL development schedules. Subsequently all waters determined to be high priority were also scheduled for TMDL development within the next two years.

Alternatives:

1. Do not include a priority and schedule setting method in the Policy. Under this alternative, each RWQCB would be allowed to establish priority and schedules for TMDL development depending on their needs, priorities, and resource availability and not necessarily in accordance with the water body priority ranking. There would be no link between priority of the water, as far as severity of impact to beneficial uses or the significance of the water body, and the need to develop a TMDL to achieve improvements in water quality. Therefore, water bodies with a

high priority ranking may not necessarily be scheduled for TMDL development.

2. Use general prioritizing and TMDL schedule setting factors used by the SWRCB in the 2002 listing process. Under this alternative water quality limited segments would be priority ranked and scheduled for TMDL development based on the following considerations:

   - Resource availability;
   - What is achievable within the next two years;
   - The importance and extent of the beneficial uses threatened;
   - Degree of impairment;
   - Potential for beneficial use recovery;
   - Public concern; and
   - Available information.

   By considering these issues, a link is established between priority setting and TMDL scheduling. This allows only those waters ranked high priority to be scheduled for TMDL development within the next two years.

3. Establish a schedule for TMDL completion without prioritizing water bodies according to the severity of the impacts, the significance of the water body, and the need to develop a TMDL. CWA section 303(d) requires the establishment of a priority ranking for waters identified for TMDL development. However, in recent guidance, USEPA (2003b) has stated that the development of such priorities and schedules should be as practical and expeditious as possible. Thus, USEPA has indicated that listed waters do not need to be classified as high, medium, or low priority and suggested that the established TMDL schedule, in and by itself, could reflect TMDL priority ranking.

   Under this alternative, a schedule would be established for waters on the section 303(d) list that would identify TMDLs that will be developed within the current listing cycle and the number of TMDLs scheduled to be developed thereafter. The schedule would reflect the State's priority ranking. Based on factors provided by the Supplemental Report of the 2001 Budget Act, each RWQCB would use their professional judgment to determine when TMDLs are scheduled for completion. It would not be necessary to identify each TMDL as a high, medium, or low priority as long as a schedule is established. The Policy would identify TMDLs scheduled for development as required by federal law and regulation (currently federal regulation requires a schedule for developing TMDLs in the next two-years). Since resource allotments can not be predicted more than one or two years into the future, schedule dates beyond two years would be considered estimates. USEPA guidance (2003b) recommends schedules no longer than 8 to 13 years but because resource commitments cannot be established over such a long period of time, no limit on completion time frame should be established in the Policy.

When developing the TMDL-completion schedule for waters needing TMDLs, RWQCBs should take into consideration factors articulated in the Supplemental Report to the 2001 Budget Act related to TMDL priority setting and scheduling. These include but are not limited to the following criteria:

- Water body significance (such as importance and extent of beneficial uses, threatened and endangered species concerns, and size of water body);
- Degree that water quality objectives are not met or beneficial uses are not attained or threatened (such as the severity of the pollution or number of pollutants/stressors of concern) [40 CFR 130.7(b)(4)];
- Degree of impairment;
- Potential threat to human health and the environment;
- Water quality benefits of activities ongoing in the watershed;
- Potential for beneficial use protection and recovery;
- Degree of public concern;
- Availability of funding; and
- Availability of data and information to address the water quality problem.

All water bodies on the section 303(d) list should be assigned a TMDL development schedule date.

This alternative represents the preferred alternative because it adheres to USEPA guidance that recommends a TMDL schedule without a set priority and because it is a reasonable, efficient way to demonstrate TMDL priority.

Recommendation: Alternative 3. See Policy section 5.

ENVIRONMENTAL EFFECTS OF THE PROPOSED POLICY

This section provides an analysis of the potential adverse environmental effects of the adoption of the “Water Quality Control Policy for Developing California’s Clean Water Act Section 303(d) List.”

The analysis that follows identifies differences between existing RWQCB listing and delisting practices pursuant to CWA section 303(d), the proposed Policy, and the potential environmental effects of these differences. Also, this analysis examines whether adoption of the proposed Policy would result in an environmental impact and, if so, does the impact have the potential for significant adverse effects.

After evaluating the potential adverse effects of each issue in the proposed Policy, no issues were found to have the potential for significant adverse environmental effects.

Baseline

The baseline conditions comprise the existing practices and procedures currently employed by the SWRCB and the RWQCBs for assessing the surface water bodies of the state in compliance with CWA section 303(d). The baseline is the process that occurred in the listing and delisting of water quality limited segments in the absence of the proposed Policy.

SWRCB and RWQCBs implement State (Porter-Cologne Act) and Federal law (CWA) for the protection of water quality. The SWRCB and RWQCBs are required to comply with all the provisions of the federal CWA. The section of the CWA pertinent to this Policy is section 303(d). To carry out the requirements of CWA section 303(d), the SWRCB and the RWQCBs have, since 1976 and every two years thereafter, assembled all readily available data and information in order to characterize and substantiate section 303(d) list updates.

SWRCB used a weight-of-evidence approach to evaluate RWQCB recommendations for the 2002-reporting year (SWRCB, 2003a). The approach required the evaluation of different types of data and information together, as well as an assessment of the strength, value, and believability of the evidence provided. The assessment determined whether there was a pollutant of concern associated with a water quality impact and the attainment of water quality standards, resulting in a scientifically defensible determination of whether beneficial uses were attained.

The categories of water bodies currently on the section 303(d) list are shown in Table 1. These water bodies were placed on the list as a result of the baseline process used by the SWRCB and RWQCBs that occurred in the listing and delisting of water quality limited segments in the absence of the proposed Policy.

Potentially Significant Adverse Environmental Effects

The proposed Policy was evaluated in terms of the baseline described above. The analysis of each issue has been formatted consistently as described below.

1. **Existing SWRCB and RWQCB Practices**
   This section provides a brief description of how the SWRCB and RWQCBs currently address this issue.

2. **Proposed Policy**
   This section briefly describes how the Policy addresses the issue and briefly explains why the Policy was developed this way.

3. **Differences Between the Policy and Existing Practices**
   Differences between (1) and (2).

4. **Potential Adverse Environmental Effects**
   What are the potential adverse environmental effects of the differences between the proposed Policy and the existing RWQCB practices?

5. **Potentially Significant Adverse Environmental Effects**
   Are any anticipated potential adverse environmental effects in (4) significant?

Issue 1: Scope of the Listing/Delisting Policy

Existing SWRCB and RWQCB Practices

The SWRCB and the RWQCBs are required to submit a new section 303(d) list every two years. The SWRCB does not have a formal Policy on the listing/delisting factors that should be considered in the development of the section 303(d) list.

Proposed Policy

The proposed Policy focuses exclusively on the listing and delisting factors as related to compliance with section 303(d) and does not consider revisions of beneficial uses or water quality standards before any listing decisions are made. In order to make decisions regarding standards attainment, this Policy provides guidance to interpret data and information by comparison to beneficial uses, existing numeric and narrative water quality objectives, and antidegradation considerations.

This approach was selected because it will establish a standardized methodology for developing California's section 303(d) list. Additional advantages include: (1) deadlines are more likely to be met for completion of the list; (2) the established triennial review process for Basin Plans and Statewide Plans would not have to conform to the 2-year time frame for development of the list; and (3) the process would be manageable with existing staff resources.

Differences Between the Policy and Existing Practices

The proposed Policy affirms that review of water quality standards and the listing and delisting of water quality limited segments in accordance with section 303(d) are two distinctly different actions. The proposed Policy requires RWQCBs to apply a consistent methodology to the listing process used to comply with CWA sections 303(d).

Potential Adverse Environmental Effects

The implementation of this Policy will not have an adverse effect on the environment. The proposed Policy will establish listing/delisting factors that will provide a consistent, scientifically defensible approach to determine whether water quality standards are being met as required under section 303(d).

Potentially Significant Adverse Environmental Effects

None.

Issue 2: Structure of Section 303(d) List

Existing SWRCB and RWQCB Practices

In the past, California has developed the section 303(d) list independently of the CWA section 305(b) report. After the section 303(d) list is developed it is typically incorporated into the section 305(b) report. In 2002, the SWRCB developed four lists consisting of the following:

1. The section 303(d) List;
2. An Enforceable Programs List;
3. A TMDL Completed List; and
4. A Monitoring List.

Proposed Policy

This Policy proposes that the California section 303(d) list contain the following categories:

- ♦ Water Quality Limited Segments; and
- ♦ Water Quality Limited Segments Being Addressed.

No other lists or categories are proposed.

Differences Between the Policy and Existing Practices

In 2002, the SWRCB developed four lists associated with the requirements of section 303(d). The proposed Policy would develop one-list with two categories that would satisfy the requirements associated with section 303(d) only. The SWRCB is not precluded from using the USEPA guidance (2003b) to develop the section 305(b) report.

Potential Adverse Environmental Effects

The development of this Policy will not have an adverse effect on the environment. The Policy will provide consistency in the assessment approaches used by all RWQCBs while allowing the flexibility necessary to address regional differences and site-specific concerns. The resulting list will satisfy the requirements of CWA section 303(d).

Potentially Significant Adverse Environmental Effects

None.

Issue 3: Weight of Evidence for Listing and Delisting

Existing SWRCB and RWQCB Practices

In 2002, the SWRCB used a weight-of-evidence approach to evaluate RWQCB recommendations. The components of the weight-of-evidence consisted of the strength of each measurement endpoint and concurrence among endpoints. Confidence in the measurement endpoint varied depending on the quality of the data available or the manner in which the data was used to determine impairment. The factors used to assess the quality of the measurement endpoints are listed in the Policy. Each water body-pollutant combination was evaluated on a case-by-case basis.

