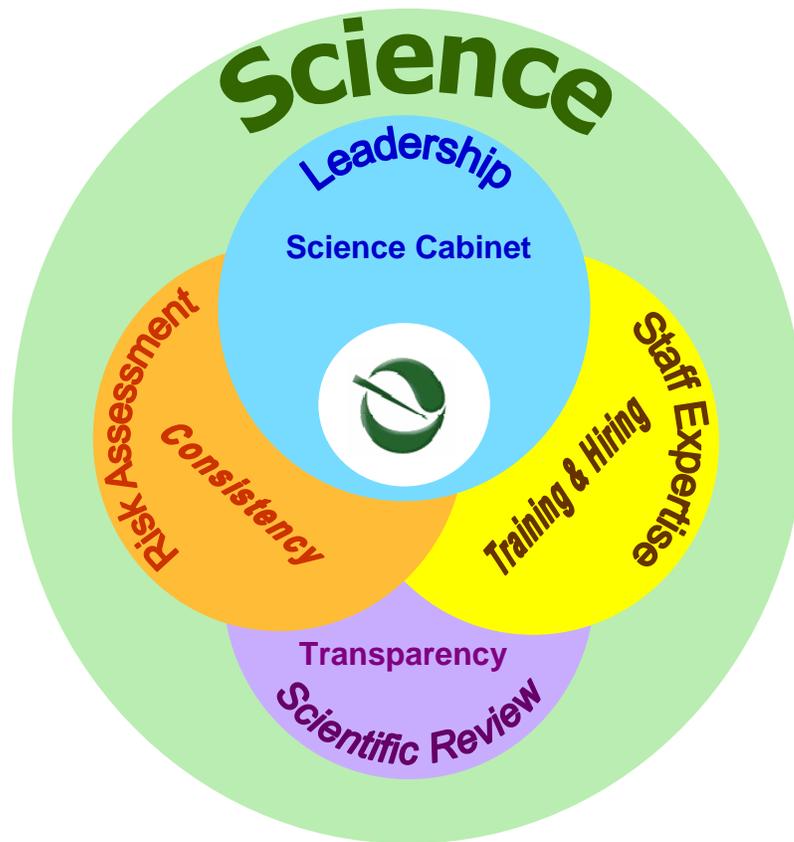




The Quality and Role of Science in Cal/EPA

July 2007



Report to the Secretary from the
Steering Committee for Science
California Environmental Protection Agency

This report was prepared by the Steering Committee for Science (SCS) and submitted to the Secretary for Environmental Protection for consideration. The SCS was chaired by Dr. Shankar Prasad, Deputy Secretary for Science and Environmental Justice, and included representatives from the Boards, Departments, and Office within the California Environmental Protection Agency.

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Executive Summary

Background

An important responsibility of the Secretary for Environmental Protection is to ensure that the California Environment Protection Agency (Cal/EPA) and its constituent boards, departments and office (BDOs) use sound scientific principles and methods in the decision-making processes. Recognizing the importance of this responsibility, former Secretary Dr. Alan Lloyd, at his confirmation hearing, committed to "... evaluate and make recommendations on the role science plays in regulatory matters across all BDOs." In order to fulfill this commitment, he directed that a Steering Committee for Science (SCS) be formed with representatives from the Secretary's Office and each of the BDOs to carry out this assessment and make recommendations for his consideration. This report is the SCS's report to the Secretary for Environmental Protection.

SCS Assessment Process

The SCS held 14 meetings in a span of eight months. The primary objectives of the SCS were to characterize the quality and role of science in decision-making and to identify ways in which the quality and role could be improved. The SCS took a dual approach to address these objectives. The SCS sent a questionnaire to each BDO requesting information on the history of major programs, along with the role of science in the implementation of those programs. In parallel, SCS disseminated a web-based, agency wide-survey (e-survey) for all Cal/EPA staff. The SCS compiled and analyzed information obtained from both these sources and prepared a draft report with findings and recommendations. SCS then sent a draft report to all Cal/EPA BDO executive officers and an external review panel of nine scientists. The SCS prepared this report after consideration of comments from the BDOs and external reviewers listed inside the cover page of this report.

BDO Questionnaire Evaluation

The BDO Questionnaire included questions on five areas covering regulatory decisions and activities, science ambience, research, strengths and areas for improvement, and additional suggestions. Following is an abbreviated analysis of the BDO responses (a summary of the BDO responses is in Chapter 3 and the analysis of those responses by the SCS in Chapter 4 of this report).

Role of Science in BDO Decision-Making Processes

A variety of considerations go into BDO decision-making processes. Most BDO goals and targets are developed using a variety of inputs, including statutory requirements, Agency guidelines, published and unpublished scientific data, input from other BDOs, advisory committees, peer review, public comment, decisions by other entities including federal and international agencies, and federal mandates. Although decisions must be based on sound science, the decisions regarding most policies and regulations must also consider additional factors such as technological feasibility, economic considerations, societal goals, and court decisions. Some respondents have expressed

concern about the transparency of decision-making processes. The public record should be sufficiently clear such that it is possible to reconstruct the decision-making process, including the factors that were considered and how each of the scientific and other factors influenced the final decision.

Quality of Science at Cal/EPA

Cal/EPA BDOs ensure the quality of science primarily through the expertise of the scientific staff employed, through contracts for additional expertise when needed, and through internal and external scientific peer review. Cal/EPA BDOs employ scientists, many with advanced degrees, from numerous disciplines. Scientists can keep abreast of the latest information and technology by attending seminars, workshops, symposia, and training both in house (intra- and inter-BDO) and outside (training provided by universities, professional societies, non-profit professional groups), etc. Scientists also utilize scientific journals available online, through subscription, or in hard copy from the Cal/EPA Library.

Beyond the workplace, scientists present their work at professional meetings and publish it in refereed journals. While the high level of qualifications of scientists and the ongoing training they receive were considered positive, questionnaire respondents noted that continued efforts are necessary to maintain the expertise of the scientists' knowledge in their fields.

Scientific Peer Review

BDOs use internal, inter-BDO, and external scientific review. Although all significant decisions receive internal review, and most also receive some form of external review, the extent to which these are carried out is variable. Some programs have specific review boards established by law. In addition, California Health and Safety Code (HSC) Section 57004 requires external peer review of the scientific basis or scientific portion of a proposed rule or regulation agency-wide. The external peer review contract with the University of California Office of the President, as part of the implementation of HSC Section 57004, while considered beneficial, was often described as cumbersome and slow. At the same time, other peer review arrangements between an individual and the University of California (UC) were described as being more efficient.

Research

Research plays a key role in BDO decision-making. BDOs use information from published literature, and they conduct or sponsor external research via grants and contracts. Some respondents felt that Cal/EPA should enhance research activities. Such research should be focused on those questions germane to supporting regulatory and other programmatic needs. In addition to addressing program-related questions, additional focus would strengthen the ties between Cal/EPA and the research community, particularly the UC system.

Funding

Funding is seen as essential to the quality of science throughout the agency. Respondents noted that competing priorities for available resources is an ongoing challenge. Managers and executives are encouraged to balance those needs with the key function that sound science plays in BDO programs.

Emerging Environmental Issues

Although the Emerging Environmental Challenges Program was an important initial effort, BDOs do not have a formal approach to address emerging issues. Some of these new challenges are outside the scope of the training and expertise of current staff. Currently, staff become aware of emerging issues through news, publications, or other sources. These emerging issues are brought to the attention of management and, if deemed worthy of further attention, may be assigned some level of support. This ad hoc approach may not capture the potential significance of a particular issue. Emerging environmental issues should be considered in a systematic, coordinated manner.

Electronic Survey Evaluation

The e-survey contained two sections. The first section provided multiple choices for a respondent to rate his/her level of satisfaction with the application of science at different organizational levels. The second section gave the respondent an opportunity to provide suggestions that could improve the quality and use of science at each organizational level. About 730 out of 4,500 Cal/EPA staff (technical or non-technical) employees participated in the e-survey, reflecting a 16 percent participation rate. But, the participants represented 16-39 percent of technical staff agency-wide. A large portion of the participants also provided a total of more than 600 comments and suggestions. A more detailed discussion of the e-survey responses is included in Chapter 5 of the report.

Overall, the majority of the staff that participated in the e-survey agreed that their work required using science frequently, and most of them were satisfied with the quality of science in their work. The majority of respondents agreed that their section ensures sound science in work products; however, this was not the majority opinion of respondents from the Department of Pesticide Regulation.

From the ratings portion of the survey, it is obvious that Cal/EPA employees are generally satisfied with the quality of science and the role that science plays in their professions. However, respondents' suggestions indicate there is also room for improvement within each of the BDOs. Based on the common threads linking many of the more than 600 comments and suggestions received, the SCS made the following findings—some of which are generally applicable throughout the Agency, and some that are more limited in applicability to a particular BDO.

General Findings

- Science is a necessary and important component of their job, and final work products reflect reasonable scientific input.
- While the system is not “broken,” the quality and role of science in decision-making could be improved. Staff members responded that they are not keeping up with the state of science in their disciplines. They recommend additional training and professional development.
- Management is not giving sound science as large a role as it should have in decision-making.
- Similar work products (e.g., risk assessment, characterization of uncertainty) are not being developed in a consistent manner in different BDOs, or even, in some cases, within BDOs.
- Higher scientific standards are needed when hiring and promoting staff and also when reviewing contractor work products.
- Increased in-house interaction with peers is desirable to provide better planning of projects, better review of work, better dissemination of results, etc.
- Staff is concerned about perceived compensation inequities.

BDO-Specific Suggestions

Some comments and suggestions were grouped under a specific BDO because they are more specific and relevant for further evaluation by that organization. About 30 of these specific comments and suggestions are listed in Chapter 5 of the report.

Examples of the organizational-specific recommendations are:

- Air Resources Board: Evaluate and characterize uncertainty related to major data bases including the Emission Inventory and models such as the Emission FACtors (EMFAC) Model.
- Integrated Waste Management Board: Strengthen scientific expertise and skills of the Board, executive and technical staff and reduce reliance on contract work for science reports.
- Department of Pesticide Regulation: Ensure consistency, transparency and review (internal and external) of the risk assessment process and products and combine the pesticide exposure assessment and other risk assessment activities into one group.
- Department of Toxic Substances Control: Ensure consistency, transparency and review (internal and external) of the risk assessment process and products.
- Office of Environmental Health Hazard Assessment: Streamline and standardize internal and external peer review processes.
- Water Boards: Re-examine the scientific basis for Basin Plans and effluent limits (including risk assessment) ensuring consistent and standardized approaches among the state and regional boards.

External Review

The SCS reviewed and incorporated the comments from the external review panel to revise its report. Many comments supported SCS' findings, and others may receive further evaluation by Cal/EPA in the future. Some of the key comments are listed:

- Cal/EPA Management should consider establishing a "Science Cabinet" with a designated chief scientist at an executive level in each BDO.
- To improve the peer-review process, Cal/EPA should streamline the process with the UC and consider inclusion of other academic institutions as well as experts from industry.
- While it is important for the report to identify recommendations, it is equally important to implement these recommendations.
- Management should establish a system of awards to recognize scientists with outstanding accomplishments and provide feedback to staff about the basis for its decisions.
- In characterizing risk estimates, it would be more balanced to present a range of risks as well as to identify and quantify uncertainties to the extent possible.

A more detailed description of the external review can be found in Chapter 6.

SCS Recommendations

After a careful evaluation and consideration of the results obtained from the BDO questionnaires and web-based agency-wide survey, and in consultation with BDO Executive Officers and External Review Panel, SCS has made ten recommendations. These recommendations can be categorized into three groups in terms of their priorities. The first group is related to consistency, leadership, and organizational structure, as well as staffing issues (expertise, retention, and recruitment). Communication and transparency, and scientific advice and peer review are in the second group. Research, emerging issues, and environmental indicators are in the third group. A more detailed discussion of the SCS recommendations can be found in Chapter 7.

Consistency, Leadership, and Organizational Structure/Staffing Issues

Lack of consistency in work products and decision-making among, and sometimes within, BDOs undermines the credibility of Cal/EPA. Cal/EPA needs to enhance consistency both in the risk assessment process and in the application of scientific findings. The SCS proposes a team of internal and external scientists be formed to evaluate the laws, protocols and procedures followed by individual BDOs in their risk assessment approaches. The team will identify areas of similarity and difference and recommend how consistent and uniform protocol could be established and followed by all BDOs.

SCS also recommends that the role of science at Cal/EPA could be enhanced by designating a "Chief Scientist" within the executive management team of each BDO. In addition, SCS recommends establishing a Cal/EPA Science Cabinet comprised of BDO

Chief Scientists and four external scientists to provide guidance and recommendations to the Secretary for issues of scientific importance. The Science Cabinet would review cross-BDO and cross-media issues including the consistency of applying risk assessment, ways to streamline peer-review process, and Agency-wide coordination in areas of research, environmental indicators, and emerging issues.

While designating chief scientists and establishing the Cal/EPA Science Cabinet will enhance the leadership role and show the commitment, it may also be necessary to change the organizational structures to complement the efforts related to consistency, communication and transparency, and inter-BDO collaboration. The SCS proposes that a team be formed with external consultants and internal executive managers to evaluate the organizational structures and identify areas where the organizational structures are not conducive to optimization of scientific integrity and the effective incorporation of scientific findings in decision-making processes.

These efforts could be taken in a concerted manner immediately and be accomplished within a year. The cost involved could be absorbed within the BDOs' existing operational budget. If the team's findings warrant further actions to improve the consistency of risk assessment and/or efficacy of organizational structures, additional resources will be sought through the normal budgetary and legislative change processes.

Cal/EPA should continue to enhance the ability to hire and retain well-trained scientists by encouraging professional development, increasing promotional opportunities, addressing the loss of the "knowledge base" due to retirements, and reviewing the multitude of scientific classifications across the Agency. In order for the staff to maintain the state-of-the-art scientific expertise, BDO management should facilitate staff attendance at scientific seminars, conferences, symposia and workshops. BDO management should improve access to scientific resources such as analytical, measurement, and modeling tools, and scientific information. Cal/EPA is now coordinating scientific journal subscriptions and making those available on intranets Agency-wide. In addition, an Agency-wide effort was undertaken to assess how scientific classifications used in the various programs and organizations can be harmonized along with a succession management plan.

Transparency and Peer Review

The second group of recommendations addresses the Agency's transparency and peer-review process. Decision-making processes, including the role of science and other factors in the final decision, must be documented and accessible in order to improve communication and transparency. The SCS proposes that the Science Cabinet will look into this issue and provide recommendations to enhance documentation and transparency in BDO decision-making processes. The implementation of these recommendations would be on an on-going basis and should have little fiscal impact.

Cal/EPA depends on strong internal and external scientific review for an effective scientific program and should seek an expedited process and funding for ensuring that all major scientific work products affecting regulations or policy receive adequate peer reviews. Internal and external scientific advice and review could be enhanced by

increasing cross-media and cross-program collaboration, and streamlining the administrative processes and expanding the “pool” of external scientific experts. The Cal/EPA organizations are collaborating on a new Interagency Agreement with the University of California. The new agreement will incorporate more efficient administrative procedures (based on State Water Resources Control Board’s model) and expand peer review to other institutions. The BDOs will allocate appropriate funds from existing budgets to the new agreement.

Research, Emerging Issues and Environmental Indicators

Recommendations in the third group consisting of Research, Emerging Issues, and Environmental Indicators are aimed at strengthening the science base at Cal/EPA. Research is needed at multiple levels to bridge gaps in scientific knowledge that guides and supports environmental policies and regulation development. Only one of the BDOs has a formally established research program while the rest of the BDOs perform research through contract on an ad hoc basis. The SCS proposes that each BDO determines whether an ongoing research program will benefit their program efforts in a cost efficient manner. Whatever mechanisms are established to meet the various research needs within each BDO, they should be efficient, transparent, and flexible to permit sound planning and review (not only of the scientific principles but also of the wise use of funds, staffing, and expertise). The Science Cabinet could serve as an oversight body to ensure that research efforts (whenever these are conducted) are coordinated with program needs and cost effective. By increasing coordination with external research organizations, BDOs could enhance environmental regulatory programs without substantial increase in state costs. Where the state directly funds research activities, better coordination will enhance the utility of these investments.

Environmental Indicators are an objective and scientific way to measure the health of the environment. In order for Cal/EPA to systematically evaluate the effectiveness of its programs in protecting public health and the environment, it needs a strong Environmental Indicators Program. BDOs should coordinate with one another and continue to collect data to update their current indicators, and establish new indicators. In addition, identifying and assessing emerging environmental challenges and cross-media issues require a systematic and coordinated efforts supported by strong leadership. BDOs should work together and develop a systematic approach to address newly identified environmental challenges and cross-media issues. The Science Cabinet could provide the required guidance and oversight for this effort.

1 Introduction

The word “science” comes from the Latin verb meaning “to know.” Webster’s Dictionary defines “science” as the process of “observation, identification, description, experimental investigation, and theoretical explanation of natural phenomena.” In order for Cal/EPA regulatory programs and decisions to be based on science, the Agency must have a competent, knowledgeable staff and management that honors the role science plays in addressing the complex issues associated with protecting public health and the environment.

This report assesses the role and quality of science as currently used within the BDOs of Cal/EPA in their decision-making. Although this assessment concludes that the current state of science is generally good, this report also makes various recommendations toward enhancing the quality and role of science within the BDOs of Cal/EPA.

An important responsibility of the Cal/EPA Secretary is to provide policy direction and coordination to the six independent BDOs within Cal/EPA. An essential part of this responsibility is to ensure that the Cal/EPA BDOs utilize science in their programs, that environmental policy is consistent across organizations, that “cross-media” issues are approached in a coordinated manner, and that the process is transparent to all sectors.

As part of the confirmation process for his appointment as Cal/EPA Secretary, Dr. Alan Lloyd committed “to evaluate and make recommendations on the role science plays in regulatory matters across all BDOs” (March 2, 2005 letter to Ms. N. Sabelhaus, Appointments Director, Senate Rules Committee). To achieve this goal, Dr. Lloyd directed that an SCS be formed with representatives from each of the BDOs to broadly evaluate the quality and role of science within Cal/EPA. This is the first time that the science throughout Cal/EPA has been assessed on a common basis for all BDOs. The objectives of the SCS were to:

- Characterize the role and quality of science in supporting decision-making within Cal/EPA.
- Identify ways in which the role of science can be enhanced or the quality of science improved to better inform decision-making within the BDOs.

The SCS has completed its qualitative review and assessment of the role of science in Cal/EPA’s decision-making processes. Based on this initial review of the state of science at Cal/EPA, and via this report, the SCS is providing to the Cal/EPA Secretary its recommendations to enhance the scientific basis for decisions and actions within the BDOs. The report provides a mechanism for ongoing review of the efforts being undertaken, and the progress being made, to ensure a solid scientific foundation for activities and decisions at Cal/EPA. The SCS believes that implementation of the recommendations in this report will help to ensure that the Cal/EPA BDOs use science in their programs, that environmental policy is consistent across organizations, that “cross-media” issues are approached in a coordinated manner, and that the process is transparent to all sectors.

2 Science Review Process

The first meetings of the SCS were held in May 2005. Dr. Lloyd joined the group for the kickoff meeting, thanked BDO representatives for their participation, and emphasized the importance of the mission. The SCS undertook and completed the following tasks:

- 1) Developed mechanisms for reviewing current decision-making processes within Cal/EPA and the role of science in those decisions.
- 2) Developed and administered a fact-finding questionnaire to the BDOs. The questionnaire was provided to upper management of all BDOs to obtain a broad overview of the role of science in guiding activities and in developing standards, protocols, and guidelines.
- 3) Developed and administered an electronic staff survey (e-survey) of the role of science in achieving the organizational missions and objectives of the BDOs. The electronic survey (e-survey) was made available to every Cal/EPA employee via a website to which staff were directed by multiple e-mails.
- 4) Prepared this draft report summarizing the results of the science review and recommending potential changes that can improve the role of science in activities and decisions within Cal/EPA.
- 5) Identified potential qualified external reviewers who reviewed the assessment by virtue of their expertise and familiarity with governmental regulatory functions and had no conflicts of interest.

The SCS pursued two primary objectives. The first was to provide a broad overview of the state of science within the BDOs of Cal/EPA. The second objective was to provide recommendations to enhance and, where appropriate, standardize the incorporation of science into the development of public policies and programs designed to protect the natural resources of the State of California and the public health and welfare of its residents.

To achieve these objectives, a two-pronged self-evaluation approach was employed. First, a questionnaire was designed to collect information on the history (background and development) of selected major programs within each BDO, along with the role of science and scientific procedures in the development and implementation of the programs. Thus, the questionnaire helped provide a general overview of the scientific ambience and procedures. However, the responses to the BDO questionnaire only provided a general perspective of the role of science in developing policies and programs. Second, to gain a broader insight into the perception of the current role of science in BDO activities and of ways to increase the role of science in BDO activities, the SCS also prepared an e-survey, which was open to participation by all employees.

The SCS developed and finalized the questions that formed the basis of the questionnaire and e-survey during several meetings in May and early June of 2005. The SCS sent the questionnaire to each BDO on June 14, 2005, with the completed response due on August 1, 2005. In parallel the SCS sent out the e-mail soliciting confidential responses to a web-based e-survey on July 11, 2005. Additional e-mails reminded staff of the survey website, and the site was closed on August 1, 2005. Information Technology (IT) staff compiled staff's individual and anonymous responses

to the e-survey into a spreadsheet and provided the information to the Office of the Secretary. The e-survey form can be found in Section 5.2.

SCS collated responses to the questionnaire and survey over a period of several weeks. The SCS also identified a report structure for presenting the information, analyzed the findings, and developed recommendations based on BDO and staff responses.

The SCS submitted the final draft report to Dr. Lloyd on October 19, 2005. After his review, Dr. Lloyd submitted the report to all Cal/EPA BDO executive offices and to an external science panel for review and comment. Dr. Lloyd selected Panel members from a list of qualified people suggested by individual BDOs. The final nine external reviewers were determined based on their interest, availability, and representation of one of the various sectors familiar with science in a regulatory setting. A brief description of their qualifications can be found in Chapter 6. The SCS revised the draft report after taking into consideration BDO and scientific panel comments. This report represents the final document prepared by the SCS.

3 Summary of BDO Responses to Questionnaire

One of the tools in this assessment was a questionnaire sent to each of the BDOs regarding the status and use of science in their BDO. Their responses to this questionnaire are summarized below. The questions were divided into four topic areas with three or four questions under each.

3.1 *Environmental Decisions and Activities*

3.1.1 List the top five major environmental programs mandated by federal or State law in which your BDO engages (e.g., setting air/water quality standards, regulating pollutant emissions, regulating toxic air/water contaminants, recycling waste products). Please briefly describe the history/background behind your BDO's responsibility for each program and how the state of the science has evolved since the program's beginning.

3.1.1.1 State Water Resources Control Board (SWRCB or State Water Board) and Regional Water Quality Control Boards

Development of State Policies for Water Quality Control and Statewide and Regional Water Quality Control Plans

The Porter-Cologne Water Quality Control Act (Porter-Cologne) is the principal law governing water quality in California. Unlike the federal Clean Water Act (CWA), Porter-Cologne applies to both surface water and ground water.

The State Water Board is responsible for developing state policy for water quality control and statewide water quality control plans, while the Regional Water Boards are required to develop and adopt regional water quality control plans (basin plans) which address all areas in a region and conform to State water quality policy. These plans, both statewide and basin, include: 1) designation or establishment of beneficial uses to be protected; 2) establishment of water quality objectives; and 3) implementation plans that control non-point and point sources of pollution in order to achieve the water quality objectives protecting each designated beneficial use.

The CWA requires each state to establish water quality standards for all water bodies in the state. Water quality "standards" consist of the designated beneficial use or uses of a water body, and a numerical or narrative statement identifying maximum concentrations of various pollutants that would not interfere with the designated use. CWA water quality standards are analogous to the beneficial uses and water quality objectives required by Porter-Cologne. Porter-Cologne was amended to authorize the State to implement the provisions of the CWA.

Water Quality Permitting

The CWA established the National Pollutant Discharge Elimination System (NPDES) for industrial and municipal dischargers. Permits are the CWA's principal enforcement tool. Permits specify the control technology applicable to each pollutant, effluent limitations, and a deadline for compliance. Sources are

required to maintain records and conduct effluent monitoring. NPDES permits must be renewed every five years.

Porter-Cologne requires any person discharging waste, or proposing to discharge waste, within any region that could affect the quality of waters of the state, to file a *report of waste discharge* with the applicable Regional Water Board. No discharge may take place until the Regional Water Board issues waste discharge requirements (WDRs) or a waiver of the WDRs.

Impaired Water Bodies

Section 303(d) of the CWA requires the states to establish a list of impaired water bodies or water segments. The State Water Board uses its "Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) List" to comply with CWA requirements. Total Maximum Daily Loads (TMDLs) are required under the CWA for each pollutant affecting an impaired water body appearing on the CWA 303(d) List. Development of TMDLs requires: 1) source analysis of the amount, timing, and origin of pollutants; 2) determination of the load capacity of a receiving water for a specific pollutant including a margin of safety; 3) assign allocations for pollutant loading among all sources; and, 4) develop an implementation plan for all sources that will achieve water quality standard(s) by a specified time.

Non-point Source Pollution Management

The 1987 amendments to the CWA directed states to develop and implement non-point source (NPS) pollution management programs. NPS is estimated to represent more than half of the water pollution problem. NPS is not subject to CWA permits or other regulatory requirements under federal law; it is delegated to the states. Porter-Cologne requires the State Water Board to prepare a detailed program for implementation of the State's NPS management plan.

Surface Water Ambient Monitoring Program (SWAMP)

The CWA requires that states have in place a monitoring program of surface water quality. The State Water Board has been developing the Surface Water Ambient Monitoring Program (SWAMP) to provide a statewide framework for coordination of high-quality, consistent and scientifically defensible methods and strategies to improve water quality monitoring, assessment, and reporting.

3.1.1.2 Office of Environmental Health Hazard Assessment (OEHHA)

OEHHA's scientific analyses are a critical component of regulatory programs and decisions. High-quality independent scientific work helps ensure that regulations and policies focus on the most significant health threats from environmental hazards, which in turn helps ensure that precious resources devoted to public health protection are expended in the most effective manner. Following are the top five environmental programs.

Air Toxicology and Epidemiology Branch (ATEB) is responsible for:

- Making recommendations to the Air Resources Board for health-based Ambient Air Quality Standards for California.

- Developing health effects assessments for Toxic Air Contaminants (TACs) and providing risk assessment guidelines for airborne emissions from stationary sources to ARB.
- Evaluating the health effects and assessing dose-response relationships of common indoor pollutants.
- Conducting epidemiological studies of air pollution health effects.

Integrated Risk Assessment Branch (IRAB) is responsible for:

- Developing health risk-based screening levels for chemical contaminants in soil and facilitating the cleanup and reuse of urban “brownfield” sites.
- Providing "multimedia evaluations" as a means of evaluation and identification of any significant adverse health impact that may result from production, use, or disposal of new motor vehicle fuel additives that require a change to Air Resources Board's motor vehicle fuel specifications.
- Providing assistance in evaluating site-specific health risk assessments for the State Water Resources Control Board and the Integrated Waste Management Board.
- Coordinating Environmental Protection Indicators for California.
- Providing ecological risk assessment guidance on methodology and evaluation.

Pesticide and Environmental Toxicology Branch (PETB) is responsible for:

- Developing health-based public health goals (PHGs) that are used by the Department of Health Services to update the drinking water Maximum Contaminant Levels.
- Providing pesticide illness surveillance, epidemiological, and other assistance to local health officers in the event of an outbreak of pesticide poisoning, and joint and mutual responsibility with the DPR for developing regulations to protect workers exposed to agriculture pesticides.
- Evaluating and publishing consumption health advisories for sport fish and wildlife with chemical contaminants.

Reproductive and Cancer Hazard Assessment Branch (RCHAB) is responsible for:

- Providing scientific support for the implementation of Proposition 65 by listing chemicals as causing cancer or reproductive toxicity, by conducting dose-response assessments and developing safe harbor levels for listed chemicals, and by developing guidelines for conducting human health risk assessments.
- Characterizing human and environmental health risks of complex mixtures associated with gasoline use in California.

Children's Health Programs involve all the above programs and are responsible for:

- Listing TACs that may disproportionately impact children, updating health risk assessment methodologies to adequately consider the different exposure patterns between infants and children and adults, the special susceptibilities to toxicants of infants and children, and interactions of air pollutants impacting the health of infants and children.

- Researching the effects of age at exposure on the potency of carcinogens to identify chemicals that are more potent when exposure occurs early in life, and incorporating the results of this research into risk assessment guidelines.
- Incorporating the same concepts of differences in exposure and susceptibility of infants and children relative to adults in developing PHGs.
- Developing guidance for use by the Department of Toxic Substances Control (DTSC) and other agencies in assessing exposures and health risks to hazardous substances at existing and proposed school sites and developing child-specific toxicity criteria for chemicals commonly found at school sites.

3.1.1.3 Department of Toxic Substances Control (DTSC)

Federal Mandates

- Comprehensive Environmental Response Compensation and Liability Act (CERCLA, 1980)
- Designation of Stringfellow Acid Pits as first Superfund site in California (1983)

State Mandates

- Hazardous Waste Control Act (1972)
- Carpenter-Presley-Tanner Hazardous Substance Account Act (1981)
- Creation of Toxic Substances Control Program (1982)
- Hazardous Waste Cleanup Bond Act (California Superfund Act, 1984)
- Emergency Response, Health and Safety Code, Section 25500-25520
- Pollution Prevention and Source Reduction Laws (several, 1980s)
- The California Superfund Act of 1984 permitted DTSC to add adequate project and support staff with training in chemistry, geology, engineering, industrial hygiene, and toxicology. DTSC uses these disciplines to define hazardous wastes, characterize waste sites and releases, derive risk-based cleanup levels, regulate risk management at hazardous waste sites, respond to emergencies, and apply better management practices to prevent pollution. Applications of scientific advances in these areas have changed the way DTSC does business:
- More sensitive analytical methods.
- Improved personnel protection.
- Life cycle assessment for pollution prevention.
- Desktop computer simulations for risk assessment.