Proposed Policy

The weight-of-evidence proposed in the Policy is a narrative process where individual lines of evidence are evaluated separately and, then, combined using the judgment of RWQCBs and SWRCB in order to make a stronger inference about water quality standards attainment. Using this approach, a single line of evidence could be sufficient by itself to demonstrate water quality standards attainment. In other situations and with many data types, multiple lines of evidence are needed to determine if standards are attained.

While most lines of evidence are addressed by the assessment and listing methodology in the Policy, there may be circumstances when additional lines of evidence may compel RWQCBs to place water bodies on the section 303(d) list. The weight-of-evidence approach specifies factors to evaluate data and information but also allows the use of a situation-specific weight-of-evidence listing factor where RWQCBs are afforded significant flexibility in assessing additional data and information. This approach was selected because it allows for a scientifically valid process to consider additional data.

Differences Between the Policy and Existing Practices

Previously, SWRCB and RWQCB staff evaluated each addition, deletion, and change to the section 303(d) list based on all data and information available for each water body and pollutant. The SWRCB accepted the recommendations and analysis of the RWQCBs and reviewed each recommendation on a case-by-case basis, making an independent assessment of each water body and pollutant. The SWRCB took into account general factors that would be considered in making a scientifically defensible water quality standard attainment determination and also considered other facts relating to individual water bodies and pollutants.

The SWRCB is required by the Supplemental Report of the 2001 Budget Act to use a weight-of-evidence approach in developing a policy for listing and delisting waters and to include criteria that ensure that the data and information used are accurate and verifiable. The primary difference between the Policy and the 2002 section 303(d) list is that the decision rules are clearly defined for RWQCBs to use in their water quality standard attainment determinations.

Potential Adverse Environmental Effects

The development of this Policy will not have an adverse effect on the environment. The Policy will provide a consistent methodology for placement of water bodies on the section 303(d) list according to the type of water quality problem, availability of data, information, and actions that are being implemented in identified water bodies.

Potentially Significant Adverse Environmental Effects

None.

Issue 4: Listing or Delisting with a Single Line of Evidence

Existing SWRCB and RWQCB Practices

In the 2002 section 303(d) listing process, data were evaluated on a case-by-case basis. The data evaluation was usually expressed as the number of samples exceeding the standard or guideline out of a total number of samples. When appropriate, the magnitude of the measurements was also considered.

RWQCBs used a variety of approaches for evaluating bacterial water quality data, postings, and beach closure information, prior to the 2002 listing cycle. In 2002, evaluation of data and information for the section 303(d) list involved following preliminary recommendations by the BWQW. These recommendations include frequency of water quality standards exceedances; additional, site-specific information; and comparison of the number of water quality standard exceedances against a relatively unimpaired watershed. A 10 percent of the total days exceeding standards per year was used as the threshold for listing. Permanent postings were counted as exceedances when they were based on site-specific water quality data. “Precautionary” postings and “Rain Advisories” were not counted as exceeding water quality standards. Listing was based on sufficient samples to determine if the numeric standards were exceeded with moderate confidence.

Bacterial water quality standards for lakes, rivers and streams are contained in the Basin Plans. Several counties have ordinances that contain bacterial standards that can trigger freshwater beach swimming warnings, postings, or closures. As with marine water bodies, postings are indicative of impaired water quality and the number of postings measure loss of a beneficial use. Each RWQCB develops recommendations for freshwater bacterial water quality objectives on a case-by-case basis. For freshwater bodies, RWQCBs compare monitoring data to Basin Plan water quality objectives. No specific approach or guidelines have been mandated. Frequency of standards exceedance has been used to assess nonattainment. Typically, RWQCBs used an exceedance frequency of 10 percent**.**

The SWRCB and RWQCBs have used a variety of guidelines or scientifically derived values to interpret narrative water quality objectives. In developing the 2002 section 303(d) list of water quality impaired segments, the determination of standard or use attainment were based on the RWQCB and SWRCB interpretation of narrative water quality objectives. Compliance with narrative water quality objectives was considered on a case-by-case basis using all relevant data submitted to the RWQCBs. Data were evaluated using relevant and well-accepted standards, criteria, guidelines, or other objective measures that interpret the sensitivity of a benchmark in determining standards or beneficial use attainment. Evaluation guidelines with no scientific basis for judging standards or beneficial use attainment were not used. Overall, constituents that violated narrative water quality objectives and were not supported with acceptable numeric evaluation guidelines were not listed.

Evaluation of tissue chemical concentrations have been based on screening values established by USEPA, NAS, and additional criteria used in the SMWP reports, such as MTRLs for the protection of human health and wildlife. In developing the 2002 section 303(d) list of water quality limited segments, measures used to interpret chemical residue concentrations in tissue included MTRLs and public health guidelines. In addition to MTRLs, guidelines that were well accepted and had a strong scientific basis with high levels of certainty and applicability were used.

Nuisance is defined in the CWC and in narrative water quality objectives in the Basin Plans. In previous section 303(d) listing cycles, water bodies were listed for trash impacts based largely on qualitative data and information. During the 2002 303(d) listing cycle, the SWRCB and RWQCBs' received several submittals of non-numeric information and a limited amount of data to support listing recommendations for trash.

Narrative water quality objectives for nutrients have been broadly applied by many RWQCBs. Recommendations for nutrient listings for the 2002 section 303(d) list included listings for DO, nitrates, ammonia and other nitrogen related substances. The 2002 section 303(d) list also cited impairments related to growth of noxious plants, algae, eutrophication, and increased turbidity (i.e., decreased water clarity).

In the 2002 section 303(d) listing process, the SWRCB did not list any new water bodies proposed for listing under section 303(d) for invasive species because, under CWA, invasive species are not a pollutant and it would be very difficult to develop TMDLs for invasive species. In 1998, the San Francisco Bay Estuary was listed for exotic species on the section 303(d) list.

Proposed Policy

The Policy proposes approaches for assessing lines of evidence for water quality objectives and beneficial uses that could be used by themselves to assess whether water quality standards are attained. They include: (1) numeric water quality objectives, criteria, or other applicable standards, (2) marine bacterial standards, (3) freshwater bacterial standards, (4) narrative water quality objectives, (5) tissue data, (6) trash, (7) nutrients, and (8) invasive species.

The Policy proposes that the evaluation of data be consistent with the expression of the numeric water quality objective, water quality criteria, or evaluation guideline. If the water quality objective, water quality criteria, or evaluation guideline state a specific averaging period and/or mathematical conversion, the data should be converted in a consistent manner prior to conducting list assessments. If sufficient data are not available for the stated averaging period, the available data should be used to represent the averaging period.

This Policy proposes a consistent process and decision rules to trigger listing recommendations for exceedances of marine and freshwater bacterial water quality standards. Data and information generated by regulatory activities (including NPDES permits compliance and special studies) conducted by the RWQCBs and various local agencies, monitoring and regulatory activities of local environmental health agencies, and recognized private and public institutions would be evaluated.

General guidance for the interpretation of narrative standards and the types of interpretative guidelines that may be used would be established. The Policy recommends the use of evaluation guidelines with appropriate quantitative translators, if the translator meets specific criteria.

The Policy recommends RWQCBs compare available tissue data and information to the most appropriate measure to interpret chemical residue concentrations. RWQCBs could also incorporate current research that may set values that are more protective of the designated beneficial use as long as the evaluation guideline criteria are met. Acceptable tissue concentrations can be measured either as muscle tissue (preferred) or whole body residues. Animals can either be deployed (if a resident species) or collected from resident populations. Recurrent measurements in tissue are required.

Waters would be placed on the section 303(d) list if visual assessments and numeric water quality objectives or evaluation guidelines show that trash is a water quality problem. The types of numeric data that could be used include trash cleanup day data or spatially and temporally representative measurements of trash in waterways or at beaches. An alternative to a trash evaluation guideline is to compare trash accumulation to reference conditions (i.e., waters scarcely impacted by trash accumulations).

Specific guidance would be applied when nutrient listing decisions are being made. The Policy discusses guidelines for the use of diel measurements for DO or acceptable guidelines to evaluate nutrient concentrations in the absence of diel measurements. Additionally, the Policy discusses the use of evaluation guidelines for nutrient related excessive algae growth, unnatural foam, odor and taste.

The Policy proposes that water bodies impacted by invasive species should not be placed on the section 303(d) list. TMDL development would not be required for these water bodies; other appropriate water quality management actions would address the cause of invasive species impacts.

Differences Between the Policy and Existing Practices

Previously, each RWQCB used its own approach and methodology when making listing decisions. The magnitude and duration expressed in water quality objectives was used to assess the States waters. In most cases, data evaluation has been expressed as the number of samples exceeding the standard or guideline out of a total number of samples. The proposed

Policy recommends rules for evaluating water quality objectives. Prior to conducting list assessments, RWQCBs would determine if there are a sufficient number of samples and whether those samples are spatially and temporally representative of the water quality in the water body. Available data would be further evaluated to avoid temporal bias and ensure, when applicable, that seasonality is represented in the sampling plan. Additionally, the duration (i.e., averaging period) of concentrations expressed in the water quality objective would be considered in the assessment when standards are achieved. Data sets would, then, be compared to the water quality objective to determine if an exceedance has occurred.

Prior to the 2002 listing cycle, the RWQCBs were given significant latitude in deciding what constituted bacterial water quality standards exceedance for marine and freshwaters. For each circumstance, RWQCBs would decide which waters to list after considering the available data and information for the site based on regional interpretation of standards, postings, and closure data and information. The proposed Policy's criteria for addressing bacterial standards in marine and freshwaters to support listings on the section 303(d) list are based on recommendations from the BWQW. These guidelines provide a basis for assessing listing decisions.