3.1.1.4 Department of Pesticide Regulation (DPR)

Federal and State Environmental Statutes Impacting DPR

Environmental Element	Federal Statute	State Statute
Air —Air Toxics, Pesticides as Ozone Precursors (Volatile Organic Compounds) or Sources of Particulate Matter	<ul style="list-style-type: none"> ▪ Federal Clean Air Act ▪ Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) 	<ul style="list-style-type: none"> ▪ Toxic Air Contaminant Act (Food and Agricultural Code - FAC) ▪ FAC (“Protect the environment”) ▪ Health and Safety Code
Water —ground water and surface water	<ul style="list-style-type: none"> ▪ FIFRA ▪ Federal Clean Water Act ▪ Safe Drinking Water Act ▪ Coastal Zone Act Reauthorization Amendments (CZARA) 	<ul style="list-style-type: none"> ▪ Pesticide Contamination Prevention Act (FAC) ▪ Porter-Cologne Water Quality Control Act (Water Code) ▪ FAC (“Protect the environment”) ▪ Health and Safety Code
Ecological impacts - endangered species, nontargets: crops, wildlife, domestic animals and pets, plants, etc.	<ul style="list-style-type: none"> ▪ Federal Endangered Species Act ▪ FIFRA 	<ul style="list-style-type: none"> ▪ FAC Sec. 12824
Human Health Impacts <ul style="list-style-type: none"> ▪ Review of toxicity studies ▪ Human health risk assessment ▪ Label review ▪ Worker protection 	<ul style="list-style-type: none"> ▪ FIFRA, ▪ amended FIFRA (FQPA) 	<ul style="list-style-type: none"> ▪ SB 950, FAC Sec. 13121, ▪ Authorizing legislation FAC Sec. 11505, Sec. 12824 ▪ Air Toxics FAC Sec 14021 ▪ GRP 1 organizing Cal/EPA ▪ FAC 13134 (dietary) ▪ FAC 12980 (worker protection)
Pest Management <ul style="list-style-type: none"> ▪ Alternatives ▪ Integrated Pest Management (IPM) ▪ School IPM 		<ul style="list-style-type: none"> ▪ FAC Sec 12786 ▪ FAC Sec 13182

The United State Environmental Protection Agency (US EPA) has the federal responsibility for the evaluation and regulation of pesticides. Authority in California has been delegated to DPR. DPR may be more stringent than US EPA, but it may not be less stringent. In the late 1970s, through both statute and regulation, the State's pesticide regulatory program was certified as being functionally equivalent to the California Environmental Quality Act (CEQA), meaning that its pesticide evaluation process was equivalent to a full-scale environmental impact report.

The legislature passed the Birth Defect Prevention Act (Senate Bill 950) in 1984 because of legislative dissatisfaction with the US EPA progress in re-evaluating pesticides. Data review and risk assessment have developed as a result of SB 950, state air toxics law, state food safety law (AB 2161) and general authorizing statutes. Risk assessment is now an integral part of the Department's regulation, enforcement, food safety, worker safety, air, and water programs. The statutes governing workplace and farmworker safety place California in a world leadership position.

The Healthy Schools Act of 2000 (Assembly Bill 2260) enacted "right-to-know" requirements for notification, posting, and recordkeeping for pesticides used in schools. The law defines integrated pest management (IPM) and is part of the Children's Health Initiative to better protect the environmental health of children. IPM is used to make decisions on managing pests at school sites in a manner that protects children and others from unnecessary exposure to pesticides. DPR also has a mandate to encourage the development and implementation of IPM to achieve acceptable levels of control with the least possible harm to non-target organisms and the environment.

3.1.1.5 Integrated Waste Management Board (IWMB)

IWMB is the State agency responsible for protecting the public's health and safety and the environment through the effective management of California's solid waste stream and the promotion of sustainable markets to support diversion efforts and practices that result in managing all materials to their highest and best use.

Fifty Percent Diversion

The California Integrated Waste Management Act (IWMA) created a new approach to managing solid waste (SW) based on integrated waste management principles. It established a statewide hierarchy of source reduction, recycling and composting, and environmentally safe transformation and land disposal. Each city or county is required to divert and maintain fifty percent diversion of all SW from landfill disposal by January 1, 2000, and thereafter. IWMB oversees and assists local governments in the development and implementation of local plans that show how the fifty percent diversion goal will be met and oversees state agencies in meeting the same goal. As the program has moved from plan development and review to program implementation, IWMB has continued to make adjustments to better capture information; developed waste characterization information; provided technical assistance, created guidelines, standards, models, online tools, research reports; and targeted specific diversion programs.

Waste Prevention and Market Development

Waste prevention is at the top of the IWMA's hierarchy, and the IWMB and local agencies are required to promote source reduction as the highest priority. Market development is key to the success of the IWMA. The Legislature declared that the IWMB should take a leadership role in encouraging the expansion of markets for recycled products and later required IWMB to develop a market development plan and to stimulate market demand for post-consumer and secondary waste materials. IWMB oversees state agencies in meeting recycled-content-product procurement goals, develops technical standards for minimum content programs, and certifies that post-consumer content standards are being met. As the programs have matured, IWMB continues to better delineate where waste prevention and secondary materials can be successfully incorporated by commercial, private, and public sectors.

Permitting and Enforcement

The IWMA declares that the responsibility for SW management is a shared responsibility between the IWMB and local governments. It requires the IWMB to oversee and evaluate local enforcement agencies (LEAs) to ensure an effective and coordinated approach to the safe management of all SW. To accomplish this, the IWMB is required to develop and enforce minimum standards for SW handling, transfer, composting, transformation, and disposal that will protect public health, safety, and the environment. Passage of the IWMA and issuance of federal Subtitle D regulations in 1991 significantly expanded IWMB's regulatory oversight and responsibility for SW facilities. To accommodate the variety of handling methods resulting from the IWMA's diversion mandates, IWMB developed a tiered regulatory structure. IWMB continues to make improvements to SW regulation and further research in innovative technologies, such as bioreactors and alternative final cover systems.

Cleanup and Remediation

IWMB was required to initiate a program for the cleanup of SW disposal and co-disposal sites, to establish the Farm and Ranch Cleanup and Abatement Program, and to provide guidance to the LEA regarding the inspection and investigation of illegal, abandoned, or inactive closed sites. IWMB has continued to make improvements, including development of new site investigation process guidance and a protocol for burn dump site investigation and characterization. For tire piles, IWMB can perform any cleanup, abatement, or remedial work to prevent substantial pollution, nuisance, or injury where responsible parties have failed to take action. IWMB has used contractors to remediate or stabilize illegal waste tire piles since the beginning of the program. With the advent of several major tire fires, IWMB now oversees the development of site remediation plans for these complex remediation projects.

Waste that Requires Special Handling

Pursuant to its mandate to reduce the number disposed in landfills or illegally dumped or stockpiled, IWMB promotes technologies that turn waste tires into useful products. In the early years of tires market development, IWMB placed

more emphasis on research and innovative product development. This emphasis is shifting to projects that can consume large numbers of tires and increase crumb rubber production.

IWMB's used oil collection and recycling program promotes and develops alternatives to the illegal or improper disposal of used oil and provides technical and financial support to local jurisdictions for paint, antifreeze, pesticides, and other household hazardous waste (HHW) collection and recycling efforts. Since the onset of the used oil program, IWMB has been building a collection infrastructure and is now encouraging cities to promote program improvements. HHW efforts have included support for permanent HHW facility construction and are now being focused on universal wastes (e.g., batteries and fluorescent tubes) generated by households and small quantity generators in response to the February 2006 deadline on landfill disposal of these wastes.

IWMB also administers and enforces the Electronic Waste Recycling Act in consultation with DTSC. This law is intended to reduce improper disposal of electronic waste and provide for its collection and recycling.

School Education

Prior to 2001, IWMB developed curricula that taught integrated waste management (IWM) concepts. In 2001, this was expanded by the School Diversion and Environmental Education Law School-Site Source Reduction and Recycling Assistance Program to develop a unified education strategy on the environment and providing greater assistance to school districts on their IWM programs. The Statewide Education and the Environment Initiative, enacted in 2003, mandates the development of a unified strategy to bring environmental education into California's K-12 schools. This law is a larger effort that looks at thirteen environmental topics beyond IWM and advances the State's commitment to encourage California teachers to use the environment as a context to teach State-required concepts in science, math, language arts, and other subject areas.

3.1.1.6 Air Resources Board (ARB)

The mission of the ARB is to promote and protect public health, welfare, and ecological resources through the effective and efficient reduction of air pollutants while recognizing and considering the effects on the economy of the state. The primary goal of the ARB in pursuing its mission is to provide safe, clean air to all Californians through the identification of health risks via air pollution followed by the development, implementation, and enforcement of air pollution rules and regulations to achieve healthful air quality. Throughout this process, the ARB seeks to base decisions on the best possible scientific and economic information. Before adoption by the Board at a public hearing, any proposed air quality standard, implementation plan, or emission control regulation is reviewed by experts and also presented at public workshops.

In pursuing its mission, the ARB sets ambient air quality standards, manages statewide emission control programs for mobile sources, fuels, and consumer products; develops fuel specifications; adopts statewide control measures for air toxic air contaminants (TACs); develops suggested control measures for

architectural coatings; and establishes gasoline vapor recovery standards and certifies vapor recovery systems.

The ARB also supports local jurisdictions in regulating stationary and area source emissions of criteria pollutants and TACs and performs necessary State-level functions as required by the Federal and California Clean Air Acts. Important activities that support ARB programs include monitoring of ambient air quality; developing an inventory of pollutant and pollutant precursor emissions; modeling of air quality; planning, regulating, and training for compliance with standards and regulations; and enforcing air pollution regulations. State law also requires that ARB conducts a research program to provide basic information on pollutants, atmospheric processes, and health effects needed to support the regulatory programs. A brief description of major ARB responsibilities is provided below.

Since 1969, the ARB has established State ambient air quality standards (AAQS) with assistance from the Department of Health Services (now OEHHA). The ARB intermittently reviews the appropriateness of each AAQS in light of the most recent health effects research. Under the federal Clean Air Act, states are required to prepare State Implementation Plans (SIPs) for each pollutant that violates a national AAQS. The SIP identifies the efforts and control measures that will be undertaken to ensure that ambient conditions will not exceed the AAQS after a specified date.

Since its formation in 1967, ARB has successfully launched numerous emission reduction programs in California for both on-road and off-road vehicles. One of the most significant accomplishments in motor vehicle emission controls was the introduction of catalytic converters in the 1970s–80s. During ensuing years, the ARB and local air pollution districts have frequently increased the scale of their air quality monitoring programs to better identify the nature and scope of problems. Quality assurance programs have expanded to help ensure that the best possible ambient air quality data are collected to support decision-making. The Legislature has established an ARB research program to help ensure that ARB's efforts will effectively combat air pollution. As air pollution problems become apparent or adverse impacts are suspected, ARB develops research projects to address the critical information gaps.

3.1.2 How are specific targets/goals determined? (e.g., staff/contractor evaluation, expert advice—including regulated community input, public workshop)

3.1.2.1 State Water Resources Control Board (SWRCB)

Porter-Cologne requires that water quality control plans be reviewed periodically, which is currently done as part of the triennial review required under the CWA. Triennial review of water quality standards for surface waters helps to ensure currency of the science. The triennial review process is subject to public notification and comment and uses public hearings. Interested parties are encouraged to send written comments and attend the State or Regional Water Board meeting at which the triennial review priority list of proposed activities is adopted.

The prioritization of specific activities identified by the triennial review is affected by several factors: new state water quality standards required by the US EPA, topics of concern to the regulated community, general public, or other interest groups, funding availability, activities mandated by the Legislature or the courts. Complicated projects may involve stakeholder groups, technical advisory groups, and staff evaluations to determine the specific objectives of the program. The Water Boards have also used contract services when funding was available.

3.1.2.2 Office of Environmental Health Hazard Assessment (OEHHA)

OEHHA staff develop criteria and guidance. When funding is available, contract consultants may be employed to gather and analyze information that goes into the development process, but OEHHA staff and management make the final decisions. OEHHA uses state-of-the-art principles, approaches, and methodologies. Science has evolved with newly available research data, expanded knowledge, and updated risk assessment guidelines developed at the federal level. These include new data on specific chemicals (e.g., new National Toxicology Program data on carcinogenicity of dioxin), an expanded understanding of (possible) modes of action of chemicals (e.g., α 2- μ globulin and rat kidney tumors in the case of methyl tertiary-butyl ether (MTBE)) and US EPA's updated cancer risk assessment guidelines and benchmark dose methodology.

The draft documents go through cross-program internal reviews to ensure quality and consistency. They are further peer reviewed by US EPA programs conducting similar work, by the ARB Scientific Review Panel (SRP) on TACs, by the Air Quality Advisory Committee, and/or by a UC peer review committee when required (e.g., by HSC 57004) or deemed necessary. The process also involves public input via written comment and public workshop. The ARB must vote on Toxic Air Contaminant identification and Ambient Air Quality Standards. All criteria and guidance are subject to public review and comment, usually including public workshops. ARB considers comments and makes appropriate changes.

3.1.2.3 Department of Toxic Substances Control (DTSC)

Specific targets for site cleanups are defined by the project teams with consultation from DTSC scientists. Such teams might be large (military base) or small (school site). Engineers, chemists, geologists, and toxicologists usually function as consultants to project teams. Cleanup targets might be driven by risk assessment or by specific regulations, such as Maximum Contaminant Levels for drinking water.

DTSC seeks public involvement at all cleanups it regulates by holding public meetings. At public meetings geologists, engineers, and toxicologists often advise elected officials and the public on the nature of the hazards at sites regulated by DTSC. They also provide information on the fate and transport of contaminants and the consequences of available remedial alternatives.

Pollution prevention projects are chosen bi-annually through a public review process, development of work plans, and an external advisory committee.

Project designs include targets and goals for expected waste reduction achievements.

3.1.2.4 Department of Pesticide Regulation (DPR)

The US EPA sets tolerances (legal limits) for pesticide levels in food. Federal law precludes the states from setting tolerances. However, states can determine the acceptable pesticide levels for other routes of exposure and enact controls to meet those targets. California has been a leader in identifying acceptable levels for pesticides in occupational settings, air, and other media scenarios in general.

All target values other than food tolerances are based on staff scientists' recommendations. The latter are the basis for management to determine whether to register pesticide products and to evaluate the risk of currently used pesticides. The registration evaluation is based on a standard set of data required of the registrants. The risk assessments rely on the data submitted by the registrants as well as the full set of data in the public domain.

Reference doses, reference concentrations, screening levels, etc. are toxicity-based values that are set through the risk assessment process. The public and the regulated community may comment on draft risk assessments. The documents receive formal peer review by OEHHA, US EPA, the Air Toxics SRP, and under Section 57004 of the California Health and Safety Code.

3.1.2.5 Integrated Waste Management Board (IWMB)

Targets and goals are determined in several ways at IWMB: mandated by statute, through literature research, staff analysis, contractor evaluation, stakeholder meetings, comparison of other programs within the state or country that are similar and could be modified, or a combination of several methods. An example of a mandated target is the fifty percent diversion of solid waste from disposal mandated by the California Integrated Waste Management Act. For the development of maximum acceptable metal concentrations in compost end products, IWMB derived technical and scientific information from IWMB's Composting Advisory Panel and allowable metal concentration limits for "Exceptional Quality" compost, listed in US EPA's Code of Federal Regulations (CFR) Title 40 Part 503 Rule and presented the information for stakeholder review and comment prior to beginning the formal rulemaking process.

For the maximum allowable concentrations of methane within facility structures and at the disposal site property boundaries during closure and post-closure, IWMB derived the information from federal regulation, 40 CFR 257.3-8, and presented the information for stakeholder review and comment as part of the formal rulemaking process. For final closure plans, facility design plans, and closed, illegal, and abandoned (CIA) site investigations and cleanups (e.g., slope stability, drainage standards, landfill gas monitoring and control), IWMB staff applies science and develops targets/goals. These include reviews and approvals using science-based regulatory standards and forensic studies where failures have occurred.

For temperature and respiration rates for compost material, and the amount of time needed for in-vessel composting operations, IWMB established a small

focus group consisting of industry, LEAs, and IWMB staff to discuss issues related to the development of regulatory requirements. IWMB circulated draft regulations via eight workshops held throughout the state to receive additional input. Ongoing consultations with environmental and community groups took place prior to the Board's regular public meeting.

3.1.2.6 Air Resources Board (ARB)

Advisory committees are created to guide research and technical procedures (e.g., standard setting) as well as to provide input for most, if not all, regulations and air toxic control measures. Monitoring/testing goals and targets for compliance and enforcement purposes are driven by the adopted regulations, their implementation schedules, and the complexity of periodic inspections/testing. The frequency of the inspections can be influenced on occasion by the availability of resources and evaluations of non-compliance rates and performance audits.

Ambient Air Quality Standards

Health and Safety Code Section 39606 specifies that the ARB shall adopt AAQS relating to health effects based upon OEHHA recommendations and that OEHHA "shall use current principles, practices and methods used by public health professionals who are experienced practitioners in the field of human health assessment. The scientific basis or scientific portion of the method used by the office to assess the factors set forth ... shall be subject to peer review as described in Section 57004 ..." This section, "Scientific peer review of rules", allows boards to enter into an agreement with a group of scientists that is recommended by the President of the UC to conduct an external scientific peer review of the scientific basis for any rule proposed for adoption or revision.

ARB's most recent staff report (March 2005) reviewed an ambient air quality standard (AAQS) for ozone. Contributing authors included staff from OEHHA and Department of Health Services (DHS), as well as ARB. ARB used peer-review contracts to enable expert scientists to either draft sections or review drafts prepared by staff scientists. The draft report was presented for review and comment at public workshops in Sacramento and Fresno. The Air Quality Advisory Committee (AQAC) subsequently peer-reviewed the draft report and discussed their review at a public meeting. In their peer review, AQAC considered public comments and staff responses to those comments. Following the AQAC meeting, staff revised the report based on comments received from AQAC and the public. The revised staff report was available for a 45-day public comment period in advance of a public meeting of the ARB to consider the staff's final recommendations.

Regulations for Mobile Sources, Fuels, and Consumer Products

The development of regulations is largely driven by air quality goals (air quality standards, etc.) that are specified by state or federal regulatory processes. Where specific engineering targets or tools must be established (determining appropriate monitoring technologies, selecting appropriate atmospheric models, etc.), two general approaches are used.

If relevant US EPA-mandated or recommended methods exist, they are reviewed to determine if they are appropriate to the particular problem or conditions in California. If this review shows a need for a new or "non-standard" approach, then the usual procedure is to conduct an in-house review of potential solutions or contract for such a study by qualified professionals (university researchers, specialized consulting firms, etc.) and then to solicit input from technical experts in the air quality community (industry, other regulatory agencies, universities, etc.) before finalizing the approach.

Large-scale studies (e.g., the multi-year, multi-district California Regional Particulate Air Quality Study) are conducted to foster technical and political consensus on the objectives, plans, operations, data analyses, etc. so that the study results can definitively guide air quality planning and subsequent regulatory decision-making. These studies are usually supported with broadly composed technical advisory committees made up of state, federal, and local agency staff, industry and academic technical specialists, and other involved parties.

In the development of regulations establishing new emission standards, staff evaluates sources to ascertain the scientific basis for emission releases, potential emission control technologies, commercial availability, cost-effectiveness, durability, enforceability, environmental justice, and impacts to small business. The evaluation of emission reduction potential is commonly done in-house, utilizing the expertise and regulatory experience of staff engineers and scientists that have worked with a wide range of affected industries in the state. For most regulations, the principal data-gathering tool is an industry survey. Staff develop, disseminate, and evaluate industry surveys to secure data essential to understanding the current state of science, the potential for emissions reductions, and time needed to comply with the requirements. For regulatory development, an open, public process ensures input from stakeholders through public workshops, focused meetings, and participating in symposia or other technical forums.

For on-road and off-road mobile sources, target emission standards are determined by available and projected technologies, which in turn are evaluated via in-house vehicle test programs and/or extramural research. ARB often collaborates with experts from academia in conducting in-house vehicle test programs and extramural research. In addition, ARB seeks expert advice from trade groups like the Manufacturers of Emission Controls Association and individual auto manufacturers. Researchers and environmental groups also provide input prior to any rulemaking.

Indoor Air Quality Program

The overall goal of ARB's non-regulatory Indoor Air Quality Program is to identify and reduce Californians' exposures to indoor pollutants. In recent years, the goals and targets of ARB's Indoor Program have been established based on: 1) the schedule and needs of ARB's TAC Program and the ambient air quality standards program; 2) legislative requirements such as a study and report to the Legislature on *Environmental Health Conditions in California's Portable Classrooms*; and 3) the recent report to the Legislature on *Indoor Air Pollution in California*, required under AB 1173 (Keeley, 2002). Expert

scientists, state scientists, private sector participants, and the general public provided advice and input on these documents and the findings and recommendations of each. This was achieved through several public workshops and comment periods, meetings at the request of interested parties, and a formally convened scientific peer review committee of UC scientists for the indoor air quality report.

3.1.3 What scientific disciplines and levels of expertise (education, or on-the-job) are used to support the activities and decisions in these environmental programs?

3.1.3.1 State Water Resources Control Board

Scientific disciplines include ecology, biology, toxicology, microbiology, statistics, chemistry, hydrology, geology, analytical chemistry, engineering, and mathematics. Education levels range from Bachelor's to Doctorate level degrees depending on the responsibility of the position.

3.1.3.2 Office of Environmental Health Hazard Assessment

OEHHA employs toxicologists, epidemiologists, biostatisticians, exposure assessors, veterinarians, and physicians with expertise in environmental chemistry, biochemistry, pathology, physiology, pharmacology, and other related disciplines. Most technical staff have masters and/or doctoral level degrees in their fields of expertise. OEHHA also uses supervised graduate students for parts of its work and may contract some work to Ph.D. level consultants.

3.1.3.3 Department of Toxic Substances Control

DTSC employs engineers, geologists, and environmental and life scientists. Typically, technical staff have undergraduate degrees in science or engineering; many have advanced degrees. The Science, Pollution Prevention, and Technology Development Program has more than thirty Ph.D. scientists on staff.

3.1.3.4 Department of Pesticide Regulation

A large proportion of the DPR scientists have master's and Ph.D. degrees, and many bachelor's-level staff have more than 25 years of experience. Areas of scientific expertise include agronomy, chemistry, ecology, entomology, industrial hygiene, meteorology, modeling, molecular biology, occupational medicine, plant pathology, plant physiology, soil science, statistics, toxicology, and water science. The toxicologists have a variety of specialties, including inhalation, reproduction, carcinogenicity, genotoxicity, nutrition, metabolism, neurotoxicity, risk assessment, chemistry, etc. Many toxicologists are certified as diplomates of the American Board of Toxicology.

3.1.3.5 Integrated Waste Management Board

IWMB has several classifications that apply scientific methods and principles in the performance of their work. These require at least a bachelor's degree in various fields such as biological, chemical, physical, environmental, or soil

sciences; environmental health; toxicology; industrial hygiene; medicine; public health; engineering; geology; mathematics; economics; statistics; or resource management.

3.1.3.6 Air Resources Board

ARB technical staff typically must have a college degree in a physical science (e.g., chemistry, biology, environmental and atmospheric sciences), health science (e.g., toxicology), computer science, or an applied science (e.g., mathematics, engineering, economics, environmental planning). Lead staff managing technical projects generally have advanced training and extensive experience in their particular areas of responsibility, and the ARB has a cadre of professional staff who have advanced degrees (many with Ph.D.s) with specialization in air-quality-related fields.

Some ARB staff are recruited from colleges and universities based on specific expertise (for example, atmospheric modelers from UC Riverside). Staff members are routinely sought out as technical experts for peer review of scientific study protocols, reports, evaluations, and manuscripts submitted for publication in technical journals (e.g., *Journal of the Air and Waste Management Association*, *Environmental Science & Technology*, *Journal of Geophysical Research*).

3.1.4 **How does science influence (e.g., inform, guide, determine) these decisions and activities?**

3.1.4.1 State Water Resources Control Board

The Water Boards endeavor to base their decisions on the best scientific information available. Many disciplines are involved in setting water quality criteria, determining beneficial uses, establishing permit limits, monitoring, data analysis, etc.

3.1.4.2 Office of Environmental Health Hazard Assessment

OEHHA bases all criteria and guidance on objective scientific information regarding the health effects of the chemicals. The final determination that leads to decisions depends on the quality of the scientific data available. Risk assessment modeling employs some assumptions due to lack of specific data, but those assumptions are based on what science is available to describe the specific parameters.

3.1.4.3 Department of Toxic Substances Control

Essentially all DTSC regulatory activity is guided by science. DTSC regulates wastes, waste streams, and cleanups according to their physical, chemical, and biological characteristics. Characterizing wastes and waste streams requires industrial engineering, chemistry, and toxicology. Achieving risk-based cleanups after toxic releases requires combining chemistry, geology, engineering, industrial hygiene, and toxicology. In order to characterize potential exposures, environmental fate and transport, statistics, and risk assessment are used.

Workable solutions to avoiding waste require a full understanding of industrial process engineering. This involves knowledge of not only engineering, but also chemistry, industrial hygiene, toxicology, and statistics. This understanding can be assembled into a life cycle assessment, from which can flow new ideas on waste reduction. Other factors that guide decisions are the degree of independent verification of technologies or methodologies, the level of uncertainty, numerical simulations, standards of professional practice, and available funding.

3.1.4.4 Department of Pesticide Regulation

Pesticide registration decisions are based on scientist recommendations. The risk assessments and study evaluations are science-driven. The primary objective of the assessments is to provide information to risk managers giving them the opportunity to make informed risk management decisions. Scientific conclusions or decisions include adequacy of submitted scientific studies, demonstration of adverse health effects in these studies, accuracy of statements on product labels, levels of human health risk resulting from the use of a pesticide, establishment of various exposure levels that are expected to be without appreciable risk, etc. Science influences the scope and breadth of rules enacted through the Administrative Procedures Act as well as permit guidance that DPR provides to county agricultural commissioners.

3.1.4.5 Integrated Waste Management Board

Information derived using scientific methods and principles provides a baseline standard for decision-making. All other information is evaluated against this standard. IWMB applies sound business, economic, and financial principles in assisting reuse, recycling, and composting businesses to divert more and more material from landfills. In doing so, IWMB understands the underlying scientific and engineering principles of the technologies and processes to be implemented by new or expanding businesses in making new products out of recycled material. Typically, scientific and engineering staff from other IWMB units are called on to evaluate these technologies and processes, and sometimes staff from other agencies are called on for this evaluation.

Where the regulatory standards for solid waste landfills are science-based (as with the more prescriptive standards such as slope stability, gas control, and drainage), enforcement of those standards through review of closure plans and report of disposal site information is influenced by science. In other cases such as research in bioreactor landfills and alternative final covers, the science is based on project-specific research goals and protocols. Study results with clear scientific credibility may, in consultation with stakeholders, be incorporated as regulatory standards or guidance information for additional project proponents. IWMB did this by partially funding the Yolo County bioreactor landfill project.

In its efforts to promote recycling and reuse of waste tires, IWMB has made significant progress promoting civil engineering applications of tire derived aggregate (TDA) and rubberized asphalt concrete (RAC). IWMB's success in these areas has been due in large part to engineering research that has been conducted by both private and public entities. IWMB has contracted research projects focusing on engineering uses of waste tires including an analysis and field study of various RAC application methods on highways, freeway

embankments, and retaining walls using lightweight fill, and sound and vibration mitigation in light rail systems. Results from these research projects are distributed by IWMB to stakeholders through a targeted outreach effort. This research has led to the development of technical standards that are used by industry to construct projects using TDA and RAC.

To determine how conversion technologies would perform in comparison to established waste management practices, IWMB contracted with UC Riverside and UC Davis for a technology evaluation. The Research Triangle Institute with subcontractors Hilton, Farnkopf, and Hobson along with the National Renewable Energy Laboratory provided key data for life cycle analysis and market assessments. This research became the basis for IWMB policies and met the requirements of AB 2770, (Matthews, Chapter 740, Statutes of 2001). AB 2770 required IWMB to research and evaluate new and emerging non-combustion thermal, chemical, and biological technologies and submit a report to the Legislature.

Research contracted by IWMB on using the compost process as a mitigation to prevent the spread of Sudden Oak Death disease was the basis for testimony to the US Department of Agriculture and California Department of Food and Agriculture. This allowed the development of compliance agreements within a 12-county quarantine zone that allowed for the movement and processing of both host and infected feedstock and product.

3.1.4.6 Air Resources Board

The role and influence of science in ARB's different activities varies. In setting an AAQS, the Health and Safety Code specifies that the ARB shall adopt AAQS "in consideration of the public health, safety, and welfare, including, but not limited to, health, illness, irritation to the senses, aesthetic value, interference with visibility, and effects on the economy." This gives staff wide latitude in reviewing ambient air quality standards that thoroughly conform to accepted scientific procedures. The process of recommending and adopting AAQS allows scientific input at several points, including internal reviews, peer reviews, public workshops, and public hearings. The Research Division (RD) has an ongoing program of managing health-related research on air pollution. Much of this research provides data that can be used in the AAQS review documents.

Ambient air quality monitoring with approved instrumentation and a rigorous quality assurance program forms the foundation of the air quality programs. Ambient data are needed to determine the severity and extent of air quality problems, to confirm reasonable performance of AAQ models, and to confirm attainment of the AAQS.

Science is emphasized throughout ARB's planning, modeling, emission inventory, compliance, and enforcement activities. ARB uses the most up-to-date air quality models and extensively evaluates the models to ensure that their performance meets specific criteria. The emissions inventory is continually updated as new information becomes available.

The data and analyses that form the basis for specific regulatory provisions (emission limits, control requirements, etc.) are generally founded on scientific principles. For example: 1) the identification of the classes of volatile organic compounds (VOCs) to be limited in consumer products and paints is based on

complex photochemical experimentation and modeling; 2) the complex numerical model used to implement ARB's gasoline property standards has been created using sophisticated statistical procedures on hundreds of highly developed, controlled exhaust emission tests; and 3) the chemical analyses prescribed in the engine testing procedures that are part of the vehicular emission standards are the products of many years of work in analytical chemistry by scientists at ARB, U.S. EPA, and contractors (e.g., universities).