The determination of standard or use attainment, for the 2002 section 303(d) list, was based on RWQCB and SWRCB interpretation of narrative water quality objectives. Overall, constituents that violated the narrative water quality objective and were not supported with acceptable numeric evaluation guidelines were not listed. The Policy would require evaluating narrative water quality objectives using interpretive evaluation guidelines that represent standards attainment or beneficial use protection. The Policy establishes general guidance for the interpretation of narrative standards and the types of interpretative guidelines that may be used.

For aquatic life tissue data, existing practices include listings based solely on USFDA action levels and MTRLs. The proposed Policy presents the use of the most appropriate measure to interpret chemical residue concentrations in tissue. This would provide RWQCBs with the flexibility to compare available tissue data and information to the most appropriate and current values that can be used to interpret chemical residue concentrations. The Policy also recommends tissue sampling from the appropriate target species and provides guidance on the minimum number of replicates and the number of individuals per replicate. The Policy does not allow the use of MTRLs and USFDA action levels.

Historically, water bodies recommended for section 303(d) listing, due to trash, have been addressed differently by each RWQCB. In general, assessments of impairments due to trash have been based largely on qualitative information. The proposed Policy recommends an approach using numerical data and non-numeric information but allows existing programs to address any water related trash problem.

During previous listing cycles, water bodies were placed on the section 303(d) list for nutrient impacts without determining the specific constituent causing biostimulation. In some cases the stimulatory substance was inappropriately identified or the guideline used to determine impacts to specific beneficial uses was inappropriately used. The Policy recommends the use of a consistent systematic approach for listing water bodies impacted by nutrients and provides specific guidance to help in the identification of the constituent, and determination of the beneficial use that is impacted.

In the 1998 section 303(d) listing process, nine water body segments were listed for exotic species impacts. The Policy would not allow listing water bodies impacted by invasive species because a pollutant does not cause those types of impacts and a TMDL is not required.

Potential Adverse Environmental Effects

The development of this Policy will not have an adverse effect on the environment. The Policy recommends a process to consistently convert data when the water quality objective, water quality criteria, or evaluation guideline state a specific averaging period and/or mathematical conversion. Specific criteria are recommended for evaluating marine and freshwater bacteriological standard exceedances. Guidance is provided on the use of available defensible criteria to quantitatively assess the potential for narrative water quality standards exceedance; to interpret chemicals bioaccumulated in fish or shellfish tissue providing consistent interpretation of the levels of residue concentrations in tissue that impact beneficial uses; and a fairly consistent approach for listing water bodies due to trash. The Policy recommends a consistent approach for listing water bodies due to nutrients impacts, providing specific guidance to help identify the biostimulatory substance as well as the beneficial use that is impacted. The Policy recommends against listing for invasive species.

Potentially Significant Adverse Environmental Effects

None.

Issue 5: Listing or Delisting with Multiple Lines of Evidence

Existing SWRCB and RWQCB Practices

Each RWQCB typically has its own approach to the methodology used for listing. RWQCBs have assessed, case-by-case, which lines of evidence to use, data analysis procedures, and exceedance frequencies depending on site-specific factors. Existing practices specific to each sub-issue follows:

The issuance of health advisories by OEHHA or shellfish harvesting bans automatically led to the water quality of the segment being considered limited, especially if the chemical or biological contaminant was associated with sediment or water in the segment. The 2002 section 303(d) list required multiple lines of evidence to list or delist a water body and generally needed the pollutant(s) that caused or contributed to the adverse condition.

Data and information describing nuisance conditions, for the most part, has been qualitative (e.g., photographs, accounts of individuals, etc.). Some numeric data have been provided that describes nuisance conditions (e.g., measures of algae cover or water color). During previous section 303(d) listing cycles, water body segments have been listed for nuisance conditions related to color, odor, and excessive algae or scum using qualitative information.

During the development of the 2002 section 303(d) list, toxicity testing was used as a basis for listing as long as concurrently sampled chemical data was available that showed the chemical caused or contributed to the observed toxicity. Prior to the 2002 section 303(d) list, water bodies were listed with and without the chemical data and/or a pollutant identified.

Determining the impacts of sediment (including settleable material and turbidity) has been based on non-attainment of narrative and numeric water quality objectives and the threat to designated beneficial uses.

Water quality objectives for temperature are specified in Basin Plans and the California Thermal Plan. In 2002, section 303(d) listings were proposed for several North Coast rivers based on evaluation of MWAT data ranges, as compared to evaluation values for impacts on anadromous fish species. In addition, temperature data were evaluated with respect to current and historic presence of cold water fish. If a stream exhibited temperatures within the chronic reduced-growth MWAT ranges, and had a decreased salmonid fishery compared with historic levels, it was listed based on inferred historical stream MWATs.

Organism response to pollutants is typically assessed with toxicity tests or by observations of change in the biological population or communities. In

2002, listings for adverse biological response were not recommended. However, in previous lists (prior to 2002), some water bodies were placed on the section 303(d) list for abnormal fish histology.

Degradation of biological populations or communities has not been, traditionally, assessed by the RWQCBs. In the 2002 section 303(d) list, degradation of aquatic life populations or communities listings required multiple lines of evidence that identified the pollutant(s) causing or contributing to the adverse condition. At present for California, there are no widely accepted approaches for documenting trends in water quality. No existing listings are known to be based on findings related to antidegradation or trends in water quality.

Proposed Policy

The Policy proposes the use of Health Advisories, in conjunction with other water quality measurements, to list a water body. When OEHHA or DHS issues a health advisory against the consumption of edible resident organisms or a shellfish harvesting ban, the water quality of the segment is automatically considered limited if the chemical or biological contaminant is associated with sediment or water in the segment. Additional indicators to assess attainment with fish and shellfish consumption-based water quality are listed in the Policy.

The use of both quantitative and qualitative data and information in the evaluation of nuisance is recommended. For the section 303(d) list, the Policy recommends the identification of the pollutant or pollutants that cause or contribute to the observed impacts. The Policy requires that RWQCBs rely on existing numeric water quality objectives (related to nutrients or other pollutants) or evaluation guidelines that represent an acceptable level of beneficial use protection.

The Policy proposes listing for toxicity alone (without the pollutant identified) as one line of evidence to place water bodies on the section 303(d) list. The RWQCBs have the option to identify the pollutant during the development of the TMDL.

The interpretation of sediment impacts on a case-by-case basis is proposed in the Policy. Water bodies would be listed based on sufficient credible data and information that indicate water quality standards for sediment are not met, by comparison to acceptable evaluation guidelines, or that impacts to beneficial uses are caused by sediment.

The proposed Policy, in lieu of data to directly assess compliance with numeric temperature water quality objectives, recommends comparing recent temperature monitoring data for a specific water body to the temperature requirements of the resident aquatic life. Information on the current and historic condition and distribution of the sensitive beneficial uses (e.g., fishery resources) in the water body is necessary, as well as recent temperature data on conditions experienced by the most sensitive life stage of the aquatic life species. Information about presence/absence or abundance of sensitive aquatic life species can be used to infer past temperature conditions.

General guidelines are outlined requiring the comparison of adverse biological response endpoints to reference conditions, the identification of pollutants suspected of causing or contributing to the adverse response, and the association of pollutants with an adverse response. Endpoints for this factor include fish kills, reduction in growth, reduction in reproductive capacity, abnormal development, histopathological abnormalities, and other adverse conditions but no specific cutoff values are proposed.

The proposed Policy recommends listing a water segment when significant degradation in biological populations and/or communities is exhibited, represented by diminished numbers of species or individuals of a single species or other metrics as compared to reference site(s) and associated water or sediment concentrations of pollutants. For population or community degradation related to sedimentation, the Policy recommends listing, if degraded populations or communities are identified and effects are associated with clean sediment loads in water or those stored in the channel.

Waters that currently meet standards but show a declining trend in water quality may not meet antidegradation requirements and could be considered for inclusion on the section 303(d) list.

Differences Between the Policy and Existing Practices

Existing practices allow RWQCBs broad flexibility in determining how to evaluate water and sediment measurements in association with health advisories. The proposed Policy recommends, when using health advisories or shellfish bans to list a water quality limited segment, that RWQCBs also consider available water segment-specific data indicating the evaluation guideline for tissue is exceeded. More than one criterion may be necessary to determine if the water segment is impaired.

In previous section 303(d) listings, qualitative information alone has been used to list water bodies for nutrient impairments; some numeric data has also been provided. The SWRCB and the RWQCBs have received documentation in the form or photographs, and accounts of individuals, etc. that describes nuisance conditions. The proposed Policy recommends using qualitative information combined with quantitative data related to excessive nutrients to evaluate the potential for nuisance conditions.

In previous section 303(d) lists, water bodies were listed with and without the chemical data and/or a pollutant identified. Listing proposals, without the pollutant identified, were not placed on the 2002 section 303(d) list. The proposed Policy recommends listing water bodies for impairments due to toxicity on the section 303(d) list.

Determining the impacts of sediment has been based on each RWQCBs interpretation of non-attainment of water quality objectives and the threat to designated beneficial uses. The Policy provides general guidance to list water bodies due to sediment impacts based on sufficient credible data and information that indicate water quality standards for sediment are not met by comparison to acceptable evaluation guidelines, or documented impacts to beneficial uses that are caused by sediment.

In 2002, section 303(d) listings were proposed based on evaluation of MWAT data ranges, as compared to evaluation values for impacts on anadromous fish species. In addition, temperature data were evaluated with respect to the current and historic presence of cold water fish. The proposed Policy would require listing water segments for temperature focusing on beneficial use impacts and likely effects of elevated temperature on sensitive species based on the assumption that aquatic life beneficial uses (e.g., cold and warm water fisheries) are sensitive to modifications to natural temperature.

In prior listings, the only adverse biological response considered was abnormal fish histology. The proposed Policy recommends general guidance when basing a listing decision on adverse biological response and provides general criteria upon which endpoints can be compared. The SWRCB and the RWQCBs would need to consider additional stronger lines of evidence (e.g. endpoints compared to reference conditions, identification of pollutants suspected of causing or contributing to the adverse response, and association of pollutants with an adverse response).

Generally, the RWQCBs have measured biological conditions indirectly, through the use of chemical-specific analysis and toxicity; they have not used bioassessment by itself prior to 2002 to substantiate a section 303(d) listing recommendation. The proposed Policy recommends specific guidance on the use of bioassessment but only if associated with water and sediment pollutant measurements.

The Policy allows that documented trends in declining water quality, to levels that may not meet the antidegradation provisions of water quality standards, are sufficient to place the water body on the section 303(d) list. Also, an indication is required that the water bodies are toxic, there are impacts on aquatic life communities or populations, or there is other adverse biological response.

Potential Adverse Environmental Effects

The development of this Policy will not have an adverse effect on the environment. The Policy only provides a consistent, comprehensive approach for: evaluating water bodies listed for impacts, due to the issuance of fish consumption advisories or shellfish bans; using both quantitative and qualitative data and information in the evaluation of nuisance conditions; and listing water bodies for toxicity with and without a pollutant identified. The Policy provides general guidance for placing water bodies impacted by sedimentation on the section 303(d) list on a case-by-case basis and the assembling of sufficient credible data and information that indicate water quality standards for sediment are not met. Additionally, the Policy provides guidance on: determining whether the beneficial uses of a waterbody are impacted by temperature; evaluating adverse biological response data and information while providing significant flexibility to interpret impacts due to these factors; using assessments of biological communities along with water and sediment measurements to determine water quality impacts; and documenting trends in water quality that may eventually exceed water quality objectives or criteria, in violation of the antidegradation provisions of water quality standards.

Potentially Significant Adverse Environmental Effects

None.

Issue 6: Statistical Evaluation of Numeric Water Quality Data

Existing SWRCB and RWQCB Practices

During previous listing cycles, the RWQCBs sampled information, but little or no statistical validation of data, was used in making recommendations for the 2002 section 303(d). The RWQCBs did not use hypothesis testing. RWQCBs and SWRCB did not employ a level of statistical confidence in section 303(d) listing decisions.

During the development of the section 303(d) list, RWQCBs used various exceedance rates and a variety of minimum sample sizes in their section 303(d) listing decision assessments. Data were evaluated on a case-by-case basis. The data evaluation was usually expressed as the number of samples exceeding the standard or guideline out of a total number of samples. When appropriate, the magnitude of the measurements was also considered.

Water quality data often include observed measurements that are below or less than the QL of the analytical instruments. In 2002, the RWQCBs used several methods to evaluate non-detect data that ranged from using one half the value of the detection limit to evaluating the number of exceedances in the total number of samples collected (i.e., the total number of samples that included non-detects).

Proposed Policy

The Policy provides guidance to base section 303(d) listing/delisting decisions on statistics to validate numeric data evaluations. It also requires SWRCB and RWQCBs follow appropriate scientific/statistical guidelines in establishing hypotheses; statistical procedures; and establishes acceptable levels of Type I and Type II errors; and preliminary hypotheses designed to minimize error. This increases confidence in decision making, quantifies the level of confidence and power, and follows standard scientific protocols for using hypothesis testing in decision-making.

When available data are less than or equal to the QL and that is less than the water quality standard, the value will be considered as meeting the water quality standard, objective, criterion, or evaluation guideline. When the sample value is less than the QL and the QL is greater than the water quality standard, objective, criterion, or evaluation guideline, the result shall not be used in the analysis. The QL includes the minimum level, practical quantitation level, or reporting limit. The Policy recommends a statistical approach that balances the Type I and Type II errors.

Differences Between the Policy and Existing Practices

During previous listing cycles, the RWQCBs assessed information, but did not statistically validate data used in making recommendations for the 2002 section 303(d) list. Previously, RWQCBs used critical exceedance rates to judge when a water body was not meeting water quality standards but the process was implemented without the use of statistical analysis. The RWQCBs used several methods to evaluate non-detect data. The Policy provides general guidelines to determine the process in interpreting when and how a non detect value can be included in the 303(d) listing evaluation.

The Policy contains provisions for using statistics to validate numeric information to make sound scientific section 303(d) listing/delisting decisions; makes a recommendation as to the form of the null hypothesis and alternate hypothesis; and recommends an exact binomial statistical test that balances errors. The Policy requires that a range of critical exceedance rates be applied to determine the number of samples needed to place waters on the section 303(d) list.

Potential Adverse Environmental Effects

The development of this Policy will not have an adverse effect on the environment. The Policy recommends using statistics to validate numeric information and test trends to make sound scientific section 303(d) listing/delisting decisions. The Policy adopts a critical exceedance frequency that assesses only the strength of the decision to list or delist based on the sample population (i.e., grab samples) available. The Policy provides general guidance on interpreting non-detect or below QL data.

Potentially Significant Adverse Environmental Effects.

None.

Issue 7: Policy Implementation

Existing SWRCB and RWQCB Practices

The SWRCB has used previous section 303(d) lists as the basis for the development of the biennial list. The 1998 section 303(d) list formed the basis for the 2002 list submittal. Previous listings were reevaluated if new data and information were available.

The RWQCBs and SWRCB, in the process of evaluating whether water quality standards are being met, have traditionally relied on data and information documenting specific environmental characteristics pertaining to the physical, chemical, and biological conditions of each region's water bodies and watershed systems.

In the 2002 section 303(d) listing cycle, SWRCB and RWQCBs solicited all readily available data and information. Each RWQCB submitted staff reports, along with copies of public submittals, data and information, and documents referenced in the submittal to the SWRCB. The SWRCB reviewed all RWQCBs recommendations and compiled a statewide listing for SWRCB approval. After several public hearings and workshops, the SWRCB approved the section 303(d) list for submittal to USEPA.

For each water body and pollutant recommended by the RWQCBs for the 2002 section 303(d) list, SWRCB staff developed fact sheets outlining all pertinent information needed to make listing decisions.

In previous section 303(d) listing cycles, the quality of the data and information used to determine impairment varied greatly not only among the RWQCBs but among the past listing cycles as well. In the 2002 listing cycle, if the RWQCB provided information on the quality of the data, it was recorded it in the fact sheet.

Spatial and temporal representation were considered on a case-by-case basis and data of varying ages were used for the 2002 section 303(d) list.

Identification of water quality limited segments during previous section 303(d) listing cycles varied between RWQCBs. Generally, RWQCBs based listings on their Basin Plan surface water segmentation classifications by either listing according to hydrologic unit, area, and sub-area or by listing on the basis of water body type and name. Some RWQCBs added water body segments not identified in Basin Plans; other RWQCBs established listings throughout watersheds even if the data indicated only a portion of the water body or segment was impacted.

Most of the RWQCB Basin Plans currently contain language distinguishing between controllable factors that result in degradation of water quality and those factors that are not controllable.

Proposed Policy

The Policy recommends revising an existing listing if requested by interested. Existing and readily available data and information in paper or electronic format from all available sources includes but is not limited to specifically listed reports and other sources of information listed in the policy. Data supported by a QAPP or equivalent would be acceptable for use in developing the section 303(d) list.

The Policy proposes that both the RWQCBs and the SWRCB manage the approval process. The RWQCBs would evaluate all readily available data and information and assemble fact sheets with the pertinent information for each potential water body-pollutant combination. Fact sheets shall present a description of the line(s) of evidence used to support each component of the weight-of-evidence approach. If the data and information reviewed indicate standards are attained, a single fact sheet may address multiple water and pollutant combinations. Public hearings, held by each RWQCB, will consider each proposed water body fact sheet, and provide written response to comments from testimony given at the hearing. After considering all testimony, the RWQCB would approve recommendations by resolution for the section 303(d) lists. The SWRCB would consider the RWQCB recommendation at a workshop. The list would be approved at a SWRCB Board meeting after consideration of all public comments.

The Policy recommends general guidance on collecting data that would be spatially and temporally representative of the water body segment. In general, samples should be available from two or more seasons or from two or more events when effects or water quality objective exceedances would be clearly manifested. Guidelines are also proposed on the age of data acceptable for listing. Only the most recent 10-year period of data and information would be used for listing and delisting waters.

RWQCBs would list water bodies or segments in accordance with the segmentation approach used in the Basin Plans but would be allowed to further divide waters if warranted. In the absence of an adequate segmentation system, the RWQCBs would be encouraged to define distinct reaches based on hydrology (e.g., stream order, tributaries, dams, or channel characteristics) and relatively homogeneous land use. These components of the stream system could be logically grouped depending on the nature of the source of the pollutant and the designation of beneficial uses. The RWQCBs would be encouraged to identify stream reaches or lake/estuary areas that may have different pollutant levels based on significant differences in land use, tributary inflow, or discharge input. Based on these evaluations of the water body setting, RWQCBs would aggregate the data by appropriate reach or area.

Differences Between the Policy and Existing Practices

The proposed Policy presents a process for reconsidering existing listings. In previous listings, each RWQCB has used its judgment in identifying which data and information to use in its listing process. The proposed Policy recommends existing and readily available data and information in paper or electronic format including but not limited to the data and written information specifically described in the Policy.