In ARB's toxics regulatory program, science forms the basis for estimates of health risk resulting from exposures to substances with known health effects. ARB applies scientific principles to develop air measurement techniques to develop data, as well as utilizing in-house scientists to conduct technical reviews of literature in support of regulatory activities.

Although multiple factors influence decisions regarding the development of mobile source technologies and regulations, science plays the dominant role by setting constraints on what is scientifically and technologically feasible. For example, more than a decade has been required to develop and optimize filters for the control of diesel exhaust particulate matter. Scientific studies of temperatures needed to optimize burning of the soot caught within the filter, while avoiding damage to the filter itself, were key to this effort. Such a scientific endeavor allows ARB to estimate a reasonable particulate matter emission level expected from such a control device, and based on that, to set the emission standard, which ultimately becomes a regulation.

The ability to measure the parameters specified in the regulations influences compliance decisions and enforcement actions. For example, qualitative and quantitative chemical analysis of samples is critical to the enforcement of the volatile organic compound limits in consumer products regulations and the maximum incremental reactivity limits in the aerosol coatings regulations. For fuels enforcement, chemists analyze the composition of fuels for various flat limits, alternative limits, and alternative specifications demonstrated through emissions testing or predictive models as specified in the regulations.

The enforcement of emission limitations for stationary and mobile sources relies on the ability to measure the concentrations of pollutants from exhaust stacks and vehicle tailpipes. Advances in measurement science and testing procedures that allow for lower detection limits, better accuracy, and precision, automation, and defensibility in court all influence the ability to ensure that compliance with the regulations achieves the desired emission reductions.

The scientific literature has increasingly shown that unhealthful concentrations of a variety of pollutants occur indoors and has pinpointed some key indoor sources that contribute to those concentrations. Based on this information, the Indoor Program has made recommendations to the Executive Office and the Board, and written reports and legislative bill analyses. ARB's TAC Program is now developing a formaldehyde emissions regulation under the TAC control program, in part because of high indoor emissions that, combined with outdoor emissions, contribute to Californians' elevated total exposure to formaldehyde.

3.2 Scientific Ambience—Promoting Science that is Thorough, Transparent, Traceable, and Well-Founded.

3.2.1 How does your BDO ensure the quality of science in the development and implementation of its programs? (e.g. internal cross-checking of work, seminars, symposia; use of Cal/EPA contract with UC for peer review)

3.2.1.1 Training

The BDOs employ a variety of means to ensure the quality of science in their programs. Staff have opportunities to attend in-house training and training provided by universities, various professional societies and nonprofit professional groups, and seminars, workshops, and symposia to help them keep abreast of the latest information and technology. In some cases, cross-BDO training is provided for specific programs, such as universal waste rule training on cathode ray tubes, consumer electronic devices, and mercury-containing wastes provided to IWMB and DTSC staff, LEAs and Certified Unified Program Agencies (CUPAs). Additional training is provided to IWMB staff and LEAs on compostable materials regulations on odor impact minimization plan development. IWMB staff, LEAs, and Regional Water Quality Control Board staff receive training on alternative final cover assessment.

Scientists regularly study scientific and technical journals available online or in hard copy from the Cal/EPA Technical Reference Library. Many professional staff share their personal subscriptions to scientific journals with their colleagues. Staff present their work at regional and national meetings and publish it in refereed journals. On a few occasions, Cal/EPA scientists have been invited to organize training for environmental scientists in other countries. ARB sponsors symposia on a variety of subjects to educate ARB staff and the scientific and regulatory communities. These symposia assemble international experts to present and discuss the most recent developments regarding an air quality topic. The ARB Chairman's Seminar series brings experts in many air quality related fields to Sacramento and El Monte to present the results of their most recent work. Because these seminars are webcast, the information is available to a wide audience. Remote participants are also able to ask questions. This accessibility helps to ensure a broader discussion of scientific issues related to the seminar topic.

3.2.1.2 Outside Expertise

If additional expertise is needed, the IWMB contracts with the California State University System (Sacramento State, California Polytechnic State University in San Luis Obispo), UC (Davis, Riverside), and other entities as needed. Examples of this include contracting for the development of processes, procedures, and specifications for the technology transfer of rubberized asphalt concrete; for research and evaluation of non-combustion technologies that can use post-recycled and/or postconsumer solid waste for the production of alternative fuels, energy, and industrial chemicals, etc.; and for an assessment of emissions from composting operations and the development of Best Management Practices to reduce volatile organic compounds and ammonia.

3.2.1.3 Review

To ensure the quality of science in their programs, proposed BDO actions are reviewed internally, usually at multiple levels, and externally. Internal reviews include intra- and often inter-BDO review. If the review raises serious technical questions about the science used, staff may schedule internal meetings and seminars to discuss those issues. Technical recommendations are often provided through use of public symposia before developing guidance on some issues. Internal and external peer reviews are discussed further in Section 3.2.2.

3.2.1.4 Quality Control

Each BDO that employs analytical procedures or other environmental measurements in its programs has procedures in place to ensure the quality of the measurements. The repeatability and reliability of measurements are ensured through rigid procedures for instrument installation, testing, and operation, along with periodic audits to confirm that these performance standards have been followed. For example, ARB's laboratories have specific procedures to guarantee the quality of the data generated, such as the "round robin" cross check of motor vehicle emissions data generated by the El Monte vehicle test facility. Each year, the same vehicle is sent to twenty vehicle test laboratories across the U.S. and tested for emissions. These data are then shared among participants and used by the laboratories to validate their testing protocol and equipment. DTSC analytical methods are constantly monitored and upgraded via in-house quality control and quality assurance.

State and Regional Water Boards provide a process for the review of Quality Assurance Project Plans (QAPP) generated by grant recipients as part of their grant requirements. The QAPP is reviewed by a team of experts and managed by a designated quality assurance (QA) Officer. The designated QA officer also reviews generated data quality during the life of the project and then reviews and approves the final report on data quality. This process is managed by the State Water Board's Quality Assurance Unit.

3.2.2 How does your BDO incorporate the scientific expertise of other BDOs both formally and informally?

BDOs typically seek scientific input from the other BDOs on draft documents when the criteria or guidance under development may impact their programs. Input can come during the development, draft review, and/or finalization of the document. For some programs, formal comments are provided in writing and final major comments and responses are posted on the BDO website. Informal contacts may also be used to take advantage of scientific expertise from other BDOs. In some cases inter-BDO information sharing takes place through advisory or steering committees.

Project teams often include scientists from multiple BDOs. For example, hazardous waste site cleanups are often overseen by chemists, geologists, toxicologists, and other environmental scientists from DTSC, the Regional Water Boards, and the local or regional Air district. DPR and ARB scientists collaborate on monitoring design, research, and emissions. ARB conducts ambient air

monitoring of pesticides for DPR, and DPR scientists have adopted the ambient air modeling methodology used by ARB.

DTSC toxicologists work closely with OEHHA to develop, review, and apply methods and guidance documents for assessing risk and exposure for humans and wildlife. The Water Boards use information developed by other BDOs in formal reports. IWMB employs interagency agreements and formal or informal work groups with other BDOs to gain scientific expertise in particular areas either to jointly complete projects or to review and comment on work products throughout their development.

IWMB requested the participation of State Water Board and ARB staff in a cross-media assessment of MSW landfill environmental performance and regulatory effectiveness in protecting the environment. ARB assisted IWMB in a study on the feasibility of converting used vegetable oils generated by Yosemite National Park's food service establishments into biodiesel fuel for use in Yosemite's tour buses.

ARB incorporates the expertise of other BDOs in many of its programs. Health and Safety Code Section 39606 specifies that the ARB shall adopt ambient air quality standards relating to health effects based upon OEHHA recommendations. Under the requirements of the Air Toxics Hot Spots Information and Assessment Act, OEHHA reviews all health risk assessments developed by facilities for the local or regional air districts. OEHHA also prepares health evaluations for every compound nominated for consideration as a toxic air contaminant in the ARB TAC identification Program. OEHHA and DTSC provide analysis and recommendations that support ARB's VOC exemption program.

3.2.3 What levels of internal and external review do scientific conclusions and recommendations receive?

3.2.3.1 How are staff's scientific conclusions and recommendations reviewed internally?

All Cal/EPA BDOs have an internal review process. Generally, significant staff work products are reviewed by the author's supervisor, section chief, branch chief, and division chief during the initial drafts. Draft documents with broader implications such as regulations and policy documents are further reviewed by BDO executives—and sometimes representatives from other BDOs—prior to becoming final. Legal counsel is involved in regulation writing from the beginning and reviews the final product.

3.2.3.2 If external committees/panels review staff's work, how are the committee/panel members selected and how often is the membership reviewed and/or replaced? Does the staff work receive external scientific review routinely or on an *ad hoc* basis?

Health and Safety Code Section 57004 states that no Cal/EPA organization shall take any action to adopt the final version of a rule having a scientific basis unless several conditions are met. One of these is that "The board, department or office submits the scientific portions of the proposed rule, along with a statement of the scientific findings, conclusions, and assumptions on which the

scientific portions of the proposed rule are based and the supporting scientific data, studies, and other appropriate materials, to the external scientific peer review entity for its evaluation.”

Generally, this external review requirement is met via the Cal/EPA contract with the University of California, although DTSC has contracted with the National Academy of Sciences, and the state and Regional Water Boards have a contract with UC Berkeley through which reviewers have been obtained from the University of California and California State University systems, Stanford University, California Institute of Technology, and universities in other parts of the country.

Other external review processes include the use of standing and/or *ad hoc* committees and panels. Technical advisory committees bring together teams of experts to help address issues. One example of this includes the convening of a technical advisory committee by IWMB to guide the UC Riverside/UC Davis conversion technology technical research contract. Another example is the convening of a technical advisory committee by the South Coast Air Quality Management District (SCAQMD) on compost emissions. IWMB participated in this committee, which periodically coordinated with the ARB.

OEHHA has used two standing committees of the Science Advisory Board—the Carcinogen Identification Committee and the Developmental and Reproductive Toxicant Identification Committee—to review documents regarding chemical carcinogenicity and reproductive toxicity under Proposition 65. The Air Resources Board’s SRP reviews health risk assessments related to determinations on whether to list a chemical as a TAC. SWRCB may use *ad hoc* external committees of well recognized experts when needed to review staff work. OEHHA standing panels include the Cancer Identification and the Developmental and Reproductive Toxicant Identification Committees, with members appointed by the Governor.

Some programs require review by an established panel of independent experts, some of which are permanent, like the SRP on TACs. Health and Safety Code Section 39670 dictates the composition and terms of SRP members, who are recommended by the UC Office of the President (UCOP) based on their professional backgrounds and are appointed by the Governor and Legislature for a three-year term. Some of the panels are temporary, like the Air Quality Advisory Committee, a UCOP-appointed scientific peer review committee that evaluates the scientific basis of recommendations for updating the ambient air quality standards.

Many ARB regulatory initiatives involve the participation of *ad hoc* technical advisory committees. These are made up of technical experts from ARB, academia, industry, or elsewhere. They provide both scientific review and general guidance to a specific program, such as the International Diesel Retrofit Advisory Committee. In some cases, the composition of a panel is formally specified as covering certain areas of expertise (e.g., the Research Screening Committee) which reviews ARB proposals for, and work products from, external contract research. In these cases, ARB staff members review qualifications of nominees, and final selection is vested in the Board.

Most IWMB committees and panels are put together on an *ad hoc* basis for a specific program. For example, in accordance with Public Resources Code Section 42475.3, IWMB convened a working group comprised of representatives from manufacturers, environmental organizations, local agencies, and other State departments to develop environmental purchasing criteria that may be used by State agencies to identify covered electronic devices with reduced environmental impacts. (A “covered electronic device” is any video display device as defined by the Department of Toxic Substances Control that falls under the Electronic Waste Recycling Act. See www.ciwmb.ca.gov/Electronics/Act2003/ for more information.) Although this is a single-purpose working group whose work is now completed, the work group could be reconvened if additional procurement issues require their involvement. IWMB strives for balanced representation and specific expertise on these committees or panels.

The IWMB formed a technical advisory group (TAG) of landfill gas experts to review and make recommendations on long-term gas regulations proposed by IWMB staff. The TAG also made recommendations on ten IWMB-mandated regulatory concepts for incorporation into these standards. Stakeholders that have been included in this process include LEAs, public and private landfill operators, and representatives of other interested State agencies.

IWMB convened a technical advisory committee to guide the conversion technology technical research contract with UC Riverside and UC Davis. Committee members were selected based on their expertise in specific environmental media (e.g., air, water, and land).

IWMB receives technical guidance on rubberized asphalt concrete through the Rubberized Asphalt Concrete Technical Group (RACTG), which is sponsored by the Cal/Trans Office of Flexible Pavement Materials MS5 Division of Engineering Services—Materials Engineering and Testing Services.

3.2.3.3 How often has your BDO used the Cal/EPA peer review agreement with the UC Office of the President? What has been your experience? What improvements can you suggest?

The BDOs have all used the Cal/EPA-UCOP agreement. Their opinions are mixed, but a majority felt that there was room for improvement. The interactions with UCOP can be cumbersome. This works against use of the agreement more frequently and for less-complicated scientific questions, or for issues that arise earlier in the process.

On the two occasions that DTSC has used the agreement, the University conducted a competent and fair review. OEHHA has used the agreement regularly for the last few years and finds the quality of work good in most, but not all, cases. The selection and confirmation of reviewers takes too long but has been improving, and the time for completion of the review is reasonable in some, but not all cases. IWMB has used the agreement three times. On one occasion, selection of areas of expertise for peer reviewers was difficult to obtain for all of the UC campuses. In the absence of guidelines from Cal/EPA or the UC Office of the President, it was unclear what peer reviewers could and would provide. On other occasions, the process was slow and cumbersome.

IWMB is concerned about an appearance of “institutional conflict of interest” when the UC system is conducting both the research and the peer review.

DPR uses the agreement for one to three peer reviews per year. Often UC does not appear to understand the project or task or to be eager to do the work. Reviews on purely statistical issues have been good. Sometimes DPR’s recommendations for reviewers depend on DPR’s particular knowledge of people at UC who may be qualified or who have completed work for DPR in the past. However, DPR cannot easily identify new individuals at UC who may be able to perform a review.

ARB has used the agreement for peer review for 17 topics. They find this mechanism for peer review extremely useful, and the quality of the reviews excellent. However, they have experienced delays in the appointment of the reviewers by the UCOP due to personnel changes at the UC and other issues related to resources between Cal/EPA and the President’s Office.

3.2.4 How does your BDO address scientific issues as they arise?

3.2.4.1 A. How are scientific principles and procedures brought into new programs/initiatives?

B. How does your BDO address emerging environmental issues, particularly those with multi-media implications and those where the state of the science is limited (e.g., greenhouse gas reduction, e-waste management, pharmaceuticals in water, treated wood waste disposal, and risk of exposure to multiple airborne pesticides)? How are new scientific findings and methods brought into programs/initiatives?

There is no departmental or Agency-wide scientific advisory body from which to seek advice on a variety of scientific questions, new issues, and new methods. Without such advice, it is sometimes difficult for a regulatory agency to adopt cutting-edge or just new scientific methods without a great deal of stakeholder resistance.

The continued loss of resources due to budget cuts and the inability to hire new scientific personnel, in conjunction with statutory and regulatory deadlines, limits each BDO’s ability to spend time on emerging issues that some may consider nonessential to day-to-day functions and responsibilities. Cal/EPA’s Emerging Environmental Challenges program was specifically created to coordinate with all BDOs in the investigation of potential future environmental concerns. Its demise due to budget cuts has left the Agency without a specific structure in place to systematically address emerging issues.

However, Cal/EPA scientists still address emerging issues in a variety of ways. Generally, they follow the latest developments in methodologies and research findings in their specific areas of responsibility. This is achieved by attending and participating in scientific conferences, symposia and workshops, special committees and panels, and interacting with other scientists and researchers. Staff are encouraged to keep current on scientific developments and are encouraged to use time assigned to training and development to identify new emerging issues. OEHHA’s drinking water program is collecting information on

pharmaceuticals and personal care products (PPCP) in water, but there is no mandate or funding to support substantive work.

Emerging issues generally come to the fore in a variety of ways: They may be initially tracked by staff with particular interest or expertise, without expressed management direction. The staff person may bring the issue before management as a threat within the agency's regulatory sphere, as a newly recognized problem, or as a likely future problem that needs attention. For example, the pervasive presence of polybrominated diphenyl ethers in human milk and other biota was brought to light by staff.

Identification of an emerging issue often occurs through attendance or participation at scientific conferences; discussions with other Cal/EPA BDOs, and top level researchers, including principal investigators for ARB-funded projects; various seminars and listserves; and personal communications with scientists in the field. Inter-BDO workgroups are assembled to address multimedia issues.

Occasionally, a new issue or problem becomes generally known to the public, and the State requires the agency to study the problem to determine its scope and urgency. For example, Health and Safety Code Section 43830.8 requires ARB to coordinate impact assessments resulting from the use of fuels in California. If the problem has multi-media implications, communication is established with other agencies that are impacted by that problem. The Fuels Multi-media Interagency Work Group was created to advise the BDOs on how to evaluate multi-media impacts of fuel constituents.

Staff for several programs within DTSC cooperated to produce new guidance on evaluating the intrusion of subsurface vapors into indoor air, an important exposure pathway for many volatile organic contaminants. DTSC has sponsored public workshops on statistical methods for estimating exposure point concentrations and bioavailability of lead and arsenic, assembling leading scientists in and out of government to identify new methods for risk assessment.

Through a cooperative research agreement with Lawrence Livermore National Laboratory in the 1990s, scientists from DTSC and the U.S. Department of Energy developed the CalTOX model for multi-media assessment of environmental fate, transport, and risk. The model was well received by the academic community and is still in use for evaluating waste sites and setting cleanup levels. DTSC's Hazardous Materials Laboratory has developed new analytical methods that have had national and international impacts.

For example, lowering the detection limit for perchlorate by a thousandfold led to discovery of widespread perchlorate contamination of groundwater. The Office of Pollution Prevention's evaluation of new technologies for treatment and reduction of waste has made DTSC a leader among regulatory agencies in fostering evaluation and adoption of new technologies.

IWMB's typical approach is to establish a team of experts from various BDOs, local governments, industry, environmental groups, and other stakeholders to receive input on scientific findings for determining next steps. These include how the issue is currently being handled, the possible approaches to managing

the issue, and what problems have been identified. Based on the team's input, IWMB incorporates the scientific findings into a new program, which often includes developing regulations and/or initiating research when discretionary funds are available.

DTSC and IWMB have co-sponsored numerous workshops to involve stakeholders in developing emergency regulations under the Electronic Waste Recycling Act and in addressing implementation issues. IWMB coordinated an electronic waste working group with representatives from DTSC, IWMB, and Cal/EPA to manage contracts for electronic waste research, to share information and data gathered by various affected parties and other states, to survey local agencies on priority needs, to respond to introduced legislation, and to participate in the National Electronic Product Stewardship Initiative. These efforts contributed to the body of scientific knowledge that became the basis for the Electronic Waste Recycling Act.

The Climate Action Team established by Executive Order #S-3-05, June 1, 2005, and led by the Secretary for Environmental Protection, is comprised of multiple BDOs and State agencies. IWMB has researched multiple life cycle environmental calculators to cross-check results of projected greenhouse gas emission reductions that serve as the basis of their portion of the Climate Action Team targets.

IWMB has pending agreements with the University of California at Davis and the SCAQMD to evaluate the technical and economic feasibility of converting landfill gas into hydrogen for use in fleet vehicles and fuel cells. IWMB contracted with San Diego State University to develop baseline emissions of VOCs and ammonia from composting operations and best management practices that could reduce the emissions.

Except when reacting to a legislative mandate with a short deadline, the ARB typically uses a phased approach to addressing new issues. The first step is typically to collect and review all relevant information. If necessary, additional research may be funded (i.e., a measurement campaign to confirm/expand knowledge of the issue as it impacts California). When the importance of the issue has been confirmed, targeted action is subsequently taken to address the issue.

3.3 *Research (Original and Literature)*

3.3.1 A) What role does research play in your BDO decision-making? Describe how research is accomplished in your BDO (e.g., plan/ad hoc, in-house/collaborative/extramural)?

B) Do you conduct your own (in-house) research? If so, how is the decision made to conduct the research in-house versus contracting it? How is the work reviewed for scientific integrity? How are the results disseminated and applied?

C) Do you fund/sponsor extramural research efforts? If so, what is its magnitude (dollars dedicated to the research)? How are the projects

planned and solicited? How are the investigator teams selected and how are the reports/products reviewed for scientific integrity and disseminated?

3.3.1.1 State Water Resources Control Board

Research supports the decisions of the Water Boards. The regulations and permit limits established by the Water Boards are required to be based on sound science. Research that the Water Boards require is normally done by outside contractors, if funding is available. The Water Boards conduct in-house research when it does not require outside resources (e.g., laboratory) or equipment. Funding for external research is provided according to the Water Boards' needs and priorities, subject to budget allowances. External projects are typically outsourced to other State agencies, State universities, or State-chartered research organizations depending upon the experience and abilities of the organization and the project needs. The Water Boards most often rely on sponsored research to develop new information the purpose of which is to bridge the gap between available published scientific data and its application to solve or alleviate important water quality problems. Whether the research is in-house or sponsored, the results are invariably intended to support the implementation of a proposed regulatory action to improve or maintain water quality.

3.3.1.2 Office of Environmental Health Hazard Assessment

OEHHA research is primarily from published studies that are reviewed, evaluated, and incorporated into assessments on the toxicity of, and exposure to, chemical contaminants. In some instances OEHHA sponsors outside research projects in support of its programs (e.g., the study comparing metal concentrations in outdoor soil to that in indoor classroom dust). OEHHA occasionally conducts research in-house, as in the case of surface sampling techniques. Research is funded from the OEHHA budget or by obtaining outside grants.

The decision to use in-house expertise or outside contractors is related to resource issues and availability of appropriate expertise and equipment. Lacking facilities to conduct most kinds of laboratory research, OEHHA contracts out laboratory-related work—such as measurements of air pollutant levels—and some Geographic Information Systems (GIS) work.

Research into the literature and regarding special issues (e.g., assessment of arsenic carcinogenicity) may be contracted out when funding is available. The decisions to contract out research consider special expertise, time efficiency, and cost effectiveness. Outside research is program-related and incorporated into the specific project. Research contracts have varied between \$15,000 and about \$150,000. Planning, solicitation, and selection all go through the formal State procedure (e.g., competitive bidding). The work is reviewed by the contract manager, and when it meets the quality requirement, is used in OEHHA documents. The documents are reviewed internally and externally and disseminated, then reviewed again at the final project report phase.

3.3.1.3 Department of Toxic Substances Control

DTSC generally uses research published in peer-reviewed journals or by other agencies such as U.S. EPA to apply to site-specific problems. However, in the 1990s DTSC managed contract research by investigators at the UC Davis, UC Medical Center in San Francisco, and Lawrence Livermore National Laboratory. Projects resulting in publications in peer-reviewed journals include the Cal/TOX model for fate, transport, exposure, and risk assessment of organic chemicals, cardiotoxicity of cadmium, dermal absorption of metals, pesticides, polychlorinated biphenyls (PCB), and trichloroethylene, and inhalation exposure to trichloroethylene from showering.

Some smaller or more specialized projects are done in-house. For the Stringfellow site, DTSC performs pilot or bench scale testing for site-specific applicability of treatment technologies. Scientists in the Hazardous Materials Laboratory research methods for identification and measurement of contaminants in environmental and biological media. They also develop techniques for biomonitoring to assess environmental fate, transport, and exposures.

3.3.1.4 Department of Pesticide Regulation

DPR requires pesticide registrants to conduct studies and contracts with UC and California State University (CSU) to conduct extramural research to address regulatory issues, and these universities are actively involved in intramural and extramural exposure and environmental monitoring studies, advising researchers on protocol design for both toxicology and exposure studies. All studies must be conducted within the parameters of Standard Operating Procedures; some studies are conducted under the U.S. EPA Good Laboratory Practice standards. Protocol reviews, in-process quality assurance audits, quality control samples are all required to ensure scientific integrity. Study reports undergo peer review in addition to a report and data quality assurance audit. The results of these studies provide data for exposure assessment and are disseminated via study reports posted to the Internet and published in scientific journals.

DPR researches agricultural and urban integrated pest management systems using GIS, pesticide use data, and remote sensing techniques. They also conduct research on pesticide use trends, analyze alternative pest management practices, use models and univariate and multivariate statistics for data analyses and prediction. The research may be conducted in-house, depending on time and the expertise required. The results are extensively peer reviewed internally and externally and are often published in scientific journals.

The results are also disseminated via the DPR website and targeted mailings. Growers and stakeholders use the information to implement less hazardous methods of pest management. Current annual research funding is less than \$100,000, although it has been as high as \$1,000,000. Contracts are usually with UC or CSU based on the principal investigator's expertise. Products or reports are peer reviewed by DPR scientific staff. Collaboration with UC Davis may impact or help drive some research conducted there, such as involvement with the Western Center for Agricultural Health and Safety.

3.3.1.5 Integrated Waste Management Board

IWMB relies on research in the development of regulatory and policy decisions. The research includes internal staff work and external contracting and review. IWMB's in-house research is primarily based on published research and its own in-house files and databases to compile information on a case-by-case basis. All other research is conducted via contract or interagency agreement. IWMB sends the work to BDOs, environmental groups, academics, industry, businesses, local government, and other stakeholders for review of its scientific integrity.

The results are applied through regulation, guidance, and/or statutory change. IWMB disseminates the results through noticing of a regular public Board meeting, on the IWMB website, and by notifying stakeholders. The decision to conduct research in-house or contract it out depends on IWMB staff time and expertise. IWMB staff regularly conduct market research to help businesses identify potential suppliers of recycled feedstock that meet their technical specifications and to identify new customers for their recycled-content products.

IWMB frequently works with other State agencies, U.S. EPA, and other entities in conducting research. An example is collaborating with Yolo County, SWRCB, and U.S. EPA on a demonstration project at the Yolo County Central Landfill for bioreactor landfill technology development in California. In collaboration with DPR, IWMB developed a work plan to address issues surrounding the herbicide clopyralid and its impact on composting. Clopyralid data were developed under IWMB contract in agreement with DPR on protocols for restricting the use and handling of pesticides containing clopyralid, a persistent herbicide.

IWMB funds large-scale demonstrations with commercial growers, University of California, the Resource Conservation Districts of Napa and Ventura Counties, and others. These projects include monitoring the effects of composted mulch or green material on various commodities by examining crop yields, incidence of plant disease, compost characteristics, soil profiles, or measurable soil erosion. IWMB collaborated with U.S. EPA, Merced Public Works, and Sustainable Conservation to develop an innovative manure management project demonstrating that manure from a combined animal feeding operation could be successfully co-composted with municipal green waste.

Compost emission testing results developed under IWMB contract served as the basis of testimony to SCAQMD for Rule 1133 rule-making process on compost emissions. This ultimately resulted in a change in SCAQMD's adopted rules.

If additional expertise is needed, IWMB contracts with the CSU system (Sacramento State, California Polytechnic State University in San Luis Obispo), UC (Davis, Riverside), and other entities as needed. IWMB contracted with the Desert Research Institute at the University of Nevada for the Alternative Cover Assessment Program, which is run by the U.S. EPA National Risk Management Research Laboratory, and is developing field-scale performance data for landfill final cover systems.

To determine how conversion technologies would perform in comparison to established waste management practices, IWMB contracted with UC Riverside

and UC Davis for a technology evaluation, and with Research Triangle Institute with subcontractors Hilton, Farnkopf, and Hobson along with the National Renewable Energy Laboratory for life cycle analysis and market assessments. This became the basis for IWMB policies and provided input into the development of AB 2770 (Matthews, Chapter 740, Statutes of 2001) regarding conversion technologies.

IWMB contracted with CSU San Diego to assess emissions from composting operations and to develop Best Management Practices to reduce volatile organic compounds and ammonia. Other contracts include those with CSU San Diego to develop odor identification and mitigation strategies from composting operations and with University of California Los Angeles to study the effect of applying a high carbon ash amendment to compost for odor control.

Research contracted by IWMB on using the compost process to reduce the spread of Sudden Oak Death Disease (*P. ramorem*) was the basis for testimony to the U.S. Department of Agriculture and the California Department of Food and Agriculture. This allowed development of compliance agreements within a twelve-county quarantine zone that allowed for the movement and processing of both host and infected feedstock and product.

IWMB contracted with DHS to conduct a laboratory-based study to measure emissions from standard building materials and compare them to those emitted from their alternative sustainable counterparts. The study also measured chemical emissions from tire-derived resilient flooring and compared them to those emitted from their non-tire-derived counterparts. IWMB awarded a grant to San Joaquin County to develop a certification standard for recycled-content paint, one of eleven projects identified in the Paint Product Stewardship Initiative Dialogue. It should increase the market for recycled-content paint. The grant was awarded as a result of a competitive process.

IWMB will be entering into agreements with UC Davis and the SCAQMD to evaluate the technical and economic feasibility of converting landfill gas into hydrogen for use in vehicle fleets and fuel cells.

The extent of extramural IWMB research in a given year depends on a variety of factors, including legislative mandates (e.g., AB 2770), legislative restrictions (e.g., regarding research on the use of tires in cement kilns), funding source, IWMB priorities, and availability. For example, the IWMA has few research mandates, so general research is dependent on available discretionary consulting and professional services funds. The need for projects is recognized either in response to identified problems, as required for cross-media pollution prevention rulemaking, or to evaluate innovations in waste management and diversion.

Once the need is established, the projects are generally developed through IWMB's contract concept process, funding is allocated, and contracts are secured through a competitive bid or an interagency agreement that matches the qualifications of the contractor with the project requirements. Work products are coordinated and reviewed by IWMB contract manager, who has a scientific background. Work products are further reviewed formally or informally by technical committees associated with the project, the UC peer review process,

and/or through publication in scientific journals. Information is disseminated at conferences and to stakeholder groups by making presentations, publishing reports, and posting information on the IWMB website (<http://www.ciwmb.ca.gov/>).