In the past, the RWQCBs have held primary responsibility in making water body-pollutant recommendations pertaining to the section 303(d) list. This proposed Policy would allow each RWQCB to go through their adoption processes by holding workshops or hearings on the proposed water body-pollutant recommendations, provide a public comment period, and for the RWQCBs to respond to those comments. SWRCB would review the RWQCB recommendations for consistency and applicability with the Policy.

Documentation of proposed listings and the quality of the data and information used have varied widely. The 2002 listing process and the proposed Policy use a standard fact sheet format. The RWQCBs would be required to submit summaries of the data and information to support recommendations for the listing and delisting of water bodies. Fact sheets would only be prepared in circumstances where data and information are available. All readily available data and information would be considered. In 2002, California used all information and data to support listings regardless of age. The proposed Policy provides general guidance on the quality data that is acceptable for use in the section 303(d) listing process. The RWQCBs would evaluate and make a finding in the fact sheets on the appropriateness of data collection and analysis practices.

In previous section 303(d) listing cycles, spatial and temporal representation were considered on a case-by-case basis. The RWQCBs Basin Plans establish lists of water bodies within each region where water quality standards apply and waters will be protected from water quality degradation. Each identified water body within the established list is segmented by hydrologic unit, area and sub area, and each segments beneficial uses are designated, where such uses are applicable. The Policy establishes general guidance when considering spatial and temporal representation in the evaluation of data and information from water body segments. The use of Basin Plan hydrologic units, areas and sub areas, and water body type classifications to determine where water quality standards are not being met is also recommended. The water segment would be listed on the section 303(d) list, although it may only be a smaller portion of the segment that is impaired. Listings of water segments would not be allowed unless data from the segment showed standards are not attained.

Previously, some water bodies not meeting water quality standards for a particular pollutant originating from natural sources were placed on the section 303(d) list. The proposed Policy does not provide guidance regarding impacts relative to natural sources. Water bodies recommended for section 303(d) listing in the future or existing listings recommended for removal from the section 303(d) list due to natural sources will require review and approval by the SWRCB.

Potential Adverse Environmental Effects

The development of this Policy will not have an adverse effect on the environment. The Policy recommends a more rigorous method of determining and specifying the data and information format to ensure that any listing recommendation is credible and scientifically defensible. The Policy allows for a more consistent approach in the development of the section 303(d) list. To support listing recommendations, the Policy provides guidance to ensure that data and information is adequately documented; of sufficiently high quality; and spatially and temporally representative of water body segments. The Policy identifies a process for establishing segments avoiding confusion regarding applicable designated beneficial uses, the name of the segment, and the size and boundaries of the affected segment.

Potentially Significant Adverse Environmental Effects

None.

Issue 8: Priority Ranking and TMDL Completion Schedule

Existing SWRCB and RWQCB Practices

In the 1998 listing cycle, the RWQCBs established priority ranking of listed water quality limited segments following a general SWRCB/USEPA guidance document. Criteria used to rank water bodies as high, medium, or low priority for TMDL development included the importance and extent of the beneficial uses threatened, degree of impairment, potential for beneficial use recovery, public concern and availability of information. However, TMDL scheduling was not linked with priority setting.

The 2002 prioritization process was based on the 1998 ranking methods. However, resource availability and considerations of achievability within the next two years were also taken into account in determining whether a water body should be ranked as high priority for TMDL development. The 2002 listing process linked priority ranking with the TMDL development schedule and subsequently scheduled TMDLs for all water bodies determined to be high priority.

Proposed Policy

The Policy proposes the establishment of a schedule for waters on the section 303(d) list that identify the TMDLs that would be developed within the current listing cycle and the number of TMDLs scheduled to be developed thereafter. The schedule in and of itself would reflect the State's priority ranking. The Policy would identify TMDLs scheduled for development using the following three categories of waters.

Differences Between the Policy and Existing Practices

The listing cycle prior to 2002 determined that water bodies would be ranked as high, medium and low and TMDL scheduling would not be linked. The Policy provides for each RWQCB to use their professional judgment to determine which TMDLs are high priority and which are not; but it would not be necessary to identify each TMDL as a high, medium, or low priority as long as a schedule is established.

Potential Adverse Environmental Effects

The development of this Policy will not have an adverse effect on the environment. The Policy establishes guidelines for and allows the TMDL scheduling to reflect the priority setting for establishing TMDLs.

Potentially Significant Adverse Environmental Effects

None.

Growth-Inducing Impacts

CEQA defines the expected discussion of growth-inducing impacts and indirect impacts associated with growth in section 15126(g) of the CEQA guidelines. That section states:

> "...Discuss the ways in which the proposed project could foster economic or population growth, or the construction of additional housing, either directly or indirectly, in the surrounding environment. Included in this are projects that would remove obstacles to population growth (a major expansion of a wastewater treatment plant might, for example, allow for more construction in service areas). Increase in the population may further tax existing community service facilities so consideration must be given to this impact. Also discuss the

> characteristics of some projects which may encourage and facilitate other activities that could significantly affect the environment, either individually or cumulatively. It must not be assumed that growth in any area is necessarily beneficial, detrimental, or of little significance to the environment."

The proposed Policy provides consistent statewide guidance on the development of CWA section 303(d) list as required by CWC section 13191.3(a). The analysis of environmental impacts concludes that each part of the proposed Policy will not have a significant effect on the environment. The proposed Policy is not expected to foster or inhibit economic or human population growth, or the construction of additional housing.

Cumulative and Long-Term Impacts

CEQA guideline section 15355 provides the following description of cumulative impacts:

> "'Cumulative impacts' refer to two or more individual effects which, when considered together, are considerable or which compound or increase other environmental impacts.
> (a) The individual effects may be changes resulting from a single project or a number of separate projects.
> (b) The cumulative impact from several projects is the change in the environment that results from the incremental impact of the project when added to other closely related past, present, and reasonably foreseeable probable future projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time."

One means of complying with CEQA's requirement to consider cumulative impacts is to provide a list of past, present and reasonably foreseeable future projects that are related to the proposed action. Foreseeable projects that would result from the placement of waters on the CWA section 303(d) can vary greatly depending on the pollutant and level of regulatory response needed.

RWQCBs have wide latitude and numerous options that apply when determining how to address waters on the section 303(d) list. Irrespective of whether section 303(d) of the CWA requires a TMDL, the process for addressing waters that do not meet applicable standards will be accomplished through many existing regulatory tools and mechanisms. If a listed water segment meets water quality standards, the appropriate regulatory response is to remove the water from the list (to delist). If the failure to attain standards is revealed to be the result of the applicable standards not being appropriate, the regulatory response should be to correct the standards through mechanisms such as Use Attainability Analysis, a Site-Specific Objective, or other modification of the water quality standard. In addition, an antidegradation finding may authorize the lowering of water quality to some degree, which may address the impairment.

The federal requirement to calculate TMDLs for listed waters is limited to those pollutants that USEPA determines are suitable for such calculation. At present this includes all pollutants. However, there are many existing regulatory tools that can be used to address water quality problems identified on the section 303(d) list.

Existing regulatory tools include individual or general WDR (NPDES permits or requirements solely under California law), individual or general waivers of WDRs, enforcement actions, interagency agreements, regulations, Basin Plan amendments, and/or other policies for water quality control. Basin Plan amendments can include implementing a specific water quality control plan, adopting prohibitions, or (where appropriate) modifying standards.

TMDLs are generally adopted at the time programs are instituted to implement actions to correct impairment. TMDLs may be adopted in any of the following ways: as part of a Basin Plan amendment, in the assumptions underlying a permitting action, in an enforcement action, or in another single regulatory action that is designed by itself to correct the impairment. The TMDL is adopted with the regulatory action that implements it.

Any environmental impacts associated with individual TMDLs or other efforts in lieu of a TMDL shall be addressed when the RWQCBs and SWRCB develop and approve those efforts. It is not possible for the SWRCB to consider potential direct and indirect environmental impacts of TMDLs planned for development or foresee all possible ways standards non-attainment will be addressed. It is unknown what actions will be necessary to implement the future TMDLs or other regulatory actions. During the development of TMDLs and implementation plans, RWQCBs and SWRCB will conduct a CEQA review and consider potential environmental impacts.

The response of RWQCBs to the placement of waters on the section 303(d) list is so varied, situation-specific, and site-specific that it is impossible to reasonably foresee the potential cumulative impacts of these projects or of placing waters on the section 303(d) list.

ENVIRONMENTAL CHECKLIST

A. Background

1. Name of Proponent: State Water Resources Control Board

2. Address and Phone Number of Proponent: Division of Water Quality
   P.O. Box 100, Sacramento, CA 95812-0100
   (916) 341-5560

3. Date Checklist Submitted: December 2, 2003

4. Agency Requiring Checklist: Resources Agency

5. Name of Proposal, if applicable: Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List

B. Environmental Impacts
(Explanations are included on attached sheets).

	Potentially Significant Impact	Potentially Significant Unless Mitigation Incorporated	Less Than Significant Impact	No Impact
I. LAND USE AND PLANNING.				
Would the proposal:				
a. Conflict with general plan designation or zoning?	[ ]	[ ]	[ ]	[X]
b. Conflict with applicable environmental plans or policies adopted by agencies with jurisdiction over the project?	[ ]	[ ]	[ ]	[X]
c. Be incompatible with existing land use in the vicinity?	[ ]	[ ]	[ ]	[X]
d. Affect agriculture resources or operations (e.g. impacts to soils or farmlands or impacts from incompatible land uses)?	[ ]	[ ]	[ ]	[X]
e. Disrupt or divide the physical arrangement of an established community (including a low- income or minority community)?	[ ]	[ ]	[ ]	[X]
II. POPULATION AND HOUSING.				
Would the proposal:				
a. Cumulatively exceed official regional or local population projections?	[ ]	[ ]	[ ]	[X]

		Potentially Significant Impact	Potentially Significant Unless Mitigation Incorporated	Less Than Significant Impact	No Impact
b.	Induce substantial growth in an area either directly or indirectly (e.g., through projects in an undeveloped area or extension of major infrastructure)?	[ ]	[ ]	[ ]	[X]
c.	Displace existing housing especially affordable housing?	[ ]	[ ]	[ ]	[X]

III. <u>GEOLOGIC PROBLEMS</u>

Would the proposal result in or expose people to potential impacts involving:

a.	Fault rupture?	[ ]	[ ]	[ ]	[X]
b.	Seismic ground shaking?	[ ]	[ ]	[ ]	[X]
c.	Seismic ground failure, including liquefaction?	[ ]	[ ]	[ ]	[X]
d.	Seiche, tsunami, or volcanic hazard?	[ ]	[ ]	[ ]	[X]
e.	Landslides or mudflows?	[ ]	[ ]	[ ]	[X]
f.	Erosion, changes in topography or unstable soil conditions from excavation, grading or fill?	[ ]	[ ]	[ ]	[X]
g.	Subsidence of the land?	[ ]	[ ]	[ ]	[X]
h.	Expansive soils?	[ ]	[ ]	[ ]	[X]
i.	Unique geologic or physical features?	[ ]	[ ]	[ ]	[X]

IV. <u>WATER</u>

Would the proposal result in:

a.	Changes in absorption rates, drainage patterns, or the rate and amount of surface runoff?	[ ]	[ ]	[ ]	[X]
b.	Exposure of people or property to water related hazards such as flooding?	[ ]	[ ]	[ ]	[X]
c.	Discharge into surface water or other alteration of surface water quality (e.g. temperature, dissolved oxygen or turbidity)?	[ ]	[ ]	[ ]	[X]
d.	Changes in the amount of surface water in any water body?	[ ]	[ ]	[ ]	[X]
e.	Changes in currents or the course or direction of surface water movements?	[ ]	[ ]	[ ]	[X]

		Potentially Significant Impact	Potentially Significant Unless Mitigation Incorporated	Less Than Significant Impact	No Impact
f.	Change in the quantity of groundwaters, either through direct additions or withdrawals, or through interception of an aquifer by cuts or excavations or through substantial loss of groundwater recharge capability?	[ ]	[ ]	[ ]	[X]
g.	Altered direction or rate of flow of groundwater?	[ ]	[ ]	[ ]	[X]
h.	Impacts to groundwater quality?	[ ]	[ ]	[ ]	[X]
i.	Substantial reduction in the amount of groundwater otherwise available for public water supplies?	[ ]	[ ]	[ ]	[X]
V.	AIR QUALITY				
	Would the proposal:				
a.	Violate any air quality standard or contribute to an existing or projected air quality violation?	[ ]	[ ]	[ ]	[X]
b.	Expose sensitive receptors to pollutants?	[ ]	[ ]	[ ]	[X]
c.	Alter air movement, moisture, or temperature, or cause any change in climate?	[ ]	[ ]	[ ]	[X]
d.	Create objectionable odors?	[ ]	[ ]	[ ]	[X]
VI.	TRANSPORTATION/CIRCULATION				
	Would the proposal result in:				
a.	Increased vehicle trips or traffic congestion?	[ ]	[ ]	[ ]	[X]
b.	Hazards to safety from design features (e.g. farm equipment)?	[ ]	[ ]	[ ]	[X]
c.	Inadequate emergency access or access to nearby uses?	[ ]	[ ]	[ ]	[X]
d.	Insufficient parking capacity on- site or off- site?	[ ]	[ ]	[ ]	[X]
e.	Hazards or barriers for pedestrians or bicyclists?	[ ]	[ ]	[ ]	[X]
f.	Rail, waterborne or air traffic impacts?	[ ]	[ ]	[ ]	[X]
g.	Conflicts with adopted policies supporting transportation (e.g., bus turnouts, bicyclists racks)?	[ ]	[ ]	[ ]	[X]

		Potentially Significant Impact	Potentially Significant Unless Mitigation Incorporated	Less Than Significant Impact	No Impact
VII.	BIOLOGICAL RESOURCES				
	Would the proposal result in impacts to:				
a.	Endangered, threatened or rare species or their habitats (including but not limited to plants, fish, insects, animals, and birds)?	[ ]	[ ]	[ ]	[X]
b.	Locally designated species?	[ ]	[ ]	[ ]	[X]
	c. Locally designated natural communities (e.g. oak forest, coastal habitat, etc.)?	[ ]	[ ]	[ ]	[X]
d.	Wetland habitat (e.g. marsh, riparian and vernal pool)?	[ ]	[ ]	[ ]	[X]
e.	Wildlife dispersal or migration corridors?	[ ]	[ ]	[ ]	[X]
VIII.	ENERGY AND MINERAL RESOURCES				
	Would the proposal:				
	a. Conflict with adopted energy conservation plans?	[ ]	[ ]	[ ]	[X]
	b. Use non- renewable resources in a wasteful and inefficient manner?	[ ]	[ ]	[ ]	[X]
	c. Result in the loss of availability of a known mineral resource that would be of future value to the region and the residents of the State?	[ ]	[ ]	[ ]	[X]
IX.	HAZARDS				
	Would the proposal involve:				
	a. A risk of accidental explosion or release of hazardous substances (including, but not limited to: oil, pesticides, chemicals or radiation)?	[ ]	[ ]	[ ]	[X]
	b. Possible interference with an emergency response plan or emergency evacuation plan?	[ ]	[ ]	[ ]	[X]
	c. The creation of any health hazard or potential health hazard?	[ ]	[ ]	[ ]	[X]
	d. Exposure of people to existing sources of potential health hazards?	[ ]	[ ]	[ ]	[X]
	e. Increased fire hazard in areas with flammable brush, grass, or trees?	[ ]	[ ]	[ ]	[X]
X.	NOISE				
	Would the proposal result in:				
	a. Increases in existing noise levels?	[ ]	[ ]	[ ]	[X]

		Potentially Significant Impact	Potentially Significant Unless Mitigation Incorporated	Less Than Significant Impact	No Impact
b.	Exposure of people to severe noise levels?	[ ]	[ ]	[ ]	[X]
XI.	PUBLIC SERVICES				
	Would the proposal have an effect upon or result in a need for new or altered government services in any of the following areas:				
a.	Fire protection?	[ ]	[ ]	[ ]	[X]
	b. Police protection?	[ ]	[ ]	[ ]	[X]
c.	Schools?	[ ]	[ ]	[ ]	[X]
d.	Maintenance of public facilities, including roads?	[ ]	[ ]	[ ]	[X]
	e. Other governmental services?	[ ]	[ ]	[ ]	[X]
XII.	UTILITIES AND SERVICE SYSTEMS				
	Would the proposal result in a need for new systems or supplies or substantial alterations to the following utilities:				
	a. Power or natural gas?	[ ]	[ ]	[ ]	[X]
	b. Communications systems?	[ ]	[ ]	[ ]	[X]
	c. Local or regional water treatment or distribution facilities?	[ ]	[ ]	[ ]	[X]
	d. Sewer or septic tanks?	[ ]	[ ]	[ ]	[X]
	e. Storm water drainage?	[ ]	[ ]	[ ]	[X]
	f. Solid waste disposal?	[ ]	[ ]	[ ]	[X]
g.	Local or regional water supplies?	[ ]	[ ]	[ ]	[X]
XIII.	AESTHETICS				
	Would the proposal:				
a.	Affect a scenic vista or scenic highway?	[ ]	[ ]	[ ]	[X]
	b. Have a demonstrable negative aesthetic effect?	[ ]	[ ]	[ ]	[X]
	c. Create light or glare?	[ ]	[ ]	[ ]	[X]
XIV.	CULTURAL RESOURCES				
	Would the proposal:				
	a. Disturb paleontological resources?	[ ]	[ ]	[ ]	[X]
	b. Disturb archaeological resources?	[ ]	[ ]	[ ]	[X]

		Potentially Significant Impact	Potentially Significant Unless Mitigation Incorporated	Less Than Significant Impact	No Impact
c.	Affect historical resources?	[ ]	[ ]	[ ]	[X]
d.	Have the potential to cause a physical change which would affect unique ethnic cultural values?	[ ]	[ ]	[ ]	[X]
e.	Restrict existing religious or sacred uses within the potential impact area?	[ ]	[ ]	[ ]	[X]

XV. RECREATION

Would the proposal:

		Potentially Significant Impact	Potentially Significant Unless Mitigation Incorporated	Less Than Significant Impact	No Impact
a.	Increase the demand for neighborhood or regional parks or other recreational facilities?	[ ]	[ ]	[ ]	[X]
b.	Affect existing recreational opportunities?	[ ]	[ ]	[ ]	[X]

XVI. MANDATORY FINDINGS OF SIGNIFICANCE

		Potentially Significant Impact	Potentially Significant Unless Mitigation Incorporated	Less Than Significant Impact	No Impact
a.	Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community. Reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	[ ]	[ ]	[ ]	[X]
b.	Does the project have the potential to achieve short-term, to the disadvantage or long-term, environmental goals?	[ ]	[ ]	[ ]	[X]
c.	Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects).	[ ]	[ ]	[ ]	[X]
d.	Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	[ ]	[ ]	[ ]	[X]

C. Determination

Based on the evaluation in FED (Environmental Effects section), I find that the proposed Policy for the development of the Clean Water Act section 303(d) list will not have a significant adverse effect on the environment.