3.3.1.6 Air Resources Board

ARB sponsors a comprehensive program of research into the causes and effects of, and possible solutions to, the air pollution problem in California. The goal of the research is to provide the scientific and technical information needed to develop and support the public policy decisions required for an effective air pollution control program.

A Strategic Research Plan was developed in 2001, and updated in 2003, to guide annual research planning. The Plan identifies broad areas where research is needed and guides ARB's Annual Research Plan so that it will aid in the Board's regulatory decision-making. The Plan will also advance efforts to meet SIPs and other commitments and facilitate coordination with other research organizations. The Strategic Plan is constructed from research ideas submitted by staff, outside experts, and the general public. During the annual process, multi-divisional groups consider important data gaps that need to be filled. Submissions are sorted by general topic and ranked by relevance to policy needs, scientific merit, and cost. A proposed plan, made up of projects selected by senior management, is then submitted to the Research Screening Committee (RSC) and to the Board for their approval.

The majority of ARB's research is supervised by the Research Division (RD), and generally deals with atmospheric processes, emission control technology, health impacts, or exploration of new measurement and analysis methods. These projects are in large part contracted to university researchers and require review and approval by the RSC both in the planning and proposal stages and to accept final work products.

Research undertaken outside the RD tends to be confined to special projects or for technological development applied to in-house functions (monitoring methods, model development, etc.). Examples of special projects include support work for the California Regional Particulate Air Quality Study and in-house vehicle testing to assess the emissions impact of ethanol vs. MTBE as a fuel oxygenate. RSC review is applied to some projects that are not routine in nature. In-house research is usually undertaken when ARB staff have particular expertise in the topic area and the nature of the project suggests more flexibility is needed than can be obtained in extramural contracts. Other decision criteria for conducting in-house research include the level of staff resources and the need for specialized instrumentation/equipment. Specific examples of in-house research include the Diesel/Natural Gas project conducted at ARB's heavy-duty dynamometer in Los Angeles and the investigation of particles counts using condensation particle counters at the Children's Health Study sites.

In-house projects range from informal cooperation with academic or government projects in which staff commitment is too small to justify extramural contracts to very large field experiments, such as SCOS97-NARSTO. ARB

must make decisions and set priorities that optimize the yield of information relevant to ARB's regulatory program. The Mobile Source Control Division often conducts in-house research at its vehicle testing facility in El Monte. Examples of previous test programs include a pilot program evaluating the emission benefits of replacing emission control devices, measurement of selected TACs (e.g., 1,3-butadiene and aldehydes) from light-duty vehicles, and the effects of fuel oxygenates on exhaust and evaporative emissions.

Large in-house projects are generally referred to the RSC or a project-specific committee for review, much as for extramural research. For example, ARB's Monitoring & Laboratory Division participates in programs to develop sampling and analytical methods needed by both industry and the compliance assurance community. In-house projects often lead to publications in peer-reviewed journals, and program-relevant findings are reported in formal ARB reports.

Extramural research is often conducted on a collaborative basis with agencies such as the South Coast Air Quality Management District, the Coordinating Research Council, and the U.S. Department of Energy. Extramural research project funding at ARB varies from year to year; the 2005–06 research budget is \$5.4 million (plus another approximately \$1.4 million in co-funding). The ARB Research Plan generally guides extramural projects. The plan consists of continuing multi-year projects and new projects added annually from research ideas submitted by staff, outside experts, and the general public.

Extramural research contractors are selected in one of three ways. As directed by the Health and Safety Code, ARB's preferred method of conducting research is through an interagency agreement with the UC or CSU. For projects with clearly defined tasks, ARB can use a general solicitation for bids (requests for proposal, or RFP) with subsequent proposals being evaluated by qualified reviewers for technical merit, management, cost, and other criteria.

Typically, the RFP is subjected to review by the RSC before its release. To meet research needs for which the necessary expertise is limited to a particular academic group or business entity, a sole-source proposal can be solicited. The proposals are reviewed and subject to approval by the RSC, as are the final work products. The final reports are disseminated to selected libraries and are available to the public via the ARB library and Internet. Additionally, the principle investigator presents a seminar of the project, which is often available live via webcast. Presentation slides are always available on the ARB website (<http://www.arb.ca.gov/homepage.htm>) shortly after the seminar.

3.4 Strengths and Areas for Improvement (Merged List)

Following is a compilation of BDO responses to each question in summary form. Although many of the items were mentioned by more than one BDO, the points listed do not necessarily represent a consensus view among the BDOs.

3.4.1 What are the strengths of your scientific programs?

- Highly educated, innovative, motivated, experienced, and productive employees who work to improve skills through education and training. They have received awards. They participate in scientific and professional

organizations, publish their work, present their work at local and national meetings, and serve as peer reviewers and committee members.

- The DTSC Hazardous Materials Laboratory serves as a reference laboratory for the State.
- Scientific research is targeted to problem-solving.
- Decision-making processes are open and transparent, with abundant opportunities for public input. These processes consider both scientific and nonscientific information.
- Work products are made widely available via the Internet and other methods of dissemination.
- Peer reviews, both internal and external, help to ensure high quality of work products.
- Supportive management. Managers participate in employee performance reviews, encourage training and staff development, and serve as advocates for staff by seeking reasonable project timelines and the availability of tools and equipment for properly conducting the effort. The BDOs generally allow flexibility in work schedules to accommodate family needs.
- Ready access to information resources such as in-house and university libraries.
- Networking and collaborative work with professionals within and between disciplines. This collaboration is particularly important with respect to cross-media issues.
- Research programs provide scientific support for Cal/EPA programs.

3.4.2 What constraints/threats exist that challenge/limit the role or quality of science in your programs?

- Inadequate funding with resulting loss of positions and contract money puts a burden on the remaining staff to meet program requirements.
- Difficulty in recruiting and retaining highly qualified scientists due to State salary levels that are not competitive with the federal government and other sectors doing similar work, and limited career ladder opportunities for staff in the current State classifications.
- High staff turnover in some areas leads to loss of institutional memory.
- Staff ability to keep current in their scientific fields is diminished by financial and other limitations on out-of-state and out-of-country travel.
- Too little time for professional development.
- The majority of chemicals in commerce lack toxicological and epidemiological data.
- BDOs other than ARB do not have their own research divisions and must depend on research conducted by others, which may not be timely or targeted to BDO specific needs.

- The lack of research resources and the cumbersome and slow contracting process limits the scope, quality, and timeliness of research support, resulting in a delay between identification of a question needing research and implementation of an appropriate project.
- In-house research keeps staff skills at the highest levels, encourages contact between Cal/EPA researchers and outside researchers, and enhances Cal/EPA's institutional credibility. Too little in-house research erodes these assets.
- Time pressures limit ability to initiate research to support science-based decision-making, along with other external pressures or demands on various aspects of BDO documents.
- As research needs exceed the available funding, the temptation exists to address the issue in a cursory manner rather than conducting a thorough definitive scientific investigation, or to try to do more with less, which risks compromising the quantity and quality of the final products.
- Challenges that are outside the scope of the training and expertise of current staff (e.g., environmental justice, small community exposures, hydrogen economy, global pollutant transport, climate change).
- BDOs lack the time and money to meet the needs of emerging issues requiring new approaches and new equipment.
- Lack of state-of-the-art equipment.
- Political constraints and opposition from various stakeholders.
- There is no real body from which to receive scientific advice on specific questions, emerging issues, or new methods.
- It is difficult to overcome the appearance of "institutional conflict of interest" when the UC system is conducting both the research and the peer review.

3.4.3 How could the scientific basis of your BDO's programs be enhanced?

- By more stable funding.
- By funding projects of interest in addition to review of sites.
- By cross-disciplinary training.
- By adding technical expertise in areas where Cal/EPA currently is not strong, such as statistics, geochemistry, health physics and radiation (DTSC), new technology development, advanced economic forecasting, behavioral sciences, urban planning, and new engineering fields of super-efficient combustion and hybrid vehicle building (ARB).
- By implementing cost-benefit analysis in decision-making.
- By moving away from "command and control" approaches. Challenges (such as environmental justice, attainment of new air quality standards) may require a better understanding of public behavior and psychology to gain public cooperation.
- By developing and funding a research branch that would be able to address the emerging Water Board issues in a more timely manner.

- By providing greater opportunities for scientists to attend scientific conferences, symposia, and workshops on topics such as new research data and findings, techniques and methodologies, emerging issues, specific chemical toxicology, mode of action discussions, and risk assessment guidelines in order to maintain effective, competitive, and meaningful scientific programs.
- By having a clear separation between the evaluation of the scientific evidence for toxic effects on humans and other organisms and the management and policy decisions that are needed to translate the scientific findings into regulatory standards or policies.
- By itemizing science policy choices and quantifying the range of possible results if alternative choices were made.
- By technology transfer to younger staff.
- By generating data on health effects of emerging chemicals, including polybrominated diphenyl ethers and individual PCB congeners.
- By acquiring skills and techniques in data mining techniques and computer imaging to address larger regional issues and to promote the best application of science to risk management, especially in the presence of cumulative risks.
- By addressing the salary inequities between State scientists and those in industry, academia, and the federal government.
- By fully funding new mandates or programs to ensure the hiring of top quality scientists and having all the resources to do a quality job.
- By increasing monitoring and research budgets.
- By allowing greater contracting flexibility with respect to multiple year research projects, contracts awarded on merit rather than price, and a less cumbersome contracting process.
- By having scientists—not administrative staff—determine those projects categorized as scientific.
- By developing a process to facilitate informal scientific exchange with other BDOs and with UC scientists in order to receive input on scientific questions as they arise. The process should be less cumbersome than the UCOP peer review to answer simpler questions earlier in the process.
- By developing an Agency scientific advisory board as the conduit of scientific input to the BDOs. (This would not replace the UCOP 57004 peer review process, which is very restricted in scope.) While no single group will have the wide-ranging expertise to cover all issues, the U.S. EPA model (a standing panel with ad hoc subcommittees made up of subject matter experts to address specific issues) should be considered.
- By developing a cross-BDO directory of scientific experts that could be used as mentors or sounding boards for scientific research and activities.
- By fostering a greater respect for the role of science in public policy-making on the part of decision-makers and stakeholders.

- By making available sufficient time and staffing to conduct thorough scientific evaluations wherever possible in view of mandated deadlines and limited resources.
- By routinely (every 2–3 years) reviewing science-based policies in light of new information. Although policies must often be adopted when the scientific basis is limited, this would entail a more open attitude about Air Board policies and the dedication of resources for the review and re-evaluation of policies to ensure they remain founded on the best science available.
- By recruiting technical staff with advanced degrees for certain highly specialized activities.
- By supplying additional funds to help alleviate current bottlenecks in the development of scientific support for ARB's regulatory programs.
- By new initiatives for in-house research accompanied by commensurate resources.
- By a commitment to longer planning and funding horizons for certain portions of the research program.
- By expanded opportunity for recognition and advancement for scientific staff in order to provide ARB with the research capabilities to meet the challenges of impending global environmental, technological, and economic changes.
- By establishing more technical advisory committees for extramural research, and also for in-house research where appropriate.
- By upgrading peer review.

With regard to the UCOP peer review contract, changes are needed to:

- Allow something easier and more informal.
- Ensure adequate funding for the program and its operation by all parties involved.
- Establish a reviewer resource list or database including qualifications criteria for the reviewer resource list and a databank of potential and actual conflict of interest files for reviewers.
- Develop a mechanism to recruit non-UC reviewers.
- Investigate ways to improve interactions between agencies and UC and promote timely response through an established channel between UC and Cal/EPA. UC needs to have a trained, responsive person in charge of processing and filling such requests.
- Develop a "quick look" option for low-sensitivity projects or for mid-project review, in which formal written reviews are replaced by verbal feedback to the staff in a conference call or meeting.
- Allow multiple options for achieving an equivalent scientific peer review.
- A guidance document with examples of past uses on the Cal/EPA peer review agreement would help those unfamiliar with the process.

3.5 **Other Comments**

Cal/EPA should foster positive working relations with the UC so that the UC faculty sees state scientists not as competition, but as partners in problem solving and implementation of environmentally sound programs. Cal/EPA scientists can utilize much of the fine work conducted by UC scientists in the regulatory process, and Cal/EPA should promote that concept.

Risk management policies should not encroach on risk assessment assumptions and methodologies. The National Research Council recommended that “regulatory agencies take steps to establish and maintain a clear conceptual distinction between assessment of risks and consideration of risk management alternatives; that is, the scientific findings and policy judgments embodied in risk assessments should be explicitly distinguished from the political, economic, and technical considerations that influence the design and choice of regulatory strategies.” Economic and feasibility considerations, policy implications, public support or lack thereof, and other considerations have an important role in environmental and public health decisions, but they should not be intermingled with the scientific support underpinning the decision.

Cal/EPA has centralized the creation of chemical toxicity and carcinogenicity criteria, promoting consistency among the BDOs. This model could be followed for other aspects of risk assessment such as environmental fate and transport of chemicals, human exposure assessment, and ecological exposure and effects assessment. Besides transparency, the advantages of following this model include:

- Efficiency—It is inefficient to have scientists in various BDOs working separately on similar problems. The problem is compounded if their solutions are different (see “consistency” below).
- Consistency—Cal/EPA has centralized the creation of chemical toxicity criteria and carcinogenic potency values, promoting consistency among the BDOs. Similar consistency could be encouraged by standardizing other aspects of risk assessment, such as environmental fate and transport of chemicals, human exposure assessment, and ecological exposure and effects assessment.

4 Analysis of BDO Responses to Questionnaire

4.1 Role of Science in BDO Decision-Making

A variety of considerations go into BDO decision-making. Most goals and targets are developed by staff using a variety of inputs, including statutory requirements, Agency guidelines, published and unpublished scientific data, input from other BDOs, advisory committees, peer reviewers and the public, decisions by other entities including federal and international agencies, and federal mandates.

Although decisions must be based on the best available science, most policies and regulations must also consider court decisions, technological feasibility, economic considerations, and societal goals such as exercising caution in the face of uncertainty, and resource conservation. Some considerations specifically mandated for various programs include technical feasibility, environmental justice, aesthetic values, differential effects on sensitive populations including children, legal issues, public acceptance of decisions, and other environmental concerns. Some programs are required to consider costs as well as benefits.

Generally, scientific data are used to support the science-based portion of the decision-making. Where scientific data are lacking, scientific judgment and default assumptions are used to fill in the data gaps. In risk assessments, these judgments and assumptions are generally designed to err on the side of caution (i.e., they are intended to cover the worst or near-worst case).

Some BDOs have expressed a concern about the transparency of decision-making. For others, transparency of decision-making is less a concern, since all policy and regulatory decisions are made in an open and transparent manner at a publicly noticed meeting and web agenda posting systems are used where the public can view or download pertinent information prior the meeting. While the situation is improving for all BDOs, there is room for further improvement. In essence, the public record should be sufficiently clear to document the decision-making process, including the factors that were considered and how each of the various factors influenced the final decision.

4.2 Quality of Science at Cal/EPA

The quality of science at Cal/EPA is assured primarily through the quality of scientists employed, through contracting for additional expertise when needed, and through internal and external scientific peer review and public review.

4.2.1 Scientists

All BDOs employ scientists, although scientists constitute a highly variable fraction of the total staff at the BDOs. Cal/EPA scientists have at least bachelor's degrees, and many have master's and/or doctorate degrees. Scientific disciplines include ecology, biology, microbiology, statistics, biochemistry, environmental chemistry, engineering, hydrology, geology, analytical chemistry, engineering, mathematics, biostatistics, medicine, veterinary medicine, epidemiology, pathology, physiology, pharmacology, agronomy, entomology, industrial hygiene, public health, environmental health, atmospheric sciences including meteorology, economics, environmental planning, resource

management, modeling, molecular biology, occupational medicine, plant pathology, plant physiology, soil science, water science, and toxicology. The toxicologists have a variety of specialties, including inhalation, reproduction, carcinogenicity, genotoxicity, nutrition, metabolism, neurotoxicity, risk assessment, etc.

BDOs ensure the quality of science in the development and implementation of their programs by staff training. Staff have opportunities to attend in-house training; cross-BDO training; seminars, workshops, and symposia; and training provided by universities, various professional societies and nonprofit professional groups to help them keep abreast of the latest information and technology. Scientists regularly study scientific and technical journals available online or in hard copy from the Cal/EPA Technical Reference Library. Scientists present their work at regional and national meetings and publish it in refereed journals.

While the high level of qualifications of scientists and the ongoing training they receive are certainly positive, BDOs are concerned that the declining competitiveness of State salaries will lead to difficulties in recruitment and retention of scientists and declining funds for travel and training will begin to erode the level of currency in the scientists' knowledge of their fields.

4.2.2 Scientific peer review

BDOs ensure the quality of science in the development and implementation of their programs with internal review, inter-BDO review and consultation, scientific and technical advisory committees, contracts with outside experts, symposia, external peer review, publication in peer-reviewed journals, public input, and quality control procedures for laboratories. Although all significant decisions receive internal review and most also receive some form of external review, the mandates for external review are varied. Some programs have specific review boards established by the statute that is the basis for the program. However, all have a requirement for external peer review of the scientific basis or scientific portion of a proposed rule pursuant to Health and Safety Code Section 57004.

4.3 Emerging Environmental Issues

BDOs lack the time and money, and in some cases the equipment, to meet the needs of emerging issues requiring new approaches and new equipment. Some of these new challenges are outside the scope of the training and expertise of current staff (e.g., environmental justice, small community exposures, hydrogen economy, global pollutant transport, climate change). No real body exists to provide scientific advice on specific questions, emerging issues, or new methods.

The public expects public officials to anticipate environmental problems so that they can be prevented or minimized. Since the demise of the Emerging Environmental Challenges program, Cal/EPA does not address emerging environmental issues in a systematic, coordinated manner. Lacking a specific mandate and a specific organizational structure, Cal/EPA addresses emerging environmental issues in an *ad hoc* manner. Generally staff members become aware of emerging issues through published information or by attending conferences. The issues are brought to the attention of management, and if deemed worthy of further attention, they may be assigned some level of support

(e.g., contract research, time and supplies for internal investigations). This approach may prove to be short-sighted. Without a coordinated effort, determining which emerging issues will become significant may be difficult.

4.4 Research

Research plays a key role in BDO decision-making. Although much of Cal/EPA's research involves searching the published literature, all BDOs conduct or sponsor some original research. ARB has a research division and corresponding budget. While Cal/EPA research programs were cited as a strength, some BDOs felt that Cal/EPA's commitment to research should be enhanced, such as by creating a Research Division.

Besides the obvious benefit of providing answers to previously unanswered program-related scientific questions, additional enhancements to conducting and/or sponsoring research would strengthen the ties between Cal/EPA and the research community, particularly the UC system. Some considered in-house research to be a factor in keeping staff sharp and motivated and more aware of the latest scientific methodology and findings.

Some considered the slow and cumbersome contracting process as limiting the scope, quality, and timeliness of research support. Time pressures limit ability to initiate research to support science-based decision-making, along with other external pressures or demands on various aspects of BDO documents. As research needs exceed the available funding, some were concerned that BDOs would try to do more with less, potentially compromising the quantity and quality of the final products by addressing issues in a cursory manner rather than conducting a thorough definitive scientific investigation.

4.5 Funding

Inadequate funding is widely seen as a threat to the quality of science at Cal/EPA. Inadequate funding may be manifested as lost positions, reduced funds for contracts, uncompetitive salaries, and recruiting and retention difficulties.

4.6 Training

Respondents widely believe that more training and professional development are needed.

4.7 Peer Review

The external peer review contract with the UC, while beneficial, is considered to be cumbersome and slow.

5 Self-Evaluation via Electronic Survey

5.1 Introduction

To gain a broader insight into the perception of the current role of science in BDO activities and ways to increase the role of science in BDO activities, the SCS also prepared an e-survey, which was open to participation by all employees. To encourage participation in the survey, Cal/EPA employees received several “All Hands” e-mails announcing the e-survey and reminding staff to complete it. To minimize bias and encourage participation without fear of potential retribution for any negative ratings or comments, the survey allowed for anonymous responses.

The overall participation rate was about 16 percent for all employees and about 19 percent among staff with technical or scientific background. The higher rate probably reflects that technical and scientific staff members have more interest than non-technical staff in participating in a science assessment survey.

Since the survey represented 15–20 percent of the staff, little can be said regarding the representativeness of the survey subset relative to the full population of employees. However, because the responses to every survey statement covered the full gamut of potential responses ranging from “Strongly Disagree” to “Strongly Agree,” it can be said that every perspective or perception was represented.

Furthermore, even the anonymous responses (BDO, job, or rank not identified), which might be expected to have a higher proportion of negative ratings, had response rates comparable to that of the identified respondents, which generally gave favorable ratings. Although the rating portion was helpful for assessing the overall state of science, it was the suggestion portion of the e-survey that identified how the quality and role of science could be improved and guided the SCS in the preparation of its findings and recommendations. This chapter details the e-survey content, a summary of the survey participation rates, a summary of the survey responses and associated interpretations, and a summary of the suggestions provided by the survey participants.

5.2 E-Survey Content

The e-survey requested information regarding the participant’s BDO, nature of work, classification or rank, and educational/vocational background. If no entry was checked within a group, the response category was assigned to “Undisclosed” or “Anonymous.” The science e-survey is presented below. The potential responses for primary science discipline include “Biological Sciences,” “Chemistry,” “Computer Science,” “Engineering,” “Environmental Science,” “Epidemiology/Toxicology,” “Hydrology/Geology,” “Legal and Law,” “Mathematics/Statistics,” and “Meteorology.” The same menu also contained two choices of “Non-science” and “Other.”



Cal/EPA Science Survey

Please complete this survey and return it electronically by **August 1, 2005**. Should you need clarifications in filling out the form, please contact Steve Hui (324-5826; shui@calepa.ca.gov)

Information provided in this survey will be kept confidential

Please mark with an "X" in the box most applicable to your answer. It will greatly help the overall survey evaluation if you can indicate your BDO, position and science discipline before completing the survey.

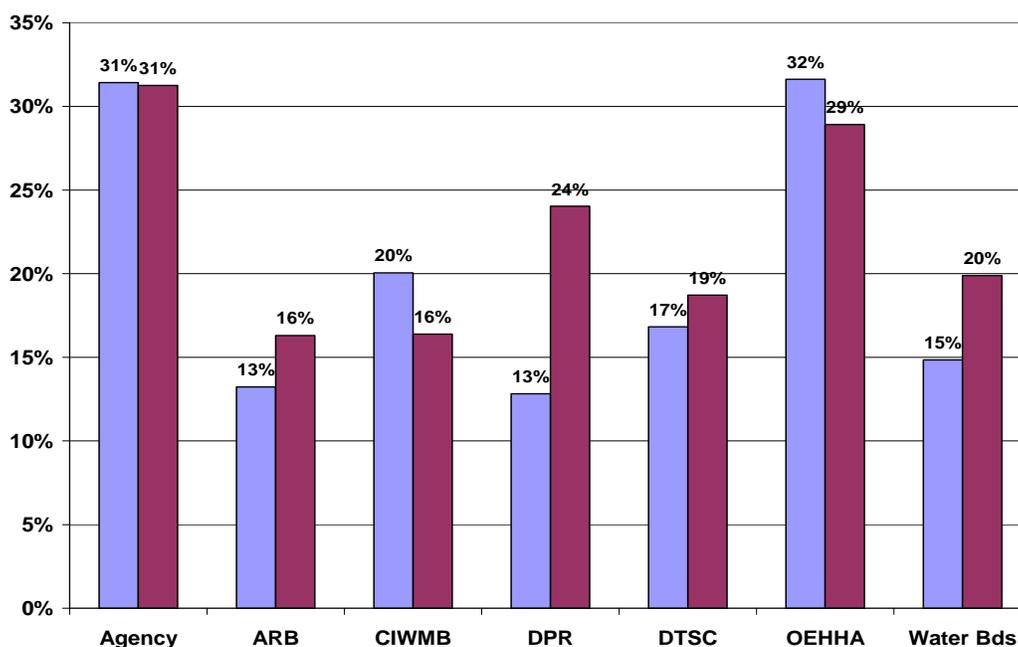
Thank you for your time and support!!

		Agency	ARB	IWMB	DPR	DTSC	OEHHA	SWRCB
Indicate the Board, Department, or Office for which you work								
	Technical	Non-technical	Staff	Supervisor	Middle Management		Upper Management	
Indicate your present position								
Science Discipline		(menu of choices provided)						
Reflecting on the role of science in your work/assignment, please share your views on the following:								
Section where I work			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
My work requires utilizing science routinely								
I am satisfied with the quality of science utilized in my work products								
Our/my group ensures that work products are based on sound science								
List two suggestions to improve the quality and utility of science in your section		1. 2.						
Branch/Division where I work			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
I am satisfied with the quality of science utilized in our work products								
Our/my branch/division ensures that work products are based on sound science								
Our branch/division routinely promotes scientific information exchanges (e.g. seminars, conferences)								
List two suggestions to improve the quality and utility of science in your branch/division		1. 2.						
BDO/Agency where I work			Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	N/A
I am satisfied with the quality of science utilized in our work products								
Our/my BDO/Agency ensures that work products are based on sound science								
Our BDO/Agency routinely promotes scientific information exchanges (e.g., seminars, conferences)								
List two suggestions to improve the quality and utility of science in your BDO/Agency		1. 2.						
Contact Information (Optional):								

5.3 E-Survey Participation Results

The survey participant information was summarized to provide a context for the interpretation of the survey responses. About 730 out of 4,500 of Cal/EPA employees participated in the e-survey. As presented in Figure 5.1, the average participation rate of all staff (technical or non-technical) was 16 percent, ranging from 13 percent to 32 percent for all BDOs, with Agency (Office of Secretary) and OEHHA more than 30 percent, and ARB and DPR at 13 percent. About 19 percent (500 out of 2,640) technical and scientific staff participated in the e-survey. When only technical and scientific staff at DPR were included, participation increased from 13 percent to 24 percent.

Figure 5.1–E-Survey Participant Rates by BDO/Agency
 (■ All staff vs. ■ Only Technical and Scientific Staff)

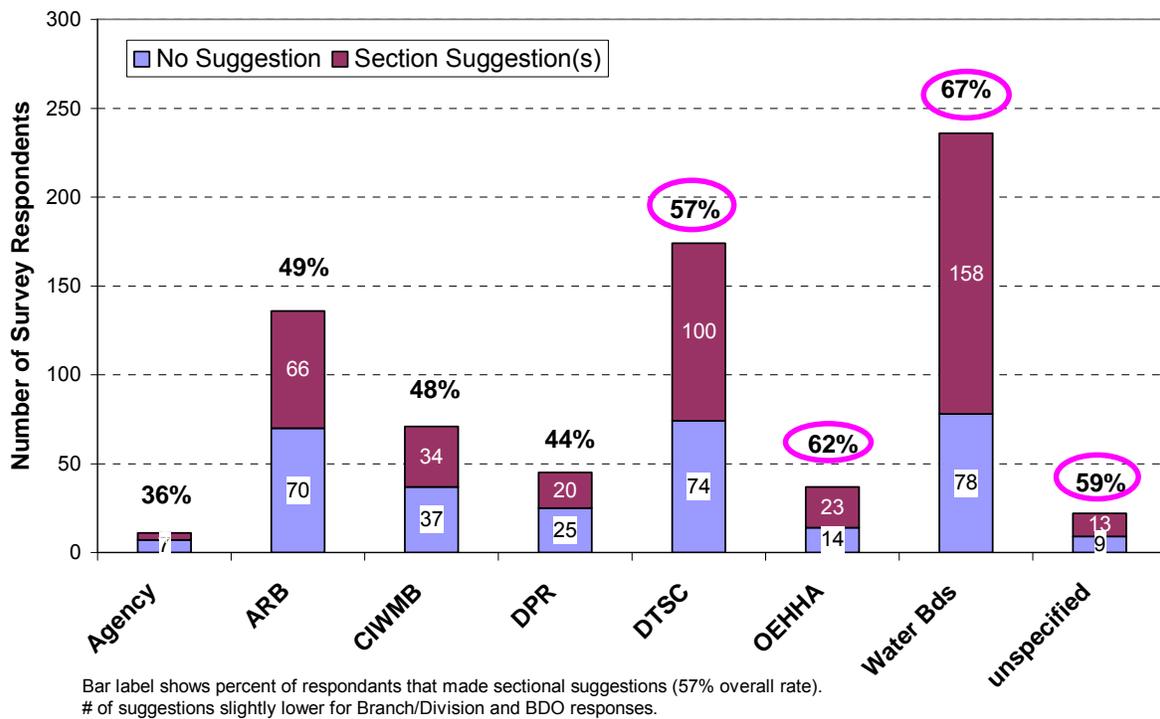


BDO:	Agency	ARB	IWMB	DPR	DTSC	OEHHA	Water Boards	Ave. Rate
All Staff Responded	11	134	71	45	174	37	237	16%
All Employed	35	1013	354	351	1,034	117	1,597	
Techs Responded	5	107	39	31	114	24	180	19%
Techs Employed	16	656	238	129	609	83	906	

The number of total employed and technical and scientific staff from each BDO that participated in the e-survey are shown in the table associated with Figure 5.1. Because of the larger number of employees in these BDOs, the grand survey results are driven by Water Quality Control Boards (Water Boards), DTSC, and ARB.

The number of survey participants who also made suggestions is indicated by the top portion of the stacked-bar plots, presented by BDO, in Figure 5.2. The percentage of survey respondents submitting suggestions is shown above each BDO bar. The Water Boards not only submitted the most suggestions (as might be anticipated based on number of employees alone) but also had the highest percentage of respondents making suggestions (67 percent). In all, 418 participants (or 9 percent of all Cal/EPA employees) provided at least one suggestion to improve the state of science within Cal/EPA.

Figure 5.2–Science survey respondents also making suggestions



Breakdowns of the survey participants by job and rank are graphically presented in Figures 5.3 and 5.4, respectively. As indicated by the figures, staff members who identify themselves as being in technical positions dominate the number of survey responses. Quantitatively, the composition (job and rank) of the e-survey participation is summarized in Table 5.1.