December 2, 2003
Date

Stan Martinson, Chief
Division of Water Quality
State Water Resources Control Board

EXPLANATIONS

I.a.,b.,c.e. Land use and planning (e.g., general plans and zoning) delineate those areas that will be developed, and the type and density of development to be allowed. There is nothing in the proposed Policy that requires property to be used in any way or prohibits property uses.

I.d. The placement of waters on the section 303(d) list, water quality limited segments category will lead to the development of TMDLs or implementation of other regulatory actions. Depending on the pollutant and pollutant source, agricultural operations may be impacted by the implementation of the TMDL or these other actions. Site-specific impacts of individual TMDLs will be considered by the RWQCBs and SWRCB when the TMDL and implementation plans are developed. Addressing these kinds on potential impacts at this stage would be speculative.

II.a.,b.,c.;XV.a. There is nothing in the proposed Policy that would affect population, housing or recreation.

III.a, b, d. These geologic problems are not caused by water pollution or the development of the section 303(d) list. However, during the implementation of TMDLs people could potentially be exposed to such impacts during the construction or operation of new facilities to treat water pollution to reduce or eliminate pollutant inputs. If such actions are necessary the potential environmental effects will be addressed during the development of the TMDL and implementation plan.

III.c. Liquefaction occurs in the subsurface when the mechanical behavior of a granular material is transformed from a solid state to a liquid state due to loss of grain-to-grain contact during earthquake shaking. It occurs most often in areas underlain by saturated, unconsolidated sediments. Seismic ground failure is not caused or affected by water pollution or the development of the section 303(d) list.

III.a.,b.,d.,e.,f.,g.,i.; V.d.; VI.a.,b.,c.,d.,e.,f.,g.; VIII.a.,b.,IX.a.,b.,e.; X.a.,b.; XI.a.,b.,c.,d.,e.; XII.a.,b.,f; XIII.a.,b.,c.; XIV.a.,b.,c.,d.,e. Exposure of people to geologic actions, landslides, erosion, impacts to transportation systems, energy impacts, odors, impacts to public services and utilities, impacts to wildlife areas, and impacts to aesthetics or cultural resources could occur during the construction or operation of new facilities to treat water pollution as a result of additional effort to reduce pollutant loads as a result of implementing TMDLs. If such actions are necessary to address pollutant impacts to ensure that water quality standards are met, potential environmental effects will be addressed in the specific TMDL designed to address the water quality problem.

III.h. Expansion of soils is influenced by amount of moisture change and type of soil (the amount of clay in the soil and the type of minerals in the clay). Shrink-swell is measured by the volume change in the soil. Placement of waters on the section 303(d) list does not affect the shrink-swell capacity of soils.

IV.a.,b.,d.,e.,f.,g.,i. The placement of waters on the section 303(d) list does not affect absorption rates, drainage patterns, surface runoff, flooding, quantity of surface or groundwater, surface water currents, or groundwater flow or supply. The proposed Policy does not apply to groundwater; it only applies to surface waters.

IV.c. The proposed Policy is expected to provide procedures that would enable the SWRCB and the RWQCBs to apply a consistent, scientifically defensible approach for assessing waters of the State in terms of water quality standards and beneficial use attainment. The section 303(d) list would also direct the scheduling of waters that receive TMDLs. Depending on the pollutant and pollutant source, many waters of the State may be impacted by the implementation of a TMDL or other regulatory actions necessary to address the listing. Site-specific impacts of individual TMDLs will be considered by the RWQCBs and SWRCB when the TMDL and implementation plans are developed. Addressing these kinds of site-specific potential impacts at this stage would be speculative.

IV.h.;V.a.,b. The proposed Policy does not apply to groundwater or air quality.

V.c. The identification of water quality limited segments does not affect significantly temperature, humidity, precipitation, winds, cloudiness, or other atmospheric conditions.

VII.a.,b.,c.,d.,e.;XVI.a. The proposed Policy is not expected to cause any significant adverse effects to plants and animals, including rare, threatened, or endangered species. The provisions of the proposed Policy are expected to result in a consistent and scientifically defensible section 303(d) listing methodology. The provisions of the proposed Policy are expected to encourage better regulation of waters that do not meet water quality standards. Therefore, the proposed Policy will encourage protection of rare and endangered species as will as fish and wildlife habitats generally. If there are potential impacts to these resources identified in the development and implementation of TMDLs or other regulatory actions, the potential environmental effects will be addressed in the environmental documentation supporting the future action.

VIII.c. The proposed Policy does not involve or affect the availability of a mineral resource.

IX.c.,d.;XVI.d. The proposed Policy is not expected to cause adverse effects to human health. The proposed Policy will identify waters that may pose a health hazard.

XII.c.,d.,e.,g. Effects on water utility and service systems could potentially occur if TMDLs (developed as a result of the proposed Policy) cause the regulated community to take compliance actions that involved construction or substantial alterations to treatment facilities. However, the Policy will not require dischargers to take such compliance actions. If there are potential impacts to these resources identified in the development of TMDLs or other regulatory actions resulting from the section 303(d) list, then the potential environmental impacts will be addressed in the environmental documentation developed for these actions. For point discharges to waters placed on the section 303(d) list, final permit limits will be unaffected by the listing because final effluent limits will be developed following the State Implementation Policy (SWRCB Order No. 2001-06).

XV.b. Pollutants in water and sediment can affect recreational opportunities such as swimming if water quality standards are not achieved in a water body. The provisions of the proposed Policy establish consistent, scientifically defensible methods to determine if specific waters are not meeting water quality standards. The provisions of the proposed Policy are expected to encourage better regulation of waters that do not meet water quality standards. Therefore, the proposed Policy will encourage protection of human health. If there are potential impacts to these resources identified in the development and implementation of TMDLs or other regulatory actions, the potential environmental effects will be addressed in the environmental documentation supporting these actions

XVI.a.,c.: See the section of the FED that addresses cumulative and long-term impacts.

GLOSSARY

α (Alpha)	The statistical error of rejecting a null hypothesis that is true. This type of error is also called Type I error.
Alternate hypothesis	A statement or claim that a statistical test is set up to establish.
Beneficial Uses	Uses of water that may be protected against degradation include, but are not limited to, domestic, municipal, agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; preservation and enhancement of fish, wildlife, and other aquatic resources and preserves (CWC section 13050(f)).
β (Beta)	The statistical error of failing to reject a null hypothesis that is not true. This type of error is also called Type II error.
Best Management Practices (BMP)	Methods, measures or practices selected by an agency to meet its nonpoint source control needs. BMPs include but are not limited to structural and nonstructural controls and operation and maintenance procedures. BMPs can be applied before, during and after pollution producing activities to reduce or eliminate the introduction of pollutants into receiving waters.
BINOMDIST	An Excel® function that is used to calculate the cumulative binomial distribution.
Binomial Distribution	A binomial distribution statistically describes the probabilities associated with the possible number of times particular outcomes will occur in series of observations (i.e., samples). Each observation may have only one of two possible results (e.g., yes/no, on/off, and violation/compliance). The following assumptions must apply in order to reliably employ binomial distribution statistics: ♦ Each observation may result in only two possible outcomes. ♦ An “experiment” consists of *N* identical trials or observations. ♦ The probability of one particular result (out of two) remains constant from one observation to the next. ♦ The observations (i.e., samples) are independent, so that the outcome of one observation has no effect on the outcome of another.
Bioaccumulation	The process by which a chemical is taken up by an aquatic organism, both from water and through food.
Bioassessment	Biological assessment is the use of biological community information along with the measure of the physical/habitat

	quality to determine, in the case of water quality, the integrity of a water body of interest.
Contamination	An impairment of the quality of the water of the state by waste to a degree which creates a hazard to the public health through poisoning or through the spread of disease. "Contamination" includes any equivalent effect resulting from the disposal of waste whether or not waters of the state are affected (CWC section 13050(k)).
California Toxics Rule (CTR)	USEPA established numerical water quality criteria for priority toxic pollutants for California Inland Surface Waters, Enclosed Bays and Estuaries.
Conventional Pollutants	Include dissolved oxygen, pH, and temperature (from the section 305(b) guidance).
Diel	Pertaining to a 24-hour period of time; a regular daily cycle.
Effect size	The maximum magnitude of exceedance frequency that is tolerated.
Effects Range-Median (ERM) and Effects Range-Low (ERL) Values	Sediment quality guidelines based on a biological effects empirical approach. These values represent chemical concentration ranges that are rarely (i.e., below the ERL), sometimes (i.e., between ERL and ERM), and usually (i.e., above the ERM) associated with toxicity for marine and estuarine sediments. Ranges are defined by the tenth percentile and fiftieth percentile of the distribution of contaminant concentrations associated with adverse biological effects.
Equilibrium Partitioning (EqP) Approach	Methodology of developing sediment quality guidelines that assumes that an organism receives an equivalent exposure from water only exposures or from any equilibrated phase (e.g., either from pore water via respiration; or from organic carbon, via ingestion; or from a mixture of the routes). Approach results in guideline values expressed in terms of a sediment phase controlling contaminant bioavailability (e.g., organic carbon for nonionic organic compounds or sulfides for metals).
Equilibrium Partitioning Sediment Guidelines	Sediment quality guidelines derived using the EqP approach. When used in conjunction with appropriately protective water only exposure concentration, a resulting guideline represents the sediment contaminant concentration that protects benthic organisms from the effects of that contaminant.

Index of Biological Integrity (IBI) — The response of indicators designed to monitor or detect biological, community, or ecological conditions. IBI is a multimetric index indicating the ability of a habitat to support and maintain a balanced, integrated, adaptive biological system having the full range of elements expected in a region's natural habitat.