Figure 5.3—Science survey respondents by position (rank) within each BDO

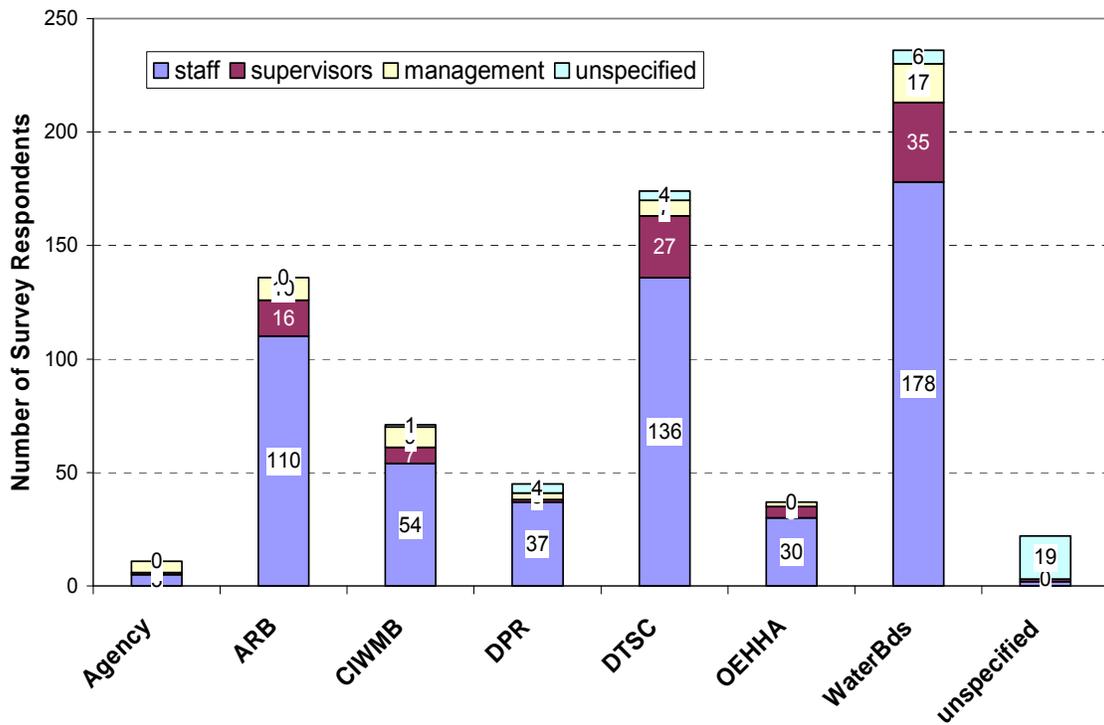


Figure 5.4—Science survey respondents by job type within each BDO

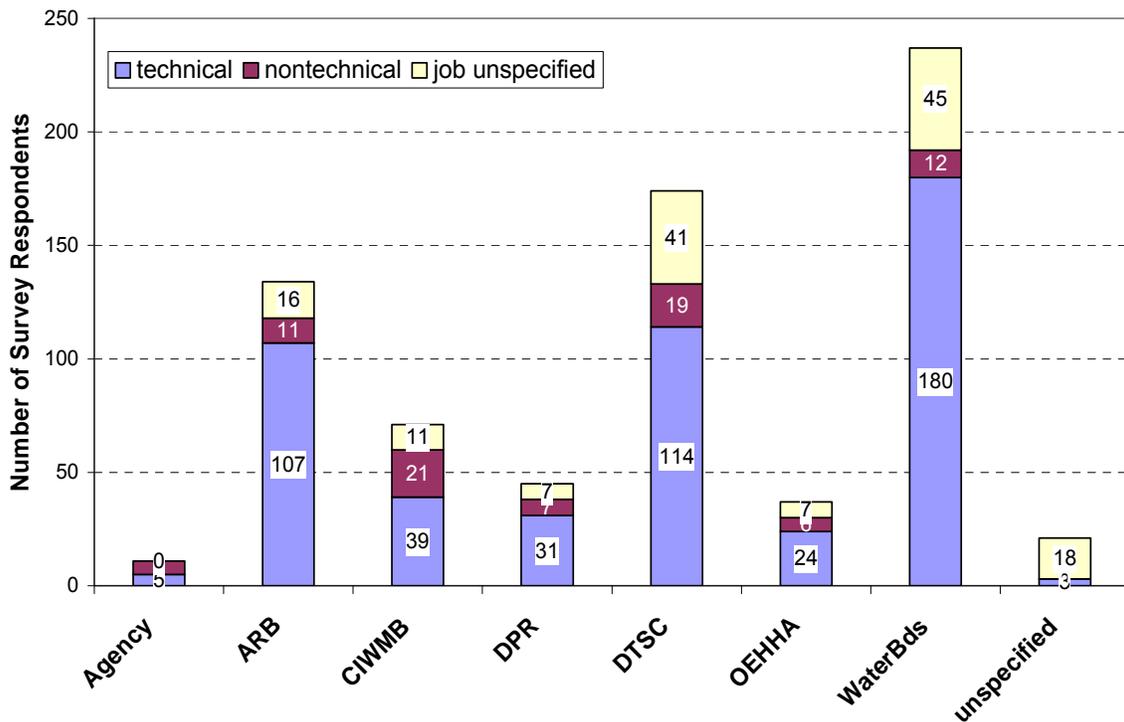


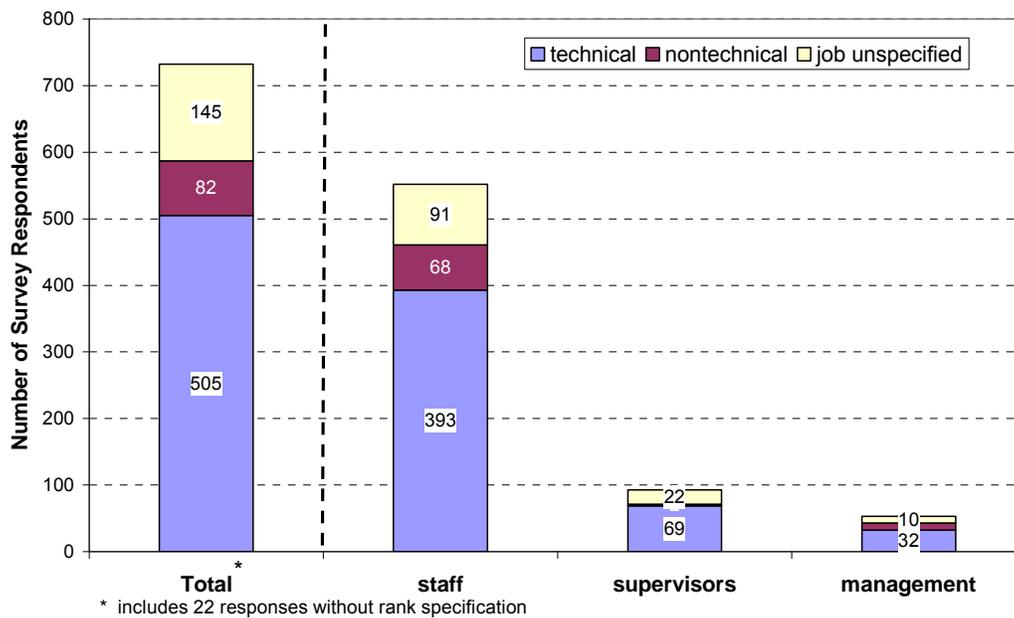
Table 5.1–Breakdown by Job and Rank of the Cal/EPA Science E-Survey Participants

(count and percent of total participants)

Job/Rank:	Staff	Supervisor	Middle & Upper Management	Unspecified	TOTAL
Technical	393 (54)	69 (9)	32 (4)	11 (2)	505 (69)
Non-technical	68 (9)	2 (0)	11 (2)	1 (0)	82 (11)
Unspecified	91 (12)	22 (3)	10 (1)	22 (3)	145 (20)
TOTAL	552 (75)	93 (13)	53 (7)	34 (5)	732

A joined, grand summary of the survey participants by job and rank is presented in Figure 5.5 (note: due to their small numbers, middle and upper management were combined). Because the survey results are dominated by the participation of technical staff, which is the group most familiar with scientific principles, the likelihood that the information provided by the respondents will be pertinent in the assessment of science is increased. Although the participation rates by technical staff were highest in Agency and OEHHA, the technical input is dominated by staff of the Water Boards, ARB, and DTSC.

Figure 5.5–Science survey respondents by job type and position

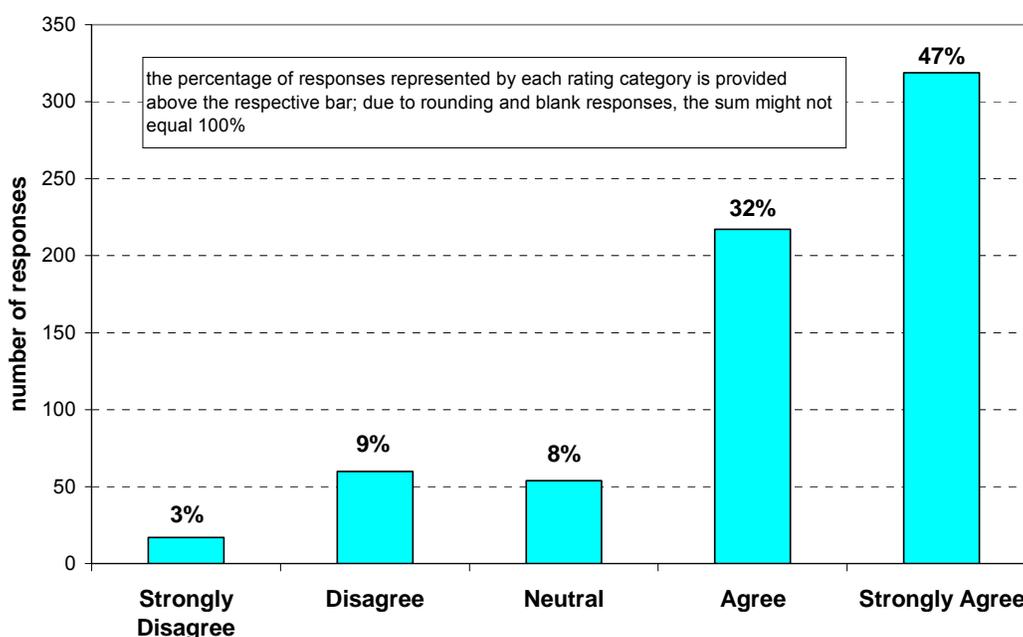


5.4 E-Survey Science Rating Results

The survey consisted of nine statements, three each for the section, branch/division, and BDO levels of assessment. Two of the statements are essentially applied to all three organizational levels: *satisfaction with the quality of science utilized in work products* and *confidence that organization ensures that work products are based on sound science*.

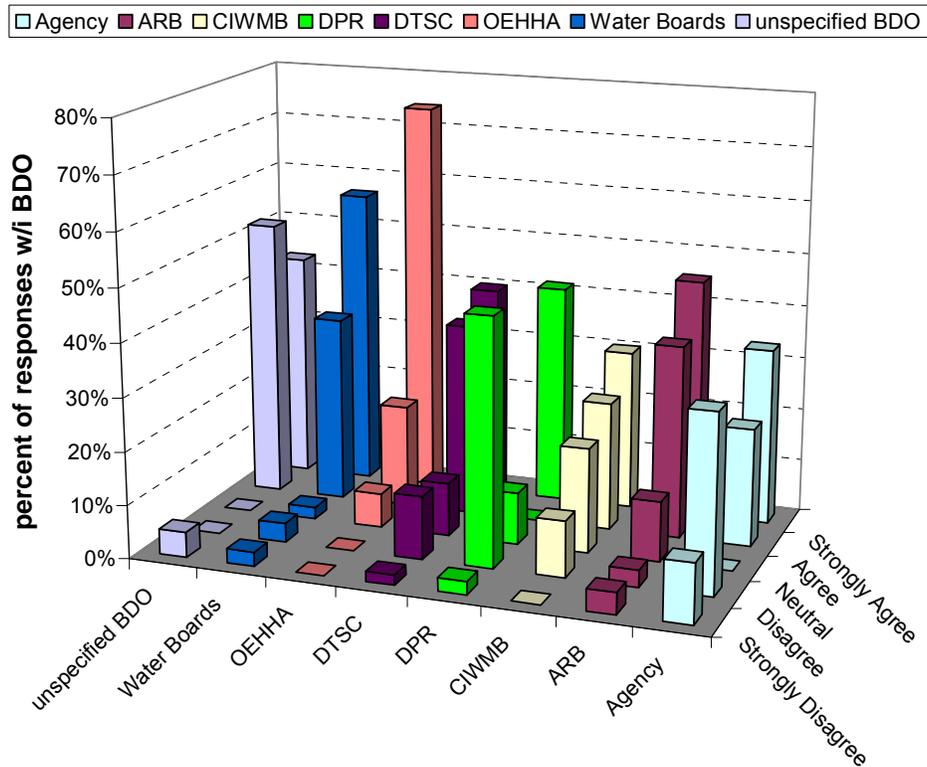
The responses to Statement #1 (*My work requires utilizing science routinely*.) indicate that most of the positions at Cal/EPA inherently require the use of science (Figure 5.6). In fact, almost half of the respondents strongly agree with the statement, with another third agreeing with the statement. In contrast, only 12 percent of the survey participants expressed any level of disagreement with the statement.

Figure 5.6—Cal/EPA Summary of Responses to Statement #1: “My work requires utilizing science frequently.”



When the responses to Statement #1 are broken down by BDO (Figure 5.7), some interesting differences appear. “Strongly Agree” was the predominant response of ARB, OEHHA, and Water Board staff, and OEHHA staff overwhelmingly believes that their jobs routinely require the use of science. On the other hand, DPR staff and, to a lesser extent, the Agency staff members have a significant portion who believe that science is not routinely required in the performance of their jobs. The dichotomy in the responses of these groups likely reflects the split in their organizational functions. In particular, DPR consists of branches with distinctly different needs for and uses of science—two for toxicological and health evaluations and four others for registration, licensing, and enforcement.

Figure 5.7–BDO Summary of Responses to Statement #1: “My work requires utilizing science frequently.”



The responses to Statement #2 (*I am satisfied with the quality of science utilized in my work.*) are summarized in Figure 5.8 and indicate a strong but tempered agreement compared to the response to Statement #1. The “Strongly Agree” response was much lower with those responders shifting to “Agree,” “Neutral,” and even a few more “Disagree.” Overall, the positive responses (“Agree” and “Strongly Agree”) overwhelmed the negative responses (“Disagree” and “Strongly Disagree”), 62 percent to 15 percent. Note in the summary by BDO (Figure 5.9) that the IWMB was the only one to have “Strongly Agree” as the predominant response. The majority of the BDOs had “Agree” as the modal response, but the Agency had “Neutral” and DPR had “Disagree” as the modal response to Statement #2. As with Statement #1, the DPR response to Statement #2 was bimodal with “Disagree” and “Strongly Agree” as the two predominant responses. Interestingly, the “Agree” response was essentially zero.

Figure 5.8—Cal/EPA Summary of Responses to Statement #2: “I am satisfied with the quality of science utilized in my work.”

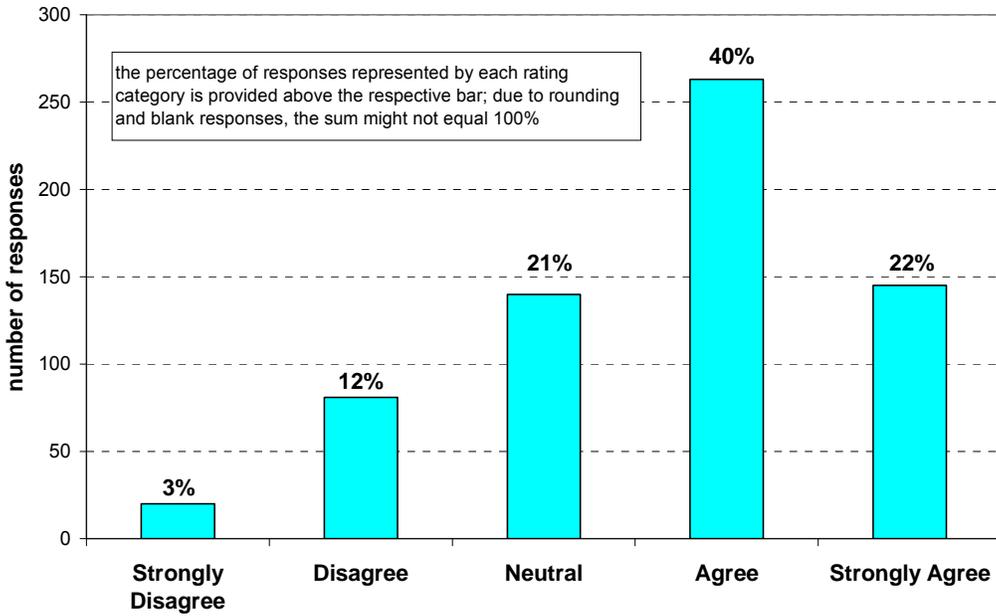
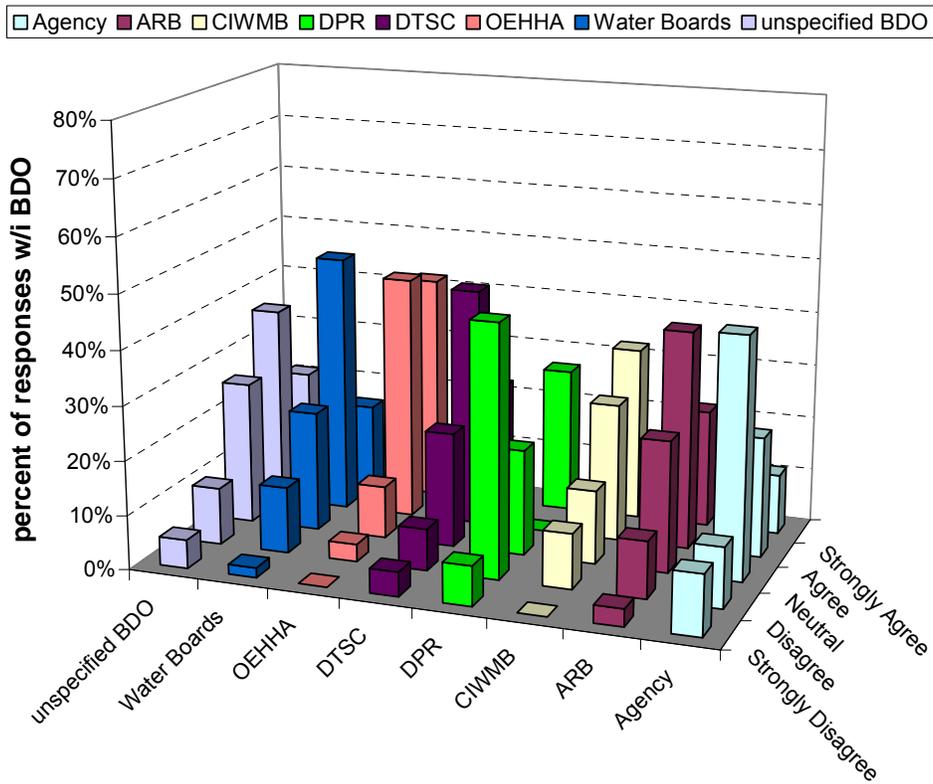


Figure 5.9—BDO Summary of Responses to Statement #2: “I am satisfied with the quality of science utilized in my work.”



The responses to Statement #3 (*My section ensures that products are based on sound science.*) are summarized in Figure 5.10 and also indicate a solid general agreement that science is ensured at the section level. The predominant response was “Agree” with 38 percent of the total responses. Together, the “Agree” and “Strongly Agree” responses overwhelmed the negative responses, 69 percent vs. 15 percent. As depicted in Figure 5.11, the majority of the BDOs had “Agree” as the modal response, but DPR had “Disagree” as the modal response to Statement #3. Similar to previous two Statements, the DPR response to Statement #3 was bimodal with “Disagree” and “Strongly Agree” as the two predominant responses.

Figure 5.10–Cal/EPA Summary of Responses to Statement #3: “My section ensures that work products are based on sound science.”

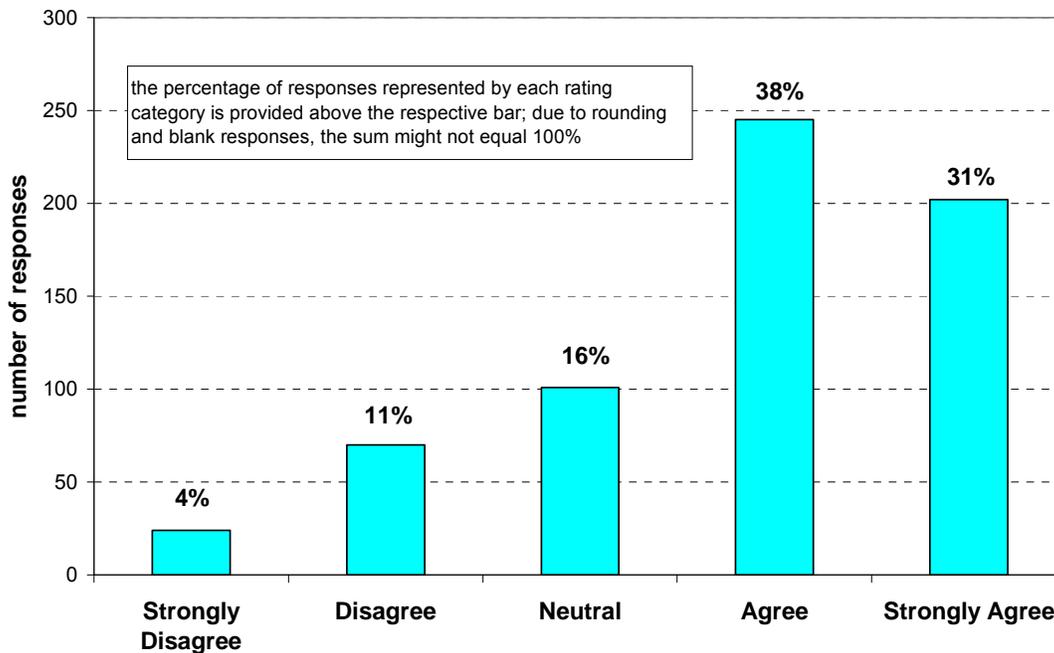
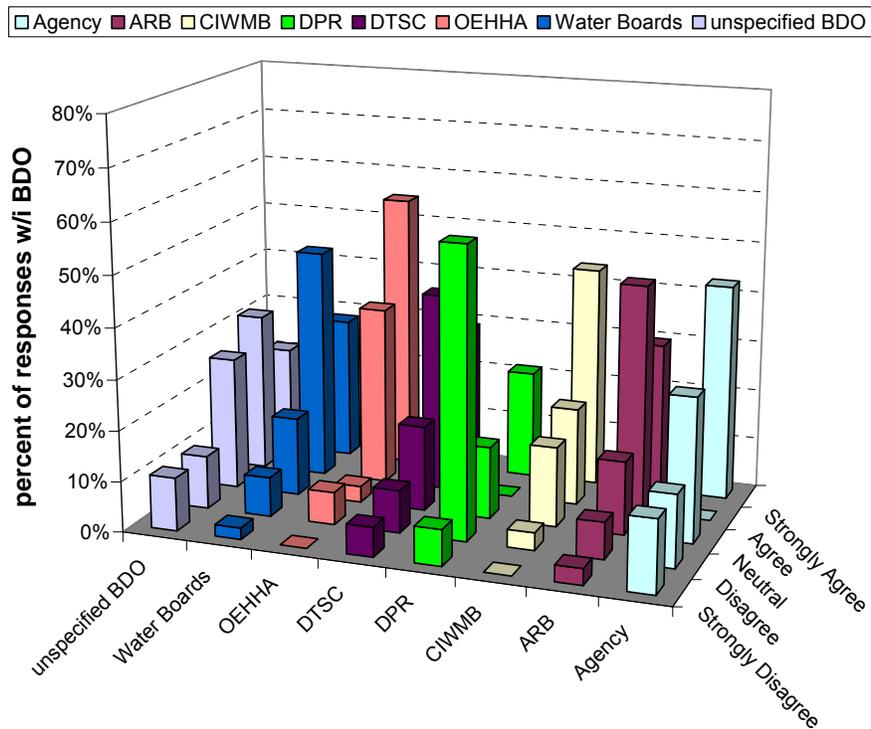


Figure 5.11–BDO Summary of Responses to Statement #3: “My section ensures that work products are based on sound science.”



Turning to the Branch/Division level of the survey, the responses to Statement #4 (*I am satisfied with the quality of science utilized in my branch's products.*) are summarized in Figure 5.12 and indicate a response pattern similar to that at the section level. The predominant response was “Agree” at 45 percent of the responses and the positive responses overwhelmed the negative responses, 65 percent to 13 percent. Looking at the responses by BDO (Figure 5.13), the Agency, IWMB, and OEHHA had “Strongly Agree” as the predominant response. The other groups had “Agree” as the predominant response. Interestingly, DPR did not have a bimodal distribution of responses at the division level as was observed at the section level. This suggests that the dichotomy in responses to Statement #2 may have been due to the distinctly different operations in the lower organizational levels.

Figure 5.12–Cal/EPA Summary of Responses to Statement #4: “I am satisfied with the quality of science utilized in my branch’s products.”

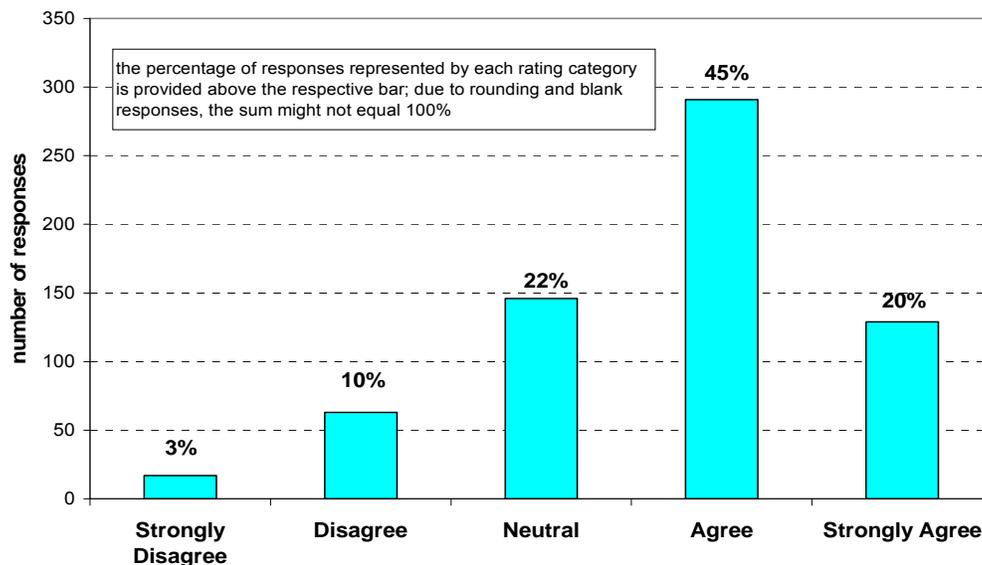
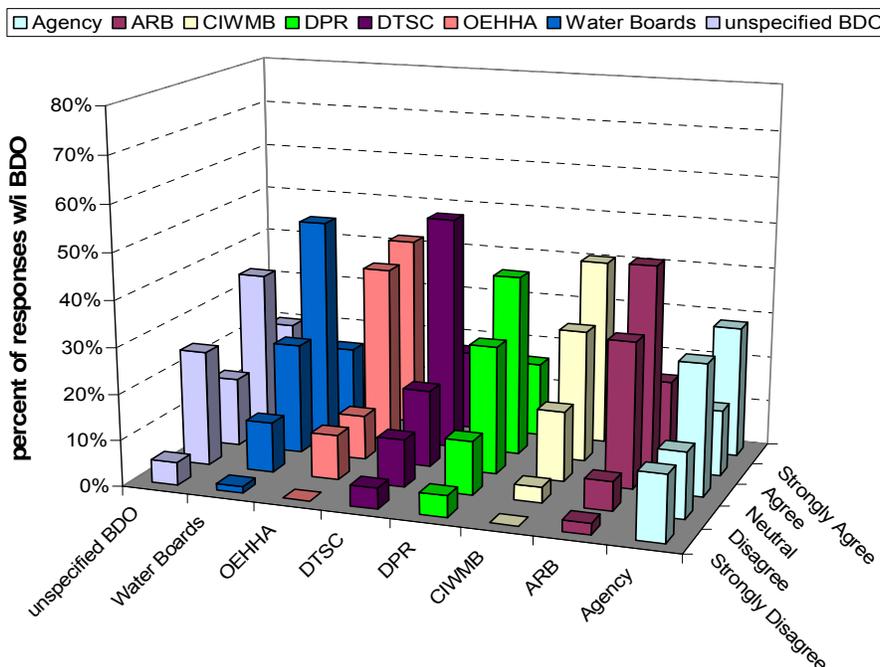


Figure 5.13–BDO Summary of Responses to Statement #4: “I am satisfied with the quality of science utilized in my branch’s products.”



The responses to Statement #5 (*My branch/division ensures that products are based on sound science utilized.*) are summarized in Figure 5.14 and are essentially identical to the responses to Statement #4. The predominant response was “Agree” (45 percent) and the positive responses overwhelmed the negative responses 65 percent to 12 percent. Looking at the responses by BDO (Figure 5.15), all of the

BDOs but Agency had “Agree” as the predominant response. “Neutral” was the modal response for Agency. The IWMB, OEHHA, and Agency also had large “Strongly Agree” responses.

Figure 5.14–Cal/EPA Summary of Responses to Statement #5: “My branch/div ensures that products are based on sound science.”

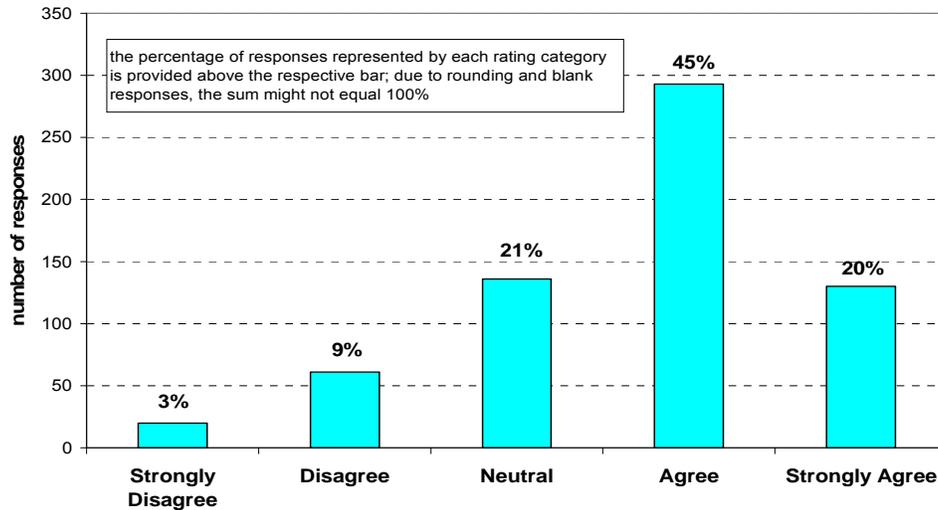
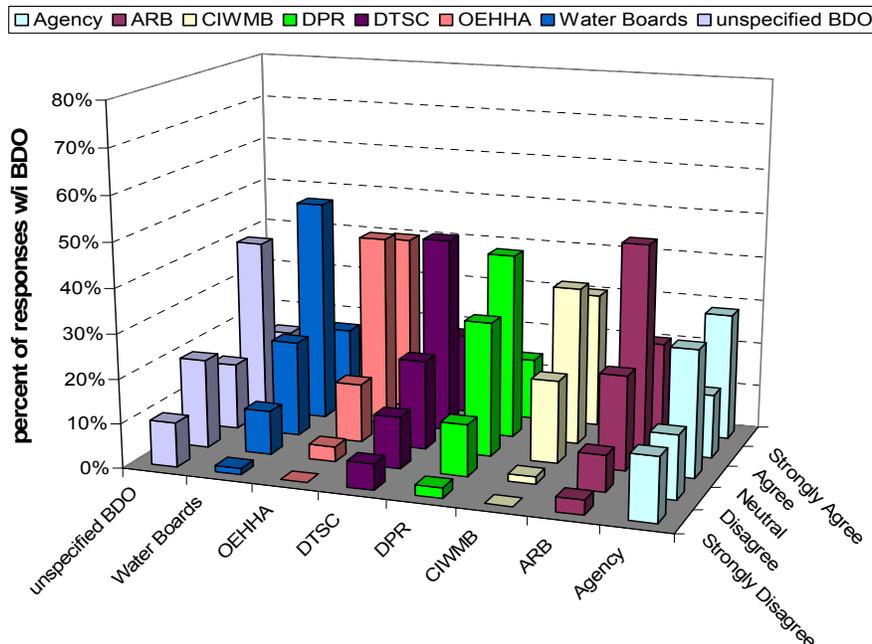


Figure 5.15–BDO Summary of Responses to Statement #5: “My branch/div ensures that products are based on sound science.”



The responses to Statement #6 (*My branch/division routinely promotes scientific information exchanges.*) are summarized in Figure 5.16 and show a more muted agreement relative to the other branch/division statements. Although the predominant response was once again “Agree” (32 percent), it was a significantly lower proportion of the responses, with the neutral and negative responses increasing. Although the positive responses still greatly outnumbered the negative responses, 50 percent to 23 percent, it was not as overwhelming as the responses to the prior statements. Looking at the responses by BDO (Figure 5.17), most of the BDOs still had “Agree” as the modal response, but it was not as predominant relative to the other responses. Only the IWMB and OEHHA did not have much of a drop-off in the response from “Agree” to “Strongly Agree.” Not unexpectedly, the predominant response for those who declined to identify the BDO in which they worked was “Disagree.” Clearly, based on the relative shift in responses to the prior statements, the perception is that information exchange efforts, although good, could be improved.

Figure 5.16–Cal/EPA Summary of Responses to Statement #6: “My branch/div routinely promotes scientific information exchanges.”

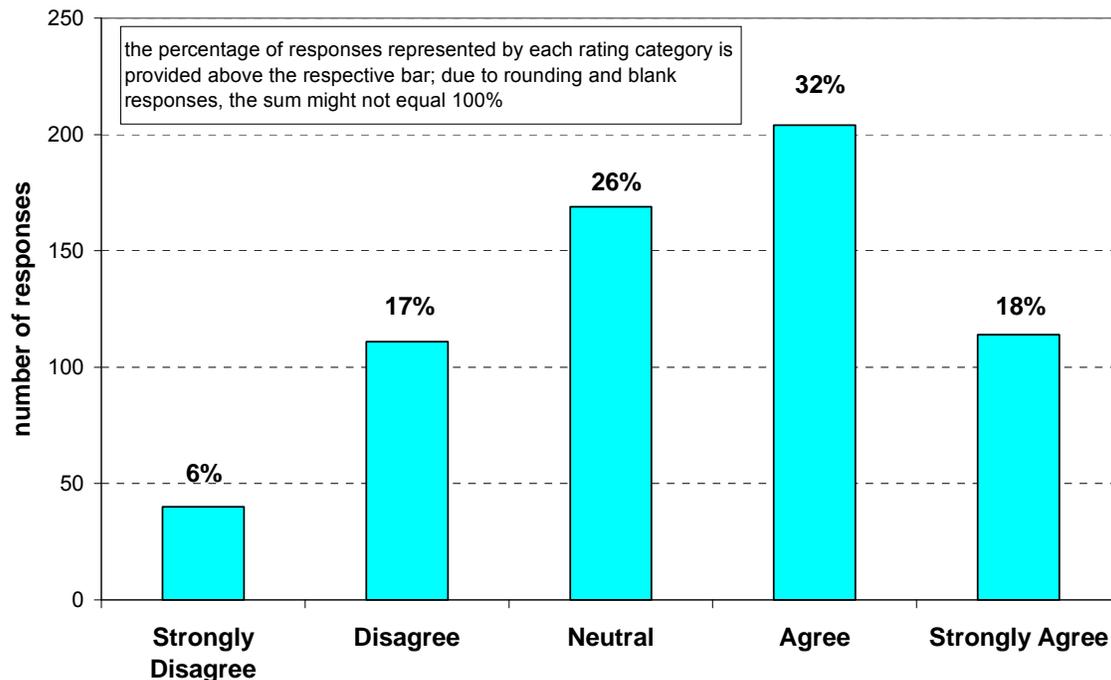
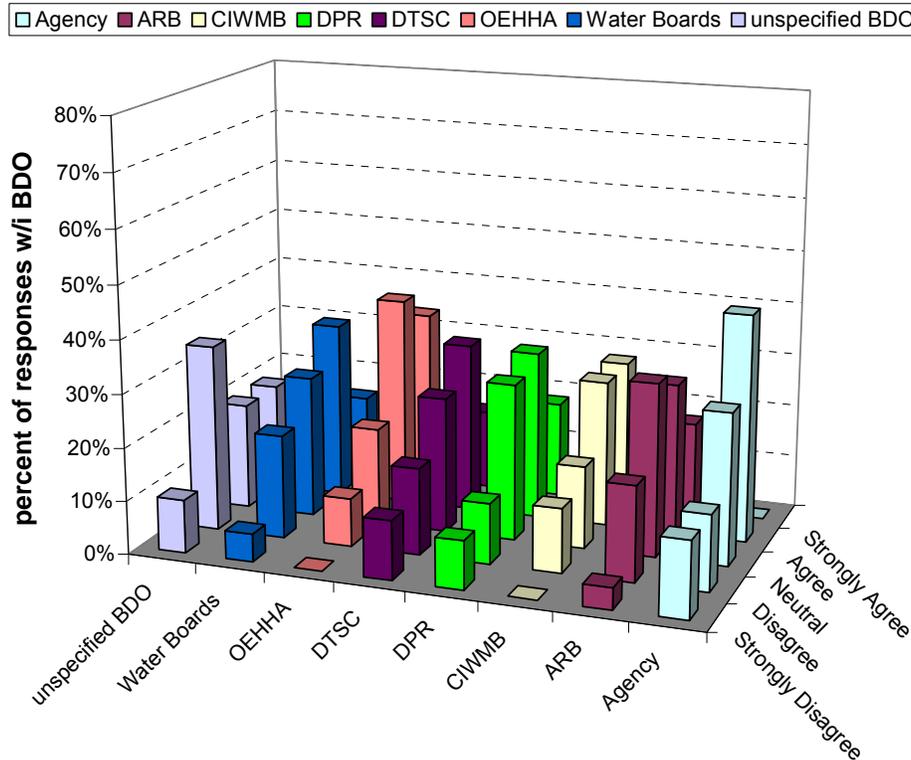


Figure 5.17–BDO Summary of Responses to Statement #6: “My branch/div routinely promotes scientific information exchanges.”



Turning to the BDO level of the survey, the responses to Statement #7 (*I am satisfied with the quality of science utilized in my BDO’s products.*) are summarized in Figure 5.18 and indicate a slightly muted response pattern but still similar to that at the section and branch levels. The predominant response was “Agree” at 39 percent of the responses. The positive responses overwhelmed the negative responses, 57 percent to 16 percent. Looking at the responses by BDO (Figure 5.19), only the IWMB had “Strongly Agree” as the predominant response. Although OEHHA had “Strongly Agree” as second most common response, the other groups saw significant, if not dramatic, decline in numbers from the “Agree” to “Strongly Agree” responses. Overall, the clear bulk of responses to Statement #7 were in the “Neutral” and “Agree” categories.

Figure 5.18—Cal/EPA Summary of Responses to Statement #7: “I am satisfied with the quality of science utilized in my BDO’s products.”

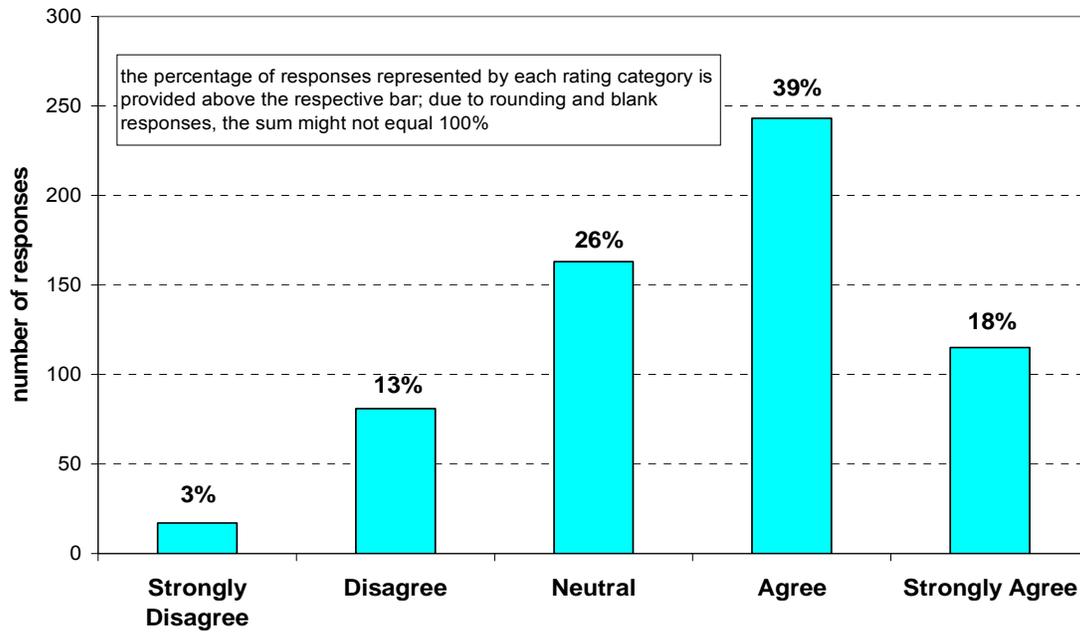
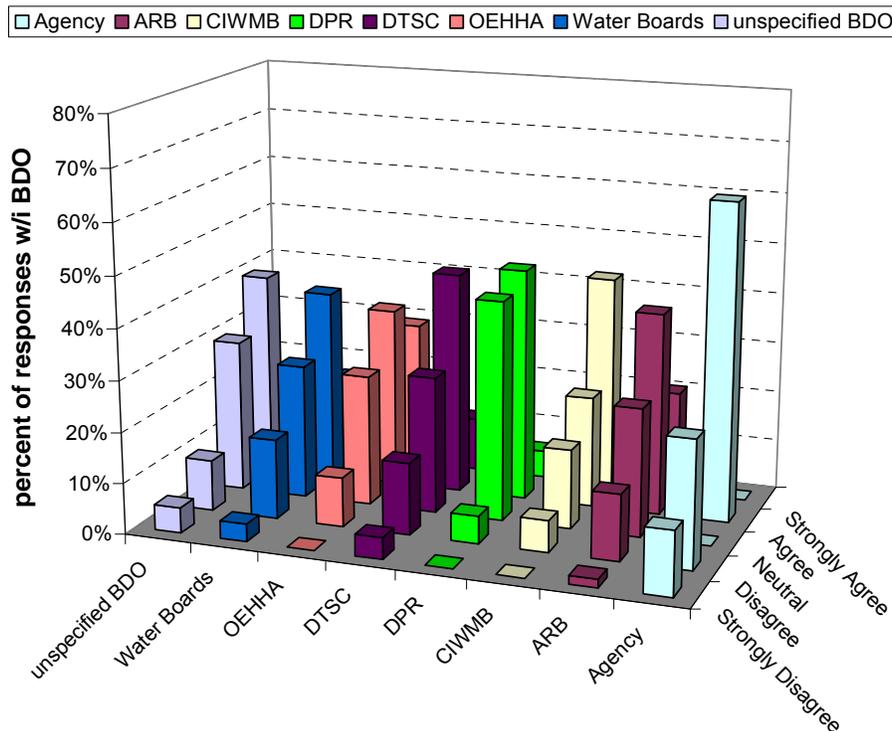


Figure 5.19—BDO Summary of Responses to Statement #7: “I am satisfied with the quality of science utilized in my BDO’s products.”



The responses to Statement #8 (*My BDO ensures that products are based on sound science.*) are summarized in Figure 5.20 and are essentially identical to the responses to Statement #7. The predominant response was “Agree” (40 percent) and the positive responses overwhelmed the negative responses 56 percent to 17 percent. Looking at the responses by BDO (Figure 5.21), all of the BDOs except OEHHA had “Agree” as the predominant response. “Strongly Agree” was the modal response for OEHHA. Most other BDOs except IWMB had large decrease in the number of “Agree” to “Strongly Agree” responses. Because the number of survey participants decreased some from the section statements to the branch/division statements and to the BDO statements, the decrease in “Strongly Agree” could simply reflect less familiarity with all the details and activities at the top of the organization. On the other hand, it could also reflect a gap between where policies are typically set and where the detailed work is performed. This is not likely, however, as evidenced by the continued small percentage of “Strongly Disagree.”

Figure 5.20–Cal/EPA Summary of Responses to Statement #8: “*My BDO ensures that products are based on sound science.*”

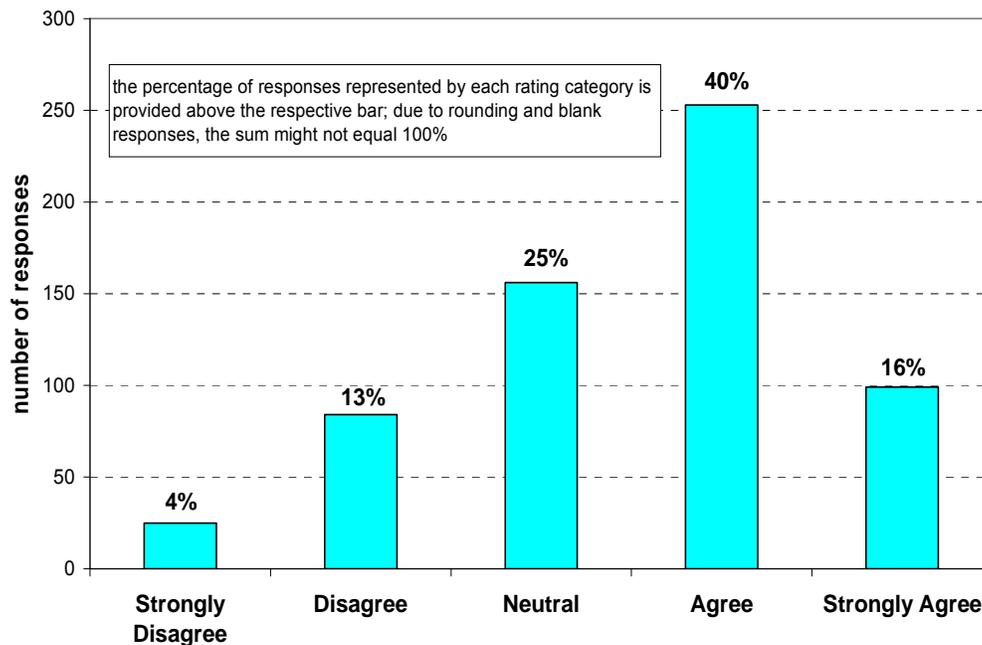
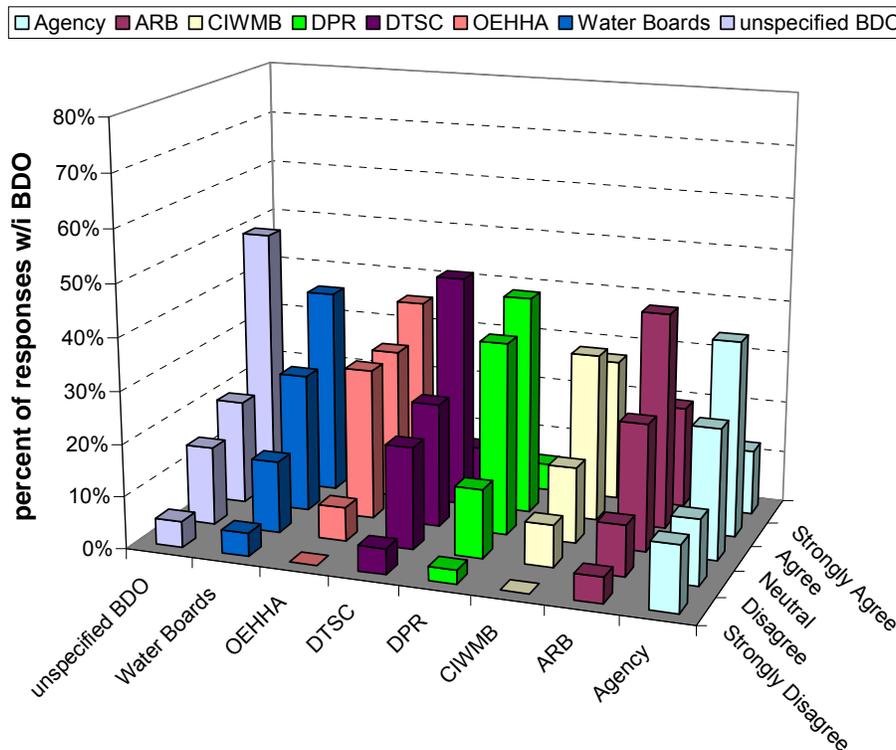


Figure 5.21–BDO Summary of Responses to Statement #8: “My BDO ensures that products are based on sound science.”



The responses to Statement #9 (*My BDO routinely promotes scientific information exchanges.*) are summarized in Figure 5.22 and have a distribution similar to that for Statement #8. The predominant response was “Agree” (38 percent) with a significant drop in the “Strongly Agree” response. One quarter of the responses were “Neutral” with the positive responses outnumbering the negative responses, 54 percent to 20 percent. Looking at the responses by BDO (Figure 5.23), many of the BDOs had “Agree” as the modal response. Only the IWMB had “Strongly Agree” as the predominant response. This is in contrast to all the other BDOs, which had a significant drop in the number of responses from “Agree” to “Strongly Agree.” The Agency and DPR had “Neutral” as their predominant response.

Figure 5.22–Cal/EPA Summary of Responses to Statement #9: “My BDO routinely promotes scientific information exchanges.”

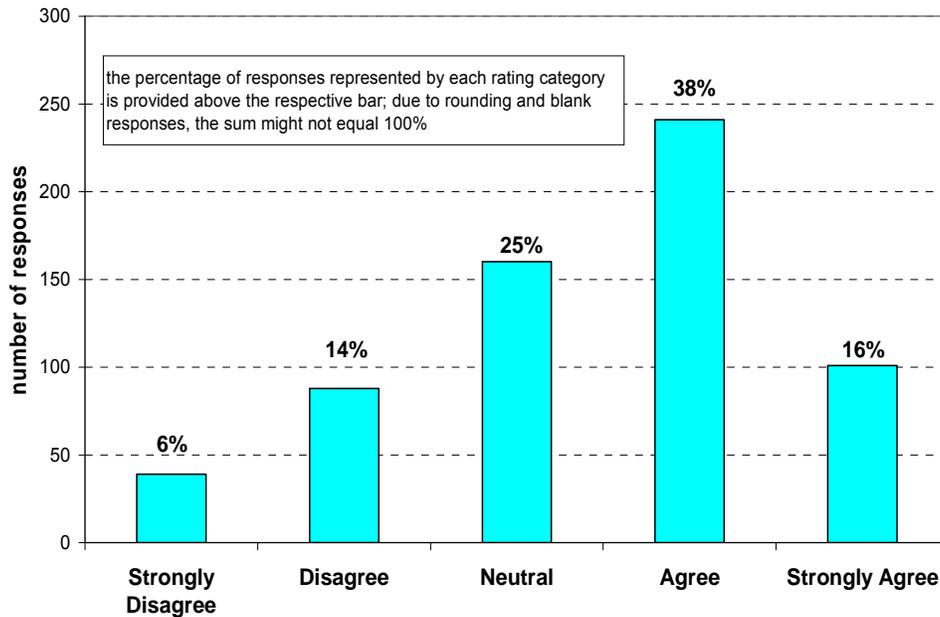
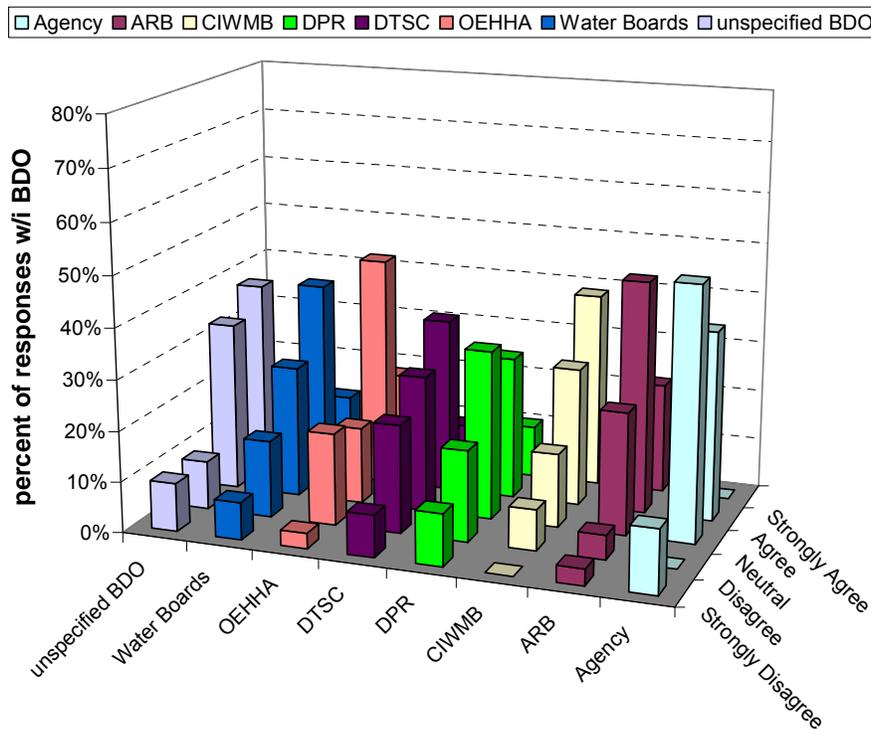
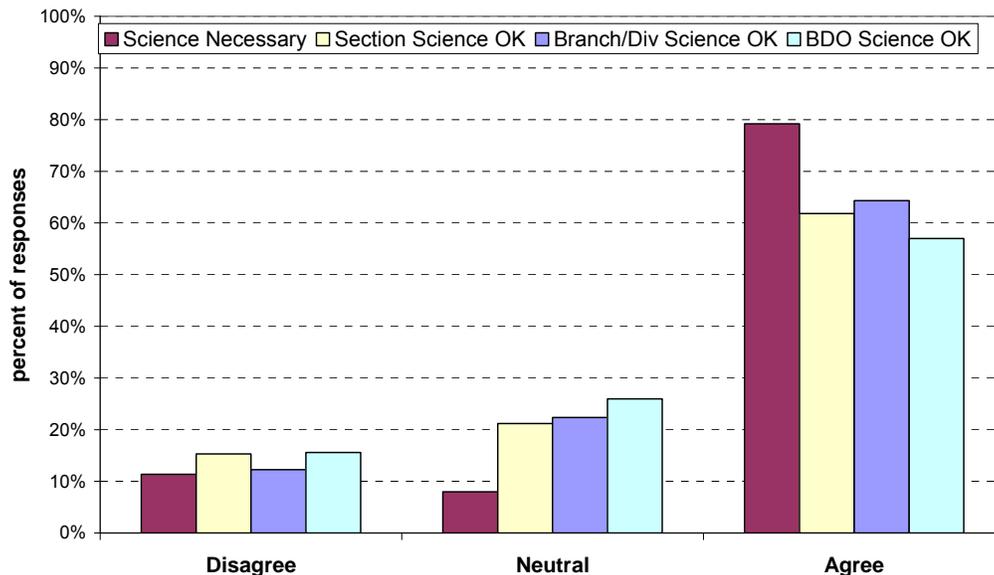


Figure 5.23–BDO Summary of Responses to Statement #9: “My BDO routinely promotes scientific information exchanges.”



Statements #2, #4 and #7 related to the satisfaction with the use of science in developing work products at the section, branch/division, and BDO levels of organization. After combining the two degrees of agreement or disagreement), the combined percentages of responses along with the response to Statement #1 regarding science being an integral (routine) part of the job are shown in Figure 5.24. In theory, the “Agree” percentages for Statements #2, #4 and #7 would be commensurate with the percentage of “Agree” responses for Statement #1 if science were fully implemented as part of BDO activities. Of course, science is not the sole factor in determining policies, activities, and products, so it is anticipated that the “Agree” responses for Statements #2, #4 and #7 would be less than for Statement #1.

Figure 5.24—General Cal/EPA science survey results for statements regarding science as part of the job and satisfaction with how that science is utilized in work products at various organizational levels (i.e., survey statements #1, #2, #4 and #7).

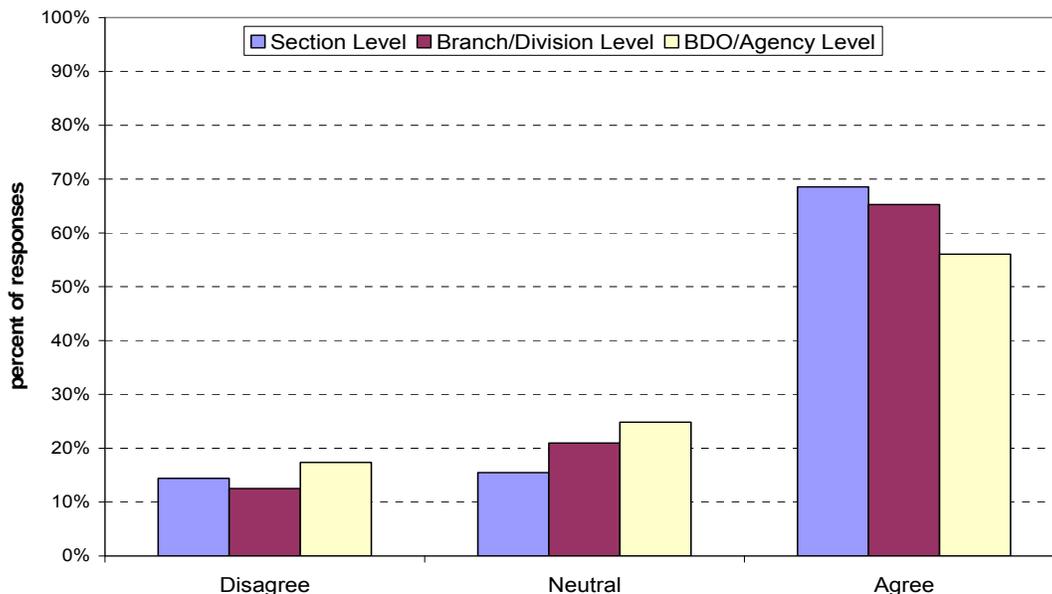


What is not known definitively is whether “satisfaction” is based on an idealistic “science only” perspective or a realistic “science factor” perspective, where science is not ignored or abused. One could assume that the respondents who do not think (or are unsure) that science is an integral part of their work would provide “neutral” responses to the satisfaction statements. In this case, the “neutral” satisfaction responses should approximate the sum of the “Disagree” and “Neutral” responses to whether science was necessary in their work. As indicated by Figure 5.24, this appears to be the case. Thus, the “Disagree” responses to the satisfaction statements indicate that the responses to Statements #2, #4, and #7 are likely based on a “science only” perspective. The drop in satisfaction relative to the scientific nature of the work is probably not a serious problem but does indicate the need for greater dialogue on the role of science in guiding policies and activities. It is noteworthy that the satisfaction with how science is utilized does decline slightly at the BDO (executive) level. Based on the suggestion (or

comment) portion of the survey, there is always room for improved communication and dialogue to foster the best use of science within Cal/EPA.