Maximum Contaminant Level (MCL) — The maximum permissible level of a contaminant in water delivered to any user of a public water system.

Maximum Tissue Residue Level (MTRL) — MTRLs were developed from human health water quality objectives in the 1997 California Ocean Plan and from the California Toxic Rule as established in the Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California. MTRLs are used as alert levels or guidelines indicating water bodies with potential human health concerns and are an assessment tool and not compliance or enforcement criteria. The MTRLs are calculated by multiplying human health water quality objectives by the bioconcentration factor for each substance.

National Academy of Science (NAS) Tissue Guidelines — NAS guidelines are established guidelines for the protection of predators. Values are suggested for residues in whole fish (wet weight) for DDT (including DDD and DDE), aldrin, dieldrin, endrin, heptachlor (including heptachlor epoxide), chlordane, lindane, benzene hexachloride, toxaphene, and endosulfan either singularly or in combination.

National Toxics Rule — USEPA established numerical water quality criteria for priority toxic pollutants for 12 states and two Territories who failed to comply with the section 303(c)(2)(B) of the Clean Water Act.

Nonpoint Source — Pollution sources are diffused and do not have a single point of origin or are not introduced into a receiving stream from a specific outlet. The commonly used categories for nonpoint sources are agriculture, forestry, mining, construction, land disposal, and salt intrusion.

Null hypothesis — A statement used in statistical testing that has been put forward either because it is believed to be true or because it is to be used as a basis for argument, but has not been proved.

Point Source — Any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigation agriculture or agricultural storm water runoff (40 CFR 122.2).

Pollutants	Defined in section 502(6) of the CWA as "dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water."
Pollution	The term *pollution* is defined in section 502(19) of the CWA as the "the man-made or man-induced alteration of the chemical, physical, biological, and radiological integrity of water." *Pollution* is also defined in CWC section 13050(1) as an alternation of the quality of the waters of the state by waste to a degree that unreasonably affects either the waters for beneficial uses or the facilities that serve these beneficial uses.
Probable Effect Concentration (PEC)	Consensus based PECs are empirically derived freshwater sediment quality guidelines (SQG) that rely on the correlation between the chemical concentration in field collected sediments and observed biological effects. PECs are based on geometric means of various SQG approaches (with matching chemical and toxicity field data) to predict toxicity for freshwater sediment on a regional and national basis.
Probable Effects Level (PELs) and Threshold Effects Levels (TEL)	Sediment quality guidelines based on a biological effects empirical approach similar to ERMs/ERLs. A generalized approach used to develop effects-based guidelines for the state of Florida and others. The lower of the two guidelines for each chemical (i.e., the TEL) is assumed to represent the concentration below which toxic effects rarely occur. In the range of concentrations between the two guidelines, effects occasionally occur. Toxic effects usually or frequently occurs at concentrations above the upper guideline value (i.e., the PEL). Ranges are defined by specific percentiles of both the distribution of contaminant concentrations associated with adverse biological effects and the "no effects" distribution.
Rank correlation	Association between paired values of two variables that have been replaced by their ranks within their respective samples (e.g., chemical measurements and response in a toxicity test).

Reference Condition	The characteristics of water body segments least impaired by human activities. As such, reference conditions can be used to describe attainable biological or habitat conditions for water body segments with common watershed/catchment characteristics within defined geographical regions.
Spatial Representation	The degree of compatibility or overlap in the study area, locations of measurements or samples, locations of stressors or potential pollutant sources, and locations of potential exposure to pollutants.
Statistical Significance	A finding (for example, the observed difference between the means of two random samples) is statistically significant when it can be demonstrated the probability of obtaining such a difference by chance only is relatively low.
Temporal Representation	Compatibility or overlap between measurements (when data were collected or the period for which data are representative) and the period during which effects of concern would likely to be detected.
Total Maximum Daily Load (TMDL)	TMDL is the sum of individual wasteload allocations and load allocations; a margin of safety. TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measures that relate to a state's water quality standards.
Toxicants	Include priority pollutants, metals, chlorine and nutrients (from the section 305(b) guidance).
Toxicity Identification Evaluation (TIE)	TIE is technique to identify the unexplained cause(s) of toxic events. TIE involves selectively removing classes of chemicals through a series of sample manipulations (e.g. solid phase extraction to remove organic compounds), effectively reducing complex mixtures of chemicals in natural waters to simple components for analysis. Following each manipulation the toxicity of the sample is assessed to see whether the toxicant class removed was responsible for the toxicity.
Toxicity Test	A test to determine the toxicity of a chemical in ambient water using living organisms. A toxicity test measures the degree of effect on exposed test organism. Toxicity is determined when there is a statistically significant difference in mortality, and/or growth and reproduction of an organism in water compared to the laboratory control.

Waste Discharge Requirements (WDR)	WDRs are issued under State law pursuant to CWC section 13263 and apply to dischargers that discharge waste to land or to water. WDRs implement water quality control plans, take into consideration beneficial uses, water quality objectives, other waste discharges, the need to prevent nuisance, and the provisions of CWC section 13241. The disposal method may be by agricultural or non-agricultural irrigation, ponds, landfills, mono-fills, or leachfields.
Water Quality Limited Segment	Any segment [of a water body] where it is known that water quality does not meet applicable water quality standards, and /or is not expected to meet applicable water quality standards, even after application of technology-based effluent limitations required by CWA sections 301(d) or 306 as defined in the federal regulation.
Water Quality Objectives	The limits or levels of water quality constituents or characteristics which are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area.
Water Quality Standard	Provisions of State and Federal Law which consist of a designated use or uses for the waters of the United States, water quality criteria for such waters based upon such uses. Water quality standards are to protect public health or welfare, enhance the quality of the water and serve the purpose of the Clean Water Act (40 CFR 131.3).

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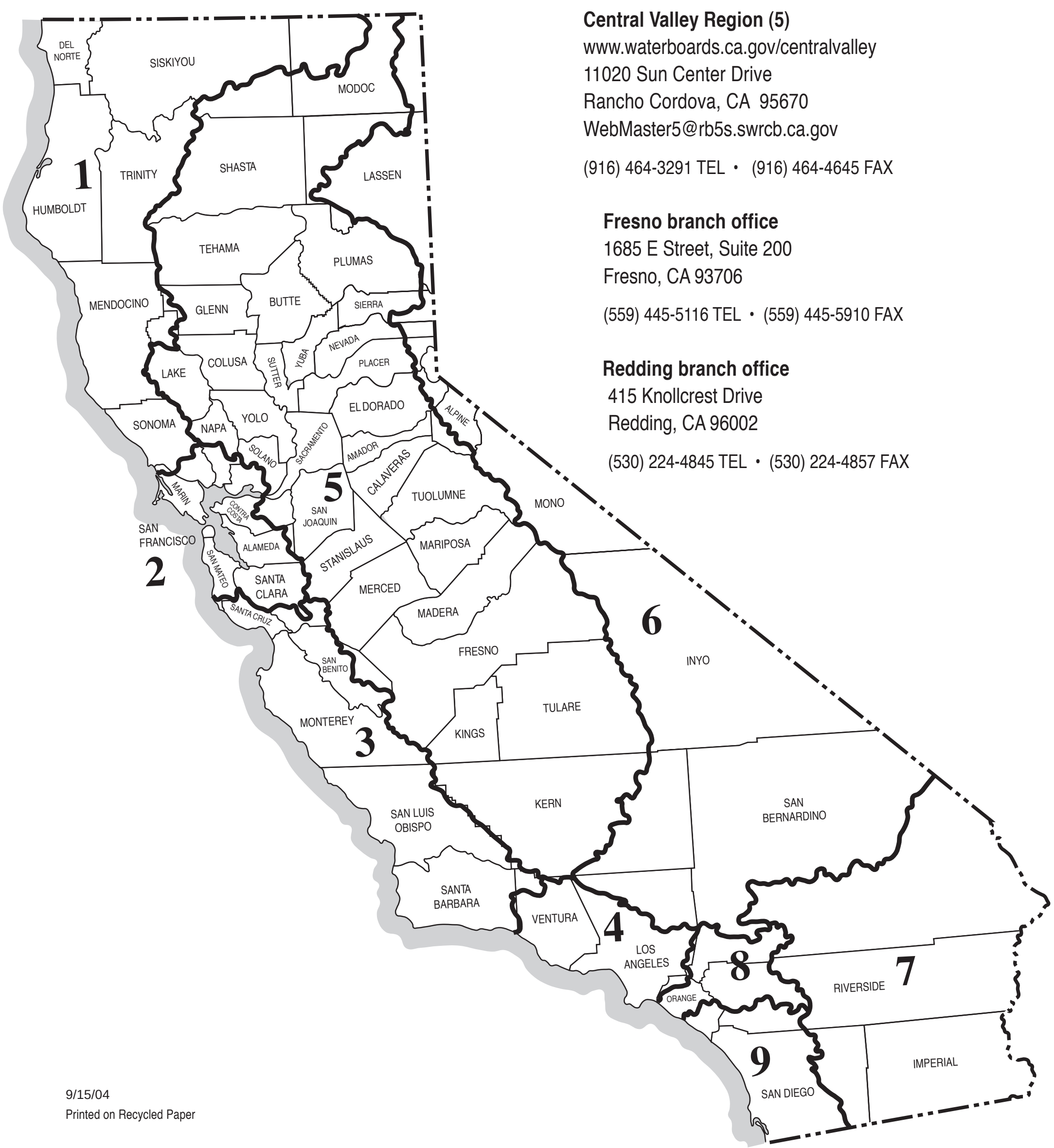

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