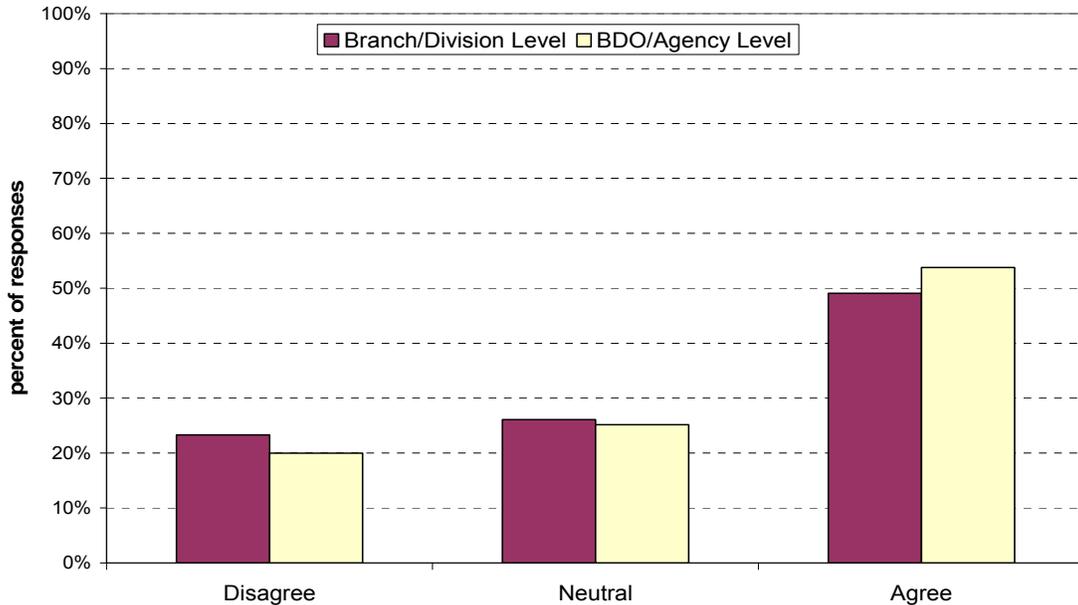
Another cross-organizational survey topic was the effort (e.g., protocols, procedures, reviews) to ensure that products are based on sound science (i.e., statements #3, #5, and #8). An interesting feature is the progressive increase in the percent of “Neutral” responses from section to branch to BDO level and a similar progressive decrease in “Strongly Agree” responses. These patterns may indicate less confidence on the part of the survey participants in evaluating something with which they are less familiar as a similar pattern was also observed for the detailed science satisfaction statements (but not as obvious for the three-response type summary). A more qualitative summary of whether sound science is ensured is presented in Figure 5.25 where disagreement with the “science ensured” statement is roughly similar at the various organizational levels but the agreement with the statement erodes with increasing organizational level. Overall though, the respondents believe that sound science is ensured throughout the various organizational levels.

Figure 5.25—General Cal/EPA science survey results for statements related to efforts to ensure sound science at various organizational levels (i.e., survey statements #3, #5, and #8).



The other cross-organizational topic in the survey was whether the sharing of scientific information is promoted (i.e., statements #6 and #9) as presented in Figure 5.26. Relative to the responses to prior survey statements, the proportion of “Disagree” and “Neutral” responses were substantially greater, while the “Agree” responses were a relatively low 50 percent. An interesting feature is the perception that the sharing of scientific information is promoted better at the BDO (executive) level than the branch/division level.

Figure 5.26–General Cal/EPA science survey results for statements related to promoting the sharing of scientific information at two organizational levels (i.e., statements #6 and #9).



5.5 Summary of E-Survey Suggestions to Improve Science Quality

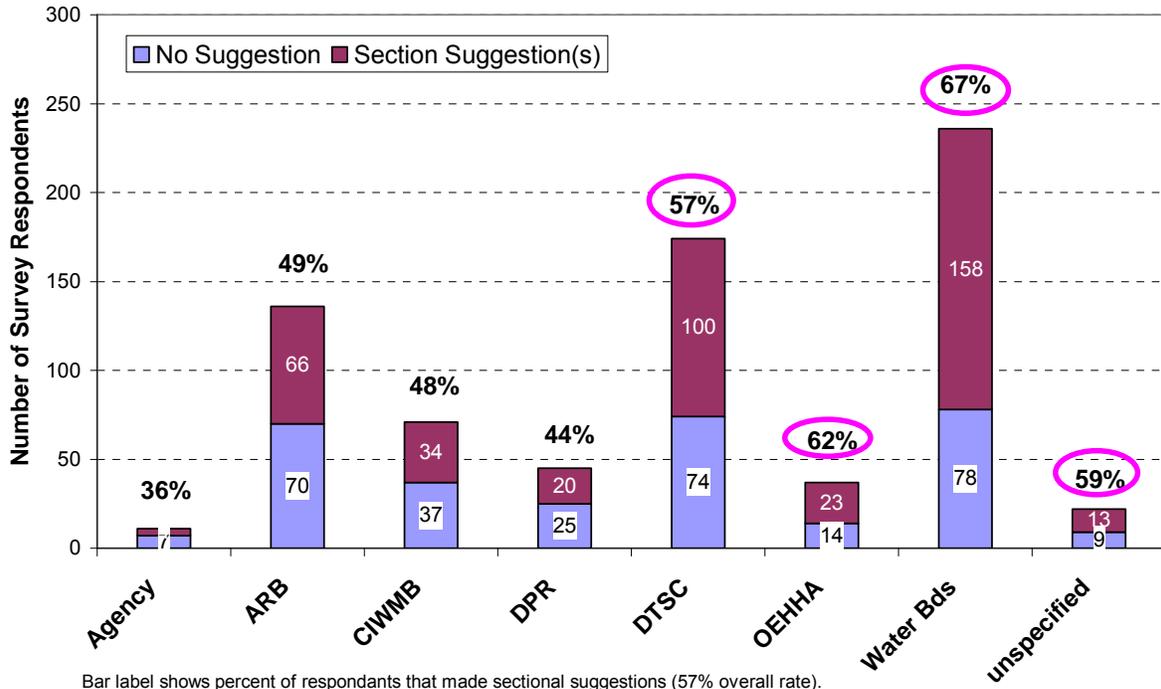
In addition to collecting ratings of the state of science within Cal/EPA, the electronic science survey also encouraged participants to make suggestions regarding how to improve the quality of science within Cal/EPA. This aspect of the survey is easily the most important and beneficial to the SCS because it is more specific about ways to improve the role of science in BDO activities. The value of these suggestions does not necessarily depend on the number of respondents.

However, in evaluating the suggestions, the SCS looked at each within the context of the completed survey to better understand the suggestion. In many cases, the suggestions are appropriate for, and potentially beneficial to all BDOs. Other suggestions are more BDO-specific, and any details that might identify an individual have been excluded. Many suggestions were more like comments than suggestions, but the comments have been interpreted to identify the underlying issue of concern. In this sub-section, the suggestions or comments are tabulated, summarized, and discussed. Later in this report, the SCS makes recommendations to improve the current role of science within Cal/EPA based on the input received via the BDO questionnaire and e-survey.

The e-survey asked for suggestions, and the majority of survey respondents (57 percent) provided at least one suggestion or comment. The count of suggestions to improve the role of science is presented by BDO in Figure 5.27. In DTSC, the Water Boards, and OEHHA, more than 50 percent of the survey participants made suggestions. The vast majority of comments came from employees of the Water

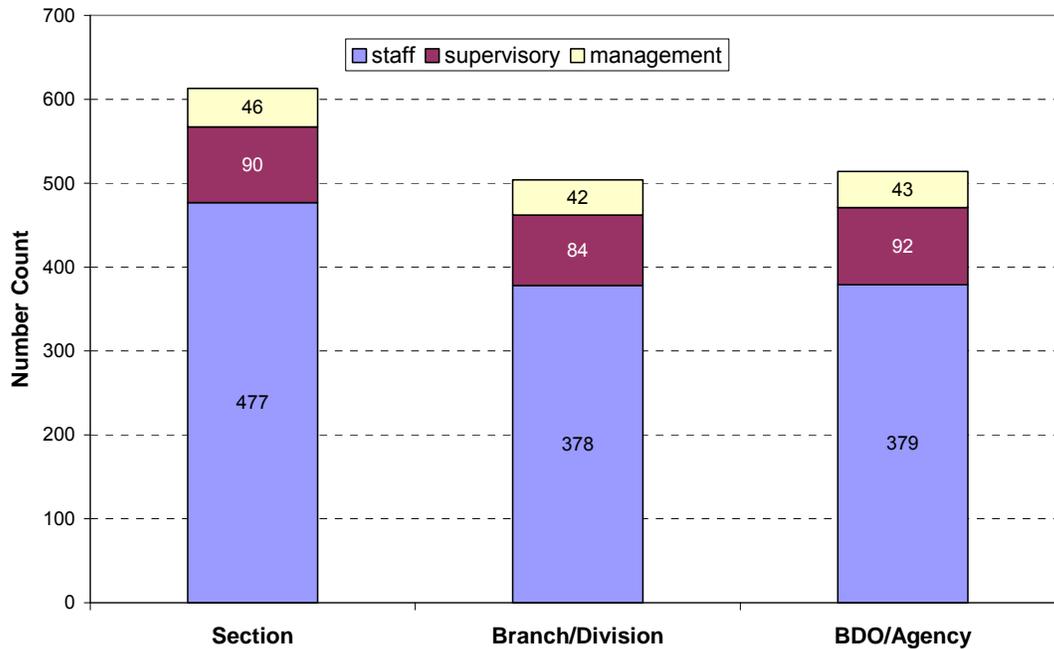
Boards (158), DTSC (100), and ARB (66), which also have the greatest number of employees.

Figure 5.27–Percent of E-Survey Respondents Making Suggestions to Improve the State of Science within Cal/EPA.



As with other aspects of the e-survey, the staff contributed roughly three-fourths of the suggestions (Figure 5.28). It should also be noted that about two-thirds of the employees at Cal/EPA have scientific (technical) positions. There were about 100 fewer suggestions (about 15 percent fewer) provided at the Branch/Division and BDO levels than at the Section level. In addition, many respondents reiterated their sectional suggestions or comments at the higher organizational levels.

Figure 5.28—Positional and Organizational Count of Suggestions to Improve the State of Science within Cal/EPA.



5.5.1 Count of Comments by Category

The SCS read and classified the comments or suggestions into various categories (Table 5.2). A list of the topics of concern was developed from an initial screening of the responses. The topics were then consolidated into a number of related themes or categories to keep the size of the list manageable and amenable to summary charts.

Although additional funding was frequently suggested to improve the scientific basis of activities within Cal/EPA, funding was not included as an issue category. Rather, the purpose or objective of the increased funding need was identified as the primary issue affecting the science quality. For example, “increased budgets for attending out-of-state conferences” was categorized under “training and development.”

In addition, the various categories used are not necessarily independent or unrelated to each other. As feasible, comments or suggestions were classified according to the primary issue embedded in the response. For example, conducting research is not unrelated to the need for quantity, quality, and specific data. Nor is the review of information and data unrelated to coordination, collaboration, and the need for consistent information.

The three major genres of responses were classified as Resources, Working Environment, and Positive Comments (vague or positive responses that indicated no improvement is necessarily needed). The Resources genre was broken into four categories: personnel, physical resources (such as equipment,

tools, and software), data, and miscellanea. The Environmental genre was broken into five categories: philosophies, politics, priorities or schedules, procedures, and miscellanea.

As indicated by Figures 5.29 a,b,c, the vast majority of comments under the Resources category related to staffing and informational issues, while under the Environment category, a significant number related to politics and procedures. Although not shown, the vast majority of suggestions in the Staffing category related to training & development, while the bulk of the suggestions in the Information and Data category related to sharing of information. The third largest category was Politics (the belief that science was not given adequate weight in the decision-making process). The fourth largest category was Procedures (primarily as related to consistency in developing products or enforcing regulations).

A count of the suggestion topics by BDO is presented in Figure 5.30. Although there is some variation among the BDOs in the ranking of concerns with fewer counts, the primary concerns are consistent in their proportions to the total comments or concerns. For example, staffing (primarily training & development but also including qualification) and information (primarily sharing) concerns comprise about 40 percent and 30 percent respectively of the responses at most BDOs. Procedural, political, and philosophical concerns, although smaller and more variable among the BDOs, also comprise consistent proportions of the total responses at the three largest BDOs (Water Boards, ARB, and DTSC).

Table 5.2 – Science Suggestions and Comments identifying science issues

Code	Genre	Category	Issue	Detail
R	Resource			
RS		Staffing		
RSA			Allocation	
RSA1				Number
RSA2				Usage
RSQ			Qualifications	
RSQ1				Hiring
RSQ2				Development
RSR			Retention	
RSR1				Pay
RE		Equipment/software		
RI		Information/data		
RIQ			Quantity/Quality	
RIC			Coordination	
RIR			Research	
RIR1				External
RIR2				Internal
RIO			Review	
RIS			Sharing	
RIS1				Accessibility
RIS2				Communication
RM		Miscellanea		
E	Environment			
EH		Philosophy		
EHI			Open to innovations	
EHO			Open to other opinions	
EHU			Undue influence	
EO		Political (science does not carry sufficient weight)		
ER		Priorities/schedules		
EC		Procedures		
ECM			Following methods	
ECP			Planning	
ECR			Reviewing	
ECB			Characterizing benefits	
ERD			Documenting	
EM		Miscellanea		

Figure 5.29a—Count of Sectional Comments or Suggestions by Genre and Category.

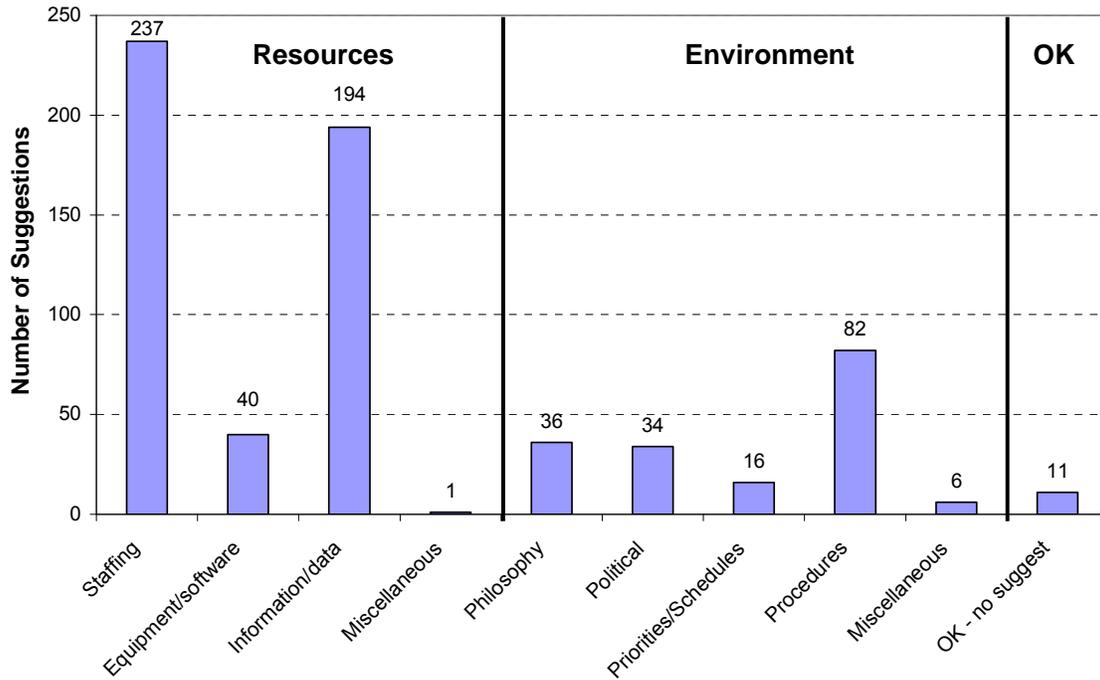


Figure 5.29b—Count of Branch/Divisional Suggestions by Genre and Category

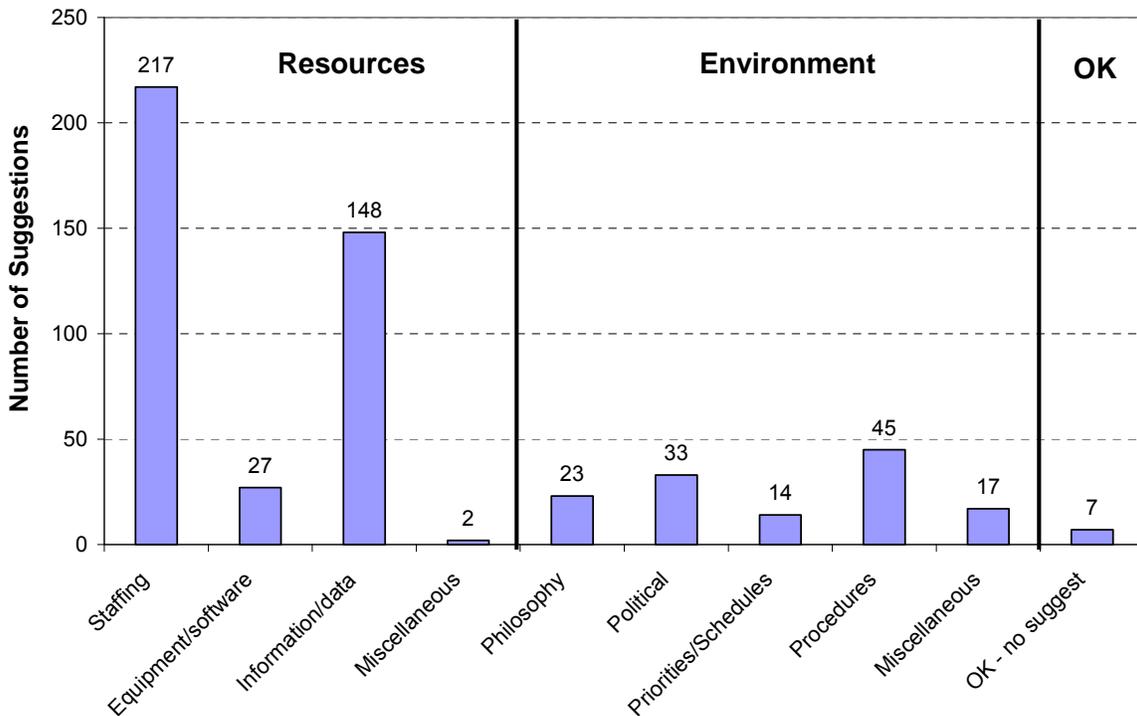


Figure 5.29c–Count of BDO Suggestions by Genre and Category

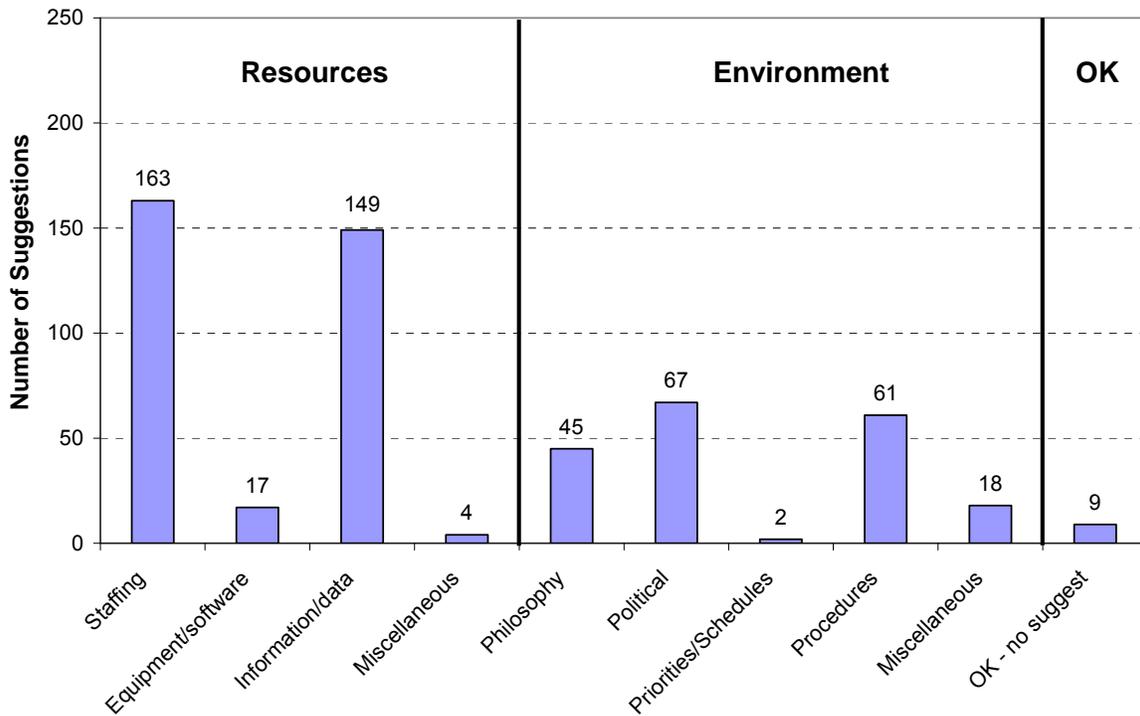
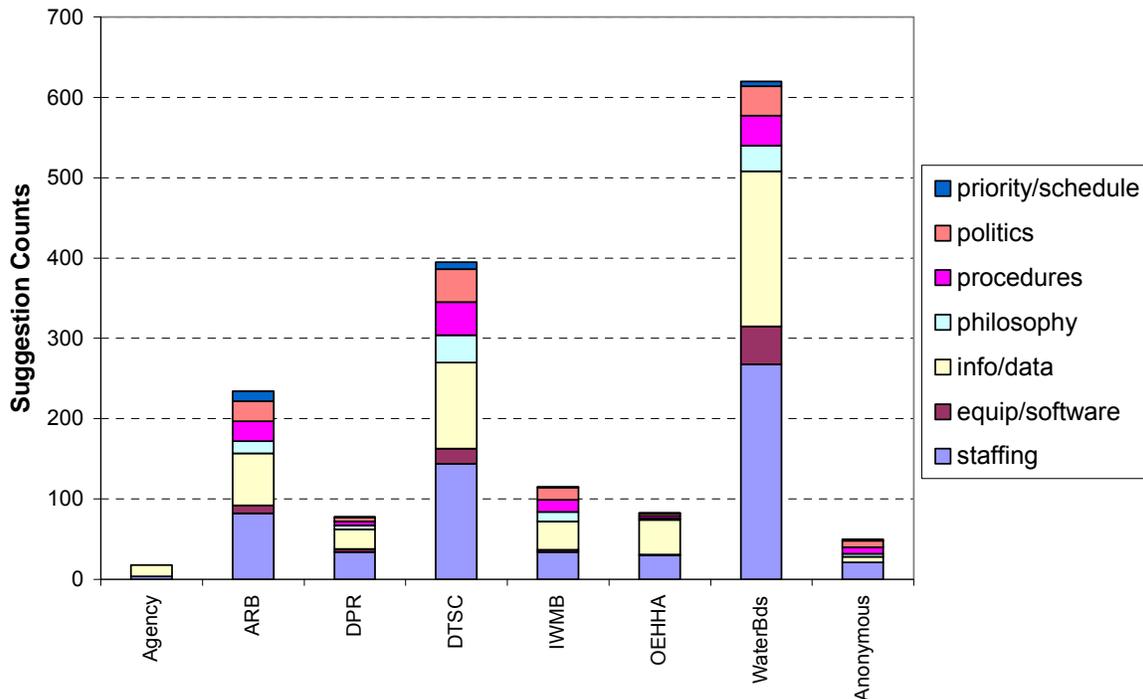


Figure 5.30–Count of Suggestion Topics by BDO



5.5.2 General Summary of Concerns and Suggestions by Category

The general (cross-cutting) concerns and suggestions are organized by the categories shown in Table 5.2. Staffing and informational issues made up the bulk of the concerns and suggestions. In total (including repetitive comments at the section, branch/division, and BDO evaluation levels) 1,713 comments or suggestions were received in response to the e-survey. Resource issues comprised the bulk of the comments and suggestions regarding the usage of science at Cal/EPA (1,187). Issues associated with the work environment made up the bulk of the remaining responses (499), with 27 being positive comments or no suggestions for improvement. The numbers enclosed in parentheses behind each science issue listed below represents the total number of comments falling in that category.

Following each area of expressed concern is a summary of the suggestions submitted that are potentially applicable to multiple BDOs. Suggestions that were repetitive or essentially redundant are listed only once, but the number of similar suggestions is noted in parentheses at the end of the sentence. The suggestions presented only reflect the content of the e-survey responses—they do not necessarily represent the opinions or recommendations of the SCS. The more BDO-specific suggestions are presented in Section 5.7 of the report.

5.5.2.1 Resources (1,187)

Staffing (608)

More than half of the Resources comments and suggestions concerned staffing issues. Staffing issues were divided into four sub-categories: Allocation, Qualifications, Retention, and Other.

Allocation (81)

Concerns exist that increased workloads affect the quality of science (29), whether due to staff cutbacks or new programs and requirements without additional staff being added. However, more concerns were expressed regarding the appropriateness of tasks assigned to staff to meet the program objectives (47). Some people felt that they needed to do administrative tasks (e.g., photocopying) that support staff should be performing. Others believed that non-technical staff members were performing scientific tasks and were not adequate in their performance. The suggestions offered to address the staff allocation concerns fell into four basic groups, which are presented in more detail below.

1) Assign work tasks commensurately with skills and experience (26)

For a variety of reasons, staff and management are often called upon to perform tasks not commensurate with their skills, experience, or interests. Additional student, clerical, and administrative support could be provided so that the efforts of scientists are not diluted by tasks that support staff (including information technology) could be performing just as well or better. Mandatory training of personnel when hired or promoted to new positions, particularly when a non-technical person is called to manage the work of technical personnel, would help ensure that personnel are performing at a high level of expertise.

Managers need to understand basic science and scientific principles. In doing so, they will be better qualified to review the science in addition to the grammar and policy implications of staff work. Furthermore, managers should be viewed as mentors rather than policy transmitters. Staff needs to be held under scientific discipline by management because heavy workloads often limit the review, if any, by peers. By increasing the scientific role of supervisors and managers, better development of sound science will occur before the political perspective or influence is brought to bear on the issue.

An alternative suggestion to increasing the scientific training of managers was to create a scientific track parallel to the management track. In this scenario, the most competent scientists are promoted as lead scientists (mentors) of technical programs rather into the manager track, where their scientific expertise is not fully utilized and their personnel and political skills may be less developed than ideal. Because technical and scientific personnel do not always have excellent writing skills, the use of a technical writer (unit) could help better communicate the science to decision-makers and the public.

2) Allocate resources in proportion to significance of project (19)

Due to staff downsizing or new programs without commensurate staffing increases, staff (and management) in many programs feel overworked. They are often unable to devote the amount of time and effort to a project that they think is necessary and reasonable for applying sound science. Furthermore, efforts may be devoted more toward style or minor issues than toward the complex issues. One suggestion to address this concern is that staff and management have honest discussions with their superiors so that staff resources can be allocated in proportion to the significance of the projects, some of which may be tangential to the primary mission of a section. Many of the suggestions promoted more funding and hiring more staff if sound science is to be the foundation of BDO programs: "Science takes time and consideration to develop and express, and we are often too short of resources..."

3) Promote task diversity (2)

Another concern implied in some responses is that staff can become "pigeon-holed" or stagnant in their tasks. It was suggested that managers promote diversity in their assignment of tasks not only to reduce the tedium in some program responsibilities but also to stretch staff to develop and expand their skills, interests, and awareness of other programs. Depending on the nature of the responsibilities, developing a section with a variety of scientific disciplines could also help facilitate the usage of sound science as broader perspectives and reviews are brought to bear on the project objectives.

4) Promote work in-house over contracting out (2)

When subject expertise exists in house, and the workload permits, it was suggested that management allow staff to conduct the work rather than contracting it out of the group. Often, with the contracting delays and the necessary oversight effort by staff, the work could be done as well, and more

expeditiously, in house. Further, the in-house work promotes a better scientific ambience within the Agency and reduces the bureaucratic frustration.

Qualifications (493)

Almost half of the Resource responses concerned employee qualifications, which included hiring and promotions (71), training and development (410), and other (15). The concerns expressed were that non-technical people who were being hired or promoted to supervisory positions often had little understanding of the scientific nature of the work being performed in their section.

Several comments were received concerning multiple pathways to the same position (classification) whereby people with vastly different scientific training were performing the same tasks (with vastly different expertise and results). This led to concerns that the quantity and quality of work being performed within that classification were highly variable but the compensation rate was the same.

Of greatest concern, however, was the training and development of staff. In particular, work loads, managerial skepticism, and primarily funding shortages seemed to prevent staff from attending technical seminars and keeping abreast of the latest scientific developments in their fields of expertise. The suggestions offered to address the staff qualification concerns fell into four basic groups, which are presented in more detail below.

1) Permit, encourage, or mandate relevant training and development (170)

Staff training and development was a very common concern as people felt they were falling behind the rapid development of information and instrumentation in their field of expertise due to their heavy work load and lack of management approval to attend training. Because the regulated community and consultants have invested the time and resources in training their staff, the perception is that the regulators are not providing sound science because they are behind on the learning curve or current state of science.

Suggestions included increased funding not only for the training budget but also for the travel budget to permit specialized training and certifications that are never or infrequently offered in California. Another suggestion was to increase the basic scientific foundation of staff work by mandating training in basic scientific principles (e.g., number rounding, significant figures, uncertainty, basic chemistry).

Interdisciplinary training may be important in many instances (e.g., managers, lawyers) to ensure that staff with very different roles are “on the same page.” It was suggested that more specialized training is needed and that the State develop training courses based on needs and recommendations developed from staff input (e.g., scientific method, research design, collection of data and evidence in a scientific manner, quality assurance, statistical methods, analyzing, writing, and presenting results to non-technical persons).

Training was also suggested via alternative venues. For example, training could be as simple as monthly in-house presentations on technical or scientific topics

or as sophisticated as setting up opportunities for specialized scientists to participate in a short-term paid sabbatical at a university. Additional training could occur in a mentoring or peer-to-peer setting among staff. With the Internet, good training and resource materials can also be made available online so that staff can develop skills and increase their knowledge via a convenient, low-cost method.

- 2) Permit and encourage awareness of the state of science (e.g., conferences, symposia, literature) (126)

The amount of scientific information is rapidly expanding, and new technologies and methods are constantly being developed. To maintain a strong scientific foundation, it is necessary for staff to keep abreast of the state of science and maintain contact with other leading scientists as sound and economical solutions are sought for environmental problems. A frequent suggestion to address this concern was increased funding to allow travel to, and participation in, conferences.

Because there are several large environmental communities, many of the annual and specialty conferences are held outside of California. It is thus imperative that sufficient funds be allotted, and permission given, to attend out-of-state conferences. Further, although scientific awareness is appropriate for managers, it should not be limited or restricted to them as the basis of scientific work then becomes eroded. Because some employees have not attended a conference in many years, a suggestion was to allot sufficient resources for each staff member to attend one conference per year.

Another common suggestion was that management allots time for staff to keep current on the scientific literature in their area(s) of expertise. Without a conscious effort on the parts of management and staff, other work demands will erode the staff's ability to remain current in the state of science. Although respondents were grateful for the progress that has been made in gaining electronic access to some journals, they suggested even broader electronic access to scientific journals.

Other suggestions called for less costly means of getting scientific information to the staff. These included more "cross-pollination" between scientists in Cal/EPA, inviting more scientists to speak at Cal/EPA, and having lunchtime teach-ins. A part of the difficulty with staying abreast of the latest scientific developments is the timely communication of events and speakers.

One suggestion called for more promotion of the seminars and conferences of which we are aware. Having an easily accessible schedule of local science-related seminars would help staff keep informed and increase participation. By hosting or webcasting various events (including out-of-town seminars and conferences), the science can be brought to most of the staff rather than sending a limited number of staff to the science and then relying on uneven transmission of that information to other staff.

One suggestion was that Cal/EPA host an annual meeting where staff scientists could present their scientific endeavors to other scientists within Cal/EPA.

Another suggestion was that the Agency or the BDOs could tape videos of seminars, conferences, etc. for staff to view at their convenience. Although not stated in the survey, this could be developed into an expanded video or online training library.

One last suggestion for increasing the exchange of technical information was to encourage more job rotations.

3) Maintain high scientific standards (e.g., skills, background) when hiring and promoting (74)

A culture of science within Cal/EPA can best be encouraged from the top down. By holding to high standards during the hiring and promotion of employees and by requiring training (continuing education) in a scientific discipline as appropriate, a high performance standard is encouraged for all employees. Specific suggestions included:

1. Strongly encouraging staff to pursue training and development, perhaps by providing certification for different levels of training and competency or formalizing it as part of the Individual Development Plans; mandating basic training in scientific principles, statistics, number rounding, use of significant figures and uncertainty estimates; mandating a minimum amount of attendance at seminars, conferences, training courses, etc.
2. Permitting supervisors and staff to attend the same technical training to foster similar knowledge and clear understanding of what science means and how to use it (i.e., scientific accountability).
3. Promoting and retaining managers that have direct experience related to the work being performed in their section (their job is to take program directives and direct the available resources toward a timely and sound scientific product; if they do not understand the technicalities of the work, they may not make appropriate decisions).
4. Placing a higher premium on scientific and technical competence (e.g., training, education, experience) when hiring or promoting in managerial ranks.
5. Fostering exchanges where staff can spend several weeks or months in other BDOs, universities, etc. to learn new skills and perspectives that they can bring back to their workplace.
6. Encouraging job classification panels to keep current on the state of science so that the exam questions are not based on antiquated science and perspectives.

4) Miscellanea (3)

Science seeks to know more and to better understand relationships (i.e., cause and effect). Therefore, scientists observe from different perspectives and seek the advice of other investigators and experts. One suggestion to enhance the role of science was that each BDO should have a "chief scientist" position or science unit as appropriate.

Recruitment and Retention (40)

Some survey respondents expressed concern that their compensation (salary) is less than the private sector, federal and local governments, and similar technical classifications in state service. They are of the opinion that new competent staff cannot be recruited without compensation that is competitive with other opportunities in the public and private sectors. Furthermore, the scientific talent pool gets depleted when the most qualified scientists in Cal/EPA cross over to the management series to maintain additional promotional opportunities.

Compounding the retention problem is that scientists and engineers perform similar work in certain BDOs but are represented by different unions. Recently, employees in one union received raises toward closing the salary gap with industry and other governmental agencies, but employees performing related work and represented by another union did not receive a raise. Survey respondents believe compensation differences for comparable work would continue under current circumstances. This salary discrepancy has caused frustration and could lead to staff movement and losses.

In addition to addressing pay parity issues, several survey suggestions addressed the issue of recruiting and retaining highly qualified scientists. One suggested path was to create (or add) senior science positions in technical sections or units. Because many top scientists perform in capacities comparable to engineering personnel, highly qualified scientists (having a Ph.D.) could be compensated to the same level as staff with the Professional Engineer license.

Equipment, Tools and Software (84)

A relatively small but significant portion of the respondents noted that the equipment, tools, and computer resources they needed to perform sound science were outdated, under-funded, or restricted. Monitoring and laboratory equipment were mentioned, but the predominant response concerned computers and software needed for processing, storing, and analyzing data that have been collected. Because of the desire or need for standard, or at least compatible, systems and qualified information technology (IT) support, the purchase of helpful or necessary software for specialized applications has been strongly discouraged.

Scientists need appropriate tools to collect, transfer, process, analyze, store, and share scientific information. Appropriate training of staff in the use of these tools is also needed if scientific efforts are to be performed in a more comprehensive, consistent, and timely manner. Several suggestions were made to help improve the state of science at Cal/EPA by providing the appropriate physical resources (e.g., monitoring instruments, laboratory equipment, specialized software) needed to perform scientific endeavors.

Increased funding will not only be needed to purchase these tools but also to train the staff in the proper use and maintenance of these physical resources. To know which tools are necessary to do their tasks well, staff should be asked about the specific types of scientific tools that are needed. Many tools likely have a range of features, and staff should clearly articulate the pros and cons of

different models or features so that management can make a knowledgeable and appropriate decision on the specific purchase. Furthermore, storage space is often inadequate for instruments that are used intermittently.

Many of the suggestions were for upgraded or new specialized software (e.g., GIS and other statistical, analytical, presentational, graphical applications). Because software can have system compatibility issues, the IT staff would need to have input in the purchase decision. Because the IT groups are often understaffed and not always aware of the state of technology in some specialized areas, additional IT personnel should be hired and routinely offered training opportunities to stay current in the rapidly expanding IT field.

In this age of information explosion, one suggested resource was the development of databases identifying scientific papers associated with specific topics (and, where possible, providing electronic links to these papers).

Information and data (488)

Information and data are the primary resource of scientific endeavors. The number of comments regarding the collection, coordination, researching, reviewing, and sharing of information was second only to the number of staffing concerns.

Quantity, quality and specificity (35)

Information and data are the basis for decisions. The quantity, quality, and specificity of those data are critical to making sound scientific decisions. All of these aspects of collecting information require money. A critical responsibility of management is to provide funding sufficient to collect the appropriate amount and quality of data to specifically address the uncertainties faced in the decision-making process.

All BDOs expressed a need for commitment to presenting uncertainties associated with the underlying data and analyses used to characterize environmental problems. While decision-makers like the “bottom line,” it is important that they understand the confidence and the uncertainty surrounding the results of the analyses. Without it, complex issues tend to become black and white, with the potential for actions and policies to be based upon a soft foundation.

Other comments, especially from the Water Boards, called for more monitoring data. Without a robust database, decisions can become arbitrary and based more on speculation and personal biases than actual science. Limited information and data regarding a specific situation often lead to extrapolation of conclusions appropriate for one location to another location where the original conclusions might not be appropriate. Incomplete data and information can also lead to inconsistency among the regional boards in their decisions and activities if they act solely on the basis of their own situation.

Suggestions noted the need to develop and follow rigorous guidelines for the collection and analysis of data to ensure that the quantity, quality, and specificity of data are sufficiently definitive to guide decision-making. It was also suggested

that “cherry picking,” the art of selectively using information or experts to support a particular outcome, was prevalent.

Many default assumptions in cancer risk assessments should be updated with newer information and more appropriate analytical methods. Furthermore, it was noted that staff should not assume that information in peer-reviewed literature does not contain flaws or reflects the current state of the science. All our references should be reviewed and tied to the source documents to make the work more definitive and transparent. The BDOs should also hold their consultants to high scientific standards and not accept mediocre or poor products that do not follow solid scientific principles of data collection and analysis.

Coordination, collaboration and consistency (85)

Coordination and collaboration between staff members working on related projects or environmental issues was a commonly mentioned science issue. Collaboration and coordination among staff and BDOs on related projects helps to improve the consistency and soundness of scientific products.

At a very basic level, it was suggested that scientific terminology be clearly defined as some terms are used in different (and sometimes conflicting) ways in different groups. Open discussion of approaches and problems, especially with similar projects, should be encouraged to improve consistency in similar work products. Heavy work loads due to staff shortages is a major deterrent to fostering collaboration as staff scramble to complete their own work rather than looking for synergistic and complementary opportunities.

Unfortunately, this independent approach on similar projects can result in inconsistent results and recommendations. More collaboration is needed between data providers and data users to ensure that the project meets the program objectives. Early and frequent discussions among staff and management of cross-cutting projects would facilitate the use of sound science from conception to completion of a project. Discussion forums enable scientists to exchange ideas, review each other’s projects, and keep abreast of scientific developments.

Easy access to leading experts (whether via formal contract or informal advice) may be needed to guide projects. Often there is regulatory overlap, and it is necessary to ensure more coordination with other State and federal programs. Increased collaboration with universities and contractors would also facilitate consistency of products, as well as the training and development of staff when sabbaticals or personnel exchanges are allowed.

Research (61)

Frequently, the information and data available to address an issue are missing or incomplete. Additional information and a better understanding of relationships between causes and effects are often needed to provide a sound scientific basis for projects. To address these knowledge gaps, research—whether conducted in-house or externally—is needed to inform and guide the decision-making process. The suggestions offered to address research concerns are presented below.

To properly address cross-media issues, it may be appropriate to establish a research program within Cal/EPA. More emphasis is needed to better utilize in-house research capabilities. When research is contracted out, it should have adequate funding and appropriate staff overview.

One suggestion was for the creation of a database detailing contracts or studies that have been performed (including out-of-state research and methodologies that could benefit California). Improvements are needed in the contracting process to ensure that contracts are awarded to the best contractor (not necessarily the low bid or “friends”), and that the results are obtained and disseminated in a timely manner.

Review (49)

Review of information and data are necessary to ensure the quality and consistency in how that information can be used and applied. Bad (erroneous) data can lead to improper conclusions and weaken the foundation of the scientific inquiries. Peer review, whether internal or external, provides a very useful independent analysis and check on the scientific integrity of work products.

One suggestion was that all work products undergo a mandatory peer review. Electronic data acquisition, transfer, and storage would facilitate more complete review of data upon which decisions are made. Too often people assume that data are of high quality when they analyze and make conclusions from the data. A formal quality assurance and data review program is needed to ensure that it feeds into sound decision-making. Internal scientific reviews could be facilitated by assembling a cadre of Cal/EPA scientists with expertise in various scientific disciplines and familiarity with the regulatory process who could be called upon for timely and expert review. Another suggestion called for a chief scientist and a science division within each BDO.

Staff should be encouraged to publish their work so that it also undergoes external peer review and is distributed where other groups can benefit from it. Other suggestions were for broader access to external review and a simplified and faster process for obtaining reviews with the UC Office of the President peer review program. Adequate funding to support external reviews is also a concern.

More common sense was recommended in the development of regulations so that they are appropriate, more feasible, and more enforceable. More and more regulations are based on modeling and technical analyses that should also be peer reviewed to ensure the results are based on sound science.

Sharing (258)

Sharing of information and data was the second most common issue in the survey affecting sound science. Although data accessibility was a major concern (86), the predominant concern was communication of information (167), not only within the section, but also within each division, BDO, Cal/EPA, and the overall scientific community (associations and publications). The amount of information and data available to scientists is rapidly expanding due to the revolution in

computer technology (e.g., automated measurement technologies, electronic publishing, the Internet).

The wealth of information necessitates a dedicated commitment of time from staff if they are to remain current in their areas of expertise. The computer age has also created an opportunity to more easily share the data, information, and expertise developed within Cal/EPA with the public, the regulated communities, and the science community.

Many suggestions received in the e-survey addressed the sharing of information, from within sections to the outside world. Several suggestions relate to creating an atmosphere conducive for learning: staff should be allowed time to access current scientific journals, they should be encouraged to write papers and make presentations at conferences, and the library should be upgraded.

The library could increase e-journal subscriptions, create more space for retaining scientific references, develop an annotated bibliography of library contents and a continuously updated list of experts by subject matter. A State Environmental Science and State Laws and Regulations Dictionary could be published, along with topical fact sheets (including answers to frequently asked scientific questions). These resources could be made available on a website, along with staff contacts.

Staff (work groups) should share more scientific information in-house (e.g., newsletters, website, seminars, clearinghouse of relevant research and information from major scientific conferences), management should initiate more dialog with scientific staff when decisions are being made (particularly when decisions will be made that deviate from the staff recommendation), promote and coordinate more seminars with other state agencies and universities, etc.

Other suggestions were directed towards communicating information outside the project work group. Staff should make more effort to present information in a manner suitable for their target audience—particularly for board members and the public, staff work groups should interact with other staff groups earlier and more often (e.g., peers, monitoring staff, legal staff) to ensure that projects are well-conceived, feasible, and likely to succeed. Communications should be improved with federal and other State agencies addressing similar issues. Other ideas included: sponsoring regular “brown bag” science presentations, holding at least one technical conference per year highlighting major developments, achievements, or projects within Cal/EPA, developing a system to debate and improve the science behind their work and to peer review staff manuscripts prior to submission to scientific journals, creating a staff scientist position in each BDO to promote the exchange of scientific information, and making the data collected by the BDOs easily accessible by the public and in a user-friendly format.

Staff members clearly believe that scientific information should influence policy, and that the scientific basis for policies should occasionally be reviewed. The perception expressed in the survey is that management should be open to modifying decisions and policies based on new information and data, rather than “battening down the hatches.”

Miscellanea

To promote sound science within Cal/EPA, the initiative needs to come from the top down. The fact that the SCS was established to address the role of science within Cal/EPA and how it can be improved is a major step toward creating a strong scientific environment. However, any recommendations to implement suggestions must consider whether the support and resources are present to implement them. Additional processes that are not adequately supported will only increase cynicism and further reduce the role of science in our activities.

5.5.2.2 Work Environment (499)

Philosophy (104)

Basic philosophical attitudes can influence the work environment and the conduct of science, both negatively and positively.

Openness to new innovations and issues (29)

A number of comments related to the openness of peers and particularly managers to new ideas, such as new means of collecting, analyzing, and sharing data, or emerging and often cross-cutting environmental issues for which no legal or regulatory authority currently exists. In essence, the underlying issue relates to the philosophy of whether the manager or section head perceive themselves as program managers and maintaining the status quo, doing things the tried and true way, or as innovators ready and willing to apply new proven methods and the current state of science to attack both old and emerging environmental problems.

Philosophical perspectives or world views influence how individuals and groups face the world and respond to new situations. Several of the e-survey responses indicate that some managers are entrenched in their opinions (e.g., “what worked when I was a staff member was good enough then and should be good enough now”) and are resistant to changes. Rather, management should have an “open door” policy “and encourage staff to come forth with their ideas and suggestions for improvement of work environment and outputs.” Some comments included “Don’t stifle my initiative and creativity. There are always new and better ways to do things.” Or “Leave behind the methods and procedures of the 1980s and move into the 21st century.”

Openness to different opinions and unbiased presentation of perspectives (25)

A number of comments related to the openness of peers—and particularly managers—to opinions different than their own and whether they were unbiased in representing alternative views and perspectives. Scientists using sound science should never think they have achieved a full understanding and should occasionally revisit policies and positions based on new information or data that come to light. Presentations should always be neutral and not skewed to promote or degrade one perspective over another—the pros and cons of all hypotheses should be presented. Evaluations of different perspectives should be held to the same rigorous standards.

Staff members are concerned about subjectivity in applying science (e.g., readily accepting the scientific results when they support a policy and being overly skeptical when they do not support a policy). One respondent suggested that “an effort should be made to present a balanced picture” rather than choosing the information that gets presented based on how it relates to a policy position. Further, it may be beneficial to have technical staff at executive staff meetings and briefings to ensure that the science is not blatantly filtered, and upper management is only told what lower management thinks they want to hear.

More “common sense” in the development of regulations was suggested, implying that if the policy-makers were open to considering the regulated community’s perspective (imagine how the regulations might impact real-world situations), they could work more toward effective but less onerous solutions. Work products should be based on a range of plausible results rather than overly conservative assumptions.

Undue outside influence (21)

Many regulatory and policy decisions have significant economic implications for some segments of society. Although the e-survey respondents recognize that regulatory science is not the same as basic or research science, the perception was often expressed that non-scientific factors were given undue influence in the decision-making process. Often the impression was given that the non-scientific influence occurred above the first-line supervisors. Some managers with limited science backgrounds and computer skills were perceived to disregard staff input and overly respond to the perspectives and “science” provided by the regulated community. In some responses, the perception was that management did not respect the qualifications of staff and automatically considered their products inferior to outside “experts.”

One suggestion was to provide more freedom to publish without interference from upper management. Another was to provide more emphasis (resources) on gathering and analyzing data and on protecting the public rather than on listening to the more vocal stakeholders and lobbyists.

Support and encouragement of staff (17)

Somewhat related to the previous type of comment is the perception that management does not always support or trust the staff to do good work. Many people commented that their training requests have been regularly denied, that they were given unrealistic deadlines, or that they were not given the opportunity to defend their work when challenged by industry experts. Staff morale is an important component of promoting and encouraging sound science.

Staff’s concerns and recommendations need to be carefully considered and feedback must occur when decisions differ from the staff recommendation. Staff feels their scientific integrity is compromised when they are asked to revise their analyses to make a program or policy look better or when decisions are made counter to their input and then are asked to defend the decision. Management must encourage staff to use sound scientific principles and must routinely

support their recommendations if sound science is to play a more significant role in the decision-making process.

It was also suggested that management better consider the background and expertise of their staff when assignments are made to help ensure resources are best used and science is best applied. Allowing staff to present their work more often (whether in papers or conferences) would help reaffirm their scientific skills. Any way to recognize or reward excellent scientific efforts by staff helps to ensure that the scientific discipline and effort will continue to be present in future projects.

Other (9)

In general, more awareness of scientific principles and of the importance of submitting to scientific discipline is necessary to encourage a culture of sound science within Cal/EPA. Too often it appears that political pressures trump the science or it is presumed that we already know and understand everything and proceed with old and potentially incorrect policies.

In the cases where the science is not clear or definitive, it is wise to follow the Precautionary Principle. Management undoubtedly must have a policy perspective, but it should refrain from promoting a biased approach or view of the results (e.g., use science to inform policy, not policy to guide scientific approaches or results).

Politics (134)

The influence of political considerations was the second most common environmental factor perceived as adversely impacting the usage of sound science on the job. Many people commented that the science was not given sufficient weight in the decision-making process. Some responses indicate that the problem may be more of perception than reality. It appears that the frustration with the role of politics has a significant component in the poor communication and feedback to staff as to why or how the decision was made.

Many of the comments were quite cynical, indicating that the role of science was non-existent or superficial in decision-making. In very few instances, however, it was implied that political decisions were directly counter to the scientific evidence. Although some “abuses” of science are noted at the staff level, the “politically correct” or “scientifically incorrect” decisions are typically seen as occurring occasionally at the supervisor level but most often above the level of first line of supervisor.

Priorities and Schedules (32)

Some survey respondents noted the urgent tasks and compressed schedules precluded staff from always taking the most appropriate or definitive scientific approach to address an issue. High-priority projects, often unanticipated but nonetheless urgent, add to already heavy work loads and must also be squeezed in with other projects, some of which may have their own tight schedules and short timelines. In essence, it appears that staff takes the best scientific approach it can within the existing constraints.

Managers must reaffirm to staff that quality is a priority by saying “no” to unreasonable assignments and negotiating deadline extensions for other projects competing for staff time, by clarifying the scope, objectives, and needs of the assignment, by fighting for more time to complete the project so that the amount of scientific work drives the schedule rather than a political or arbitrary agenda, and by avoiding the temptation to micro-manage the staff efforts.

In a sense, the deferral and postponement of training due to hectic and tight schedules exacerbates the problem because when work loads are heavy and project deadlines are short, staff might not have the background or training to use the available resources and tools as efficiently and confidently as possible. In addition, the timing of some projects appears more related to the end of a fiscal year or when personnel reviews occur (i.e., bean counting).

Procedures (188)

Most groups have established means of addressing informational needs and performing its tasks. The following sub-sections provide more specificity concerning this highest ranked environmental constraint to conducting sound science.

Developing and following protocols and methods for consistency (60)

The majority of the procedural comments and suggestions related to the development and establishment of protocols and methods and then following them. Having established protocols that are followed is essential for providing consistency in the application of sound science and regulations. Arbitrary application of science and citations are detrimental to the image and public support of any program.

Developing clear and comprehensive protocols and then following them is a critical component of ensuring consistency and sound science. If management is not involved and promoting a commitment that quality is important, data streams from the lab or the field will be compromised. Besides consistency in collecting data, consistency is needed in how data are used. Each BDO needs to establish a position, separate from data collection, to improve and standardize quality control programs (e.g., establish Data Quality Objective Guidance similar to the U.S. EPA).

Agency-wide guidance for common activities is needed to promote uniformity (consistency) among the BDOs in the collection, interpretation, and evaluation of data. For example, more standardized guidance is needed regarding the development of work plans and sampling protocols (including QA/QC process); data collection, submittal, and analysis; margins of safety, risk assessments, evaluating or writing reports, etc. In addition, staff must ensure that State contractors use the same science-based processes.

An overall emphasis, from top down, must be present for the importance of collecting data of known quality and of analyzing the data in standard or appropriate manners. Too often statistics are misused or selectively used to make the results of the data analysis fit a desired outcome.

Planning (18)

Having open and consistent planning procedures promotes the design of solid science products. A relatively small number of participants highlighted the need for improved planning and design of programs.

Sound, quality products do not just happen; well-thought-out plans are necessary to avoid and overcome common and unforeseen problems. Too many important decisions get made by the “knee jerk reaction” method because there is no “plan.” The decisions wind up being inconsistent and create credibility problems. Preparation of project plans that are realistic and weekly status reports that keep management informed help to keep options open and more flexible.

All data collection efforts should have a Data Quality Objectives Plan. Better anticipation of future data needs are necessary so that the equipment can be installed and people trained to generate good quality data. The alternative leads to delays and incomplete or poor quality data because sufficient time might not be available to acquire proper sites and equipment and to develop and implement a quality assurance plan for collecting good quality data.

Reviewing (31)

The cornerstone of any sound science program is to have work products (e.g., plans, analyses, reports) reviewed by peers, whether expert associates or external experts, in an open review process. A significant number of respondents noted that reviews by supervisors were uneven, especially when a non-technical manager is involved. An inherent element of sound science is skepticism. It is not sufficient to trust someone’s statement; it is necessary to review and verify statements.

Although the goal is to understand why something is true, information may be incomplete. It becomes necessary to develop hypotheses of the causes and embark on measures (e.g., experiments) to eliminate other factors or causes. Thus, a hallmark of science is the sharing of ideas (from developing hypotheses to planning how to test the hypotheses to collecting and analyzing the data to developing conclusions).

One person’s conclusion must be reviewed and independently confirmed before it is generally acceptable and allowed to become part of the foundation supporting future advances. Thus, reviewing staff work at a variety of stages is important for creating a strong scientific foundation able to support conclusions and direct future work.

The survey respondents made several suggestions pertaining to the review of staff products. Management needs to be more open to questioning assumptions that form a basis for staff products. An internal “science review committee” could be established to discuss work carried out by staff and its contractors, from conception to completion. At a minimum, all technical reports should be reviewed by an internal science committee. Some respondents noted the need for independent third-party reviewers.

Cal/EPA should look at reinstating the pool of funds for peer review at the UC system. In addition, and upon funding, it would help to have a simplified process for obtaining peer reviewers. Because scientific expertise is not confined to the UC system, an efficient mechanism for securing and funding external peer review outside the UC system is also needed.

Draft reports should be treated in the same manner as articles submitted for publication in that a thoughtful and timely review with comments from those responsible demonstrates that the work is being taken seriously.

Several respondents indicated that the review of the technical aspects of risk assessment needs to be more thorough. Additional external scientific review of BDO programs may be warranted on an occasional basis to ensure that program objectives continue to be met. Often, an informal consultation with an expert is needed rather than a large formal review. To address this need, Cal/EPA should provide a quick and easy way to obtain peer review or access to technical support.

To help ensure the quality of science being used by contractors and other parties, it would be helpful if the submittals to a State agency were required to meet minimum standards set by the Agency.

Because the state of science and instrumentation is developing rapidly, staff should regularly (perhaps annually) review new techniques and equipment that are available that may allow them to perform work in their program with better accuracy or precision.

Characterizing results, benefits, and uncertainties (33)

The bottom line of any scientific endeavor is to report information and data that will help guide decision makers. In many cases, respondents commented that results and benefits were not always presented in an unbiased manner, nor were the uncertainties of the results relayed. Characterization of results without expression of uncertainties (whether qualitative or quantitative) may prevent decision-makers from a full and balanced consideration of all the factors influencing their deliberations.

Suggestions noted the need to include and propagate uncertainty in measurements and analyses, to be able to calculate quantitative improvements in environmental quality or environmental risks. A program evaluation component should be incorporated into Cal/EPA activities to measure whether this information gets to the public, whether they understand it, whether they use it to change behavior, and how to improve presentation and delivery of the information. More effort should be made to standardize the calculations, documenting the thought process and methodology.

The science underlying the assumptions and default values used in various analyses (e.g., modeling) should be examined to determine if the latter are still scientifically valid and appropriate. Work products are a mix of good and bad. Bad projects usually result from promising results to support pre-determined outcomes and then manipulating the data to make it fit. Another survey respondent noted that management needs to understand that not all human

activities result in bad environmental outcomes. If the data do not support any regulatory action, that's not necessarily a bad outcome.

Because limited resources (people, time, instruments, physical constraints, etc.) frequently mean that the approach and results are seldom definitive (applying scientific principles only reduces uncertainty), work products might benefit from the incorporation of alternative views and approaches that help convey the actual uncertainties. In addition to quantifying anticipated benefits where assumptions must be made, the regulatory community needs to conduct pre- and post-regulatory analyses to more accurately demonstrate the actual benefit of any regulation that is put in place.

Documenting (43)

Documentation of all work efforts (e.g., planning, monitoring, procedures) is essential if current and future staff are to maintain consistent and open processes. Furthermore, any review process, whether internal or external, needs to have a transparent path of science to enable full and complete reviews and full confidence in the results and decisions. Documenting information and procedures is a critical component of sound science so that others can review and reproduce results and arrive at similar conclusions. Although interpretations of the available information may be colored by policy or world views, the underlying information and data must be developed in a scientific manner and well documented.

A fundamental starting point for the generation of high quality data is to develop and implement data quality objectives for each project. Groups should develop and maintain clear guidance that can be used internally and, where similar work is performed for the group, externally. Standard operating procedures (SOP) should be prepared not only for making measurements but also for the preparation of documents. In particular, DTSC and WQCB respondents tended to point out the need for better documentation if consistency in enforcing regulations is desired.

Some effort should be made to document the basis for scientific decisions so that there is a way to check (and defend) the validity of the methods and assumptions that go into important documents and decisions. Another point made was the importance of documentation and training as staff turnover occurs; without it, historical perspectives and information will be lost. Planning and enforcement efforts can then become uneven and inconsistent as the "science" wheel is reinvented. Groups should maintain a Q&A file so that the "wheel doesn't get reinvented."

Other (3)

Additional procedural types of comments included the need to devote comparable resources to the data analysis as to data collection to provide a comprehensive scientific foundation for decisions. In addition, Cal/EPA needs a science or granting component that specifically addresses the data, tools, or techniques needed for improving the scientific foundation for human health and

ecological risk assessment. All too often, risk management decisions are made using little or no science.

Miscellanea (10)

Other comments and suggestions related to the work environment included providing clarity on science and its role as well as clarity about the expected work product. Management must not prematurely adopt a position because it either results in vagaries that confuse and upset the regulated community or in the contortion of data and interpretations to support a questionable policy. Management must treat employees with respect (e.g., providing appropriate training and development opportunities, positive encouragement regarding scientific inquiry).

5.5.2.3 Positive Comment or No Suggestion (27)

The responses to the suggestion portion of the e-survey included some positive comments that noted no improvement was needed or no suggestions came to mind at the moment.

5.6 *Findings Based on E-Survey*

Based on the general theme of the responses provided in the e-survey, which may characterize the general working conditions, some findings can be made regarding the current state of science within Cal/EPA and BDOs. From the ratings portion of the survey, it is obvious that Cal/EPA employees are generally satisfied with the quality of science and the role that science plays in their professions. However, based on the input from the approximately one-half of the e-survey respondents who also provided suggestions, opportunities remain for improving the quality and role of science within each of the BDOs. By the sheer magnitude of comments and suggestions, the primary finding is that the respondents feel they do not have adequate resources to perform their scientific roles.

Based on the common threads linking many of the more than 600 comments and suggestions received, the Steering Committee for Science makes the following findings—some of which are generally applicable throughout Cal/EPA and some that are more limited in applicability. The fact that a finding is listed under an individual BDO does not mean the finding is applicable only to that BDO.

- 1) **Science is a necessary and important component of work performed at Cal/EPA, and final work products need to reflect the scientific input.**
- 2) **The quality and role of science in decision-making could be improved.** In fact, the expressed comments and suggestions indicate serious concerns regarding working conditions and resources.
- 3) **Staff members are not keeping up with the state of science** in their disciplines because they are unable to receive training and participate in conferences as much as they would like. Staff does not have adequate resources to stay current with the rapidly changing state of science. The resources include: a) time available to read the journal articles or visit the library; b) inadequate library facilities and access to technical information; c)

lack of funds and management support to attend scientific meetings; and d) lack of training opportunities.

- 4) **Management is not giving science as large a role as it should in decision-making.** Several respondents expressed the view that non-scientific factors were given undue influence in decision-making. This staff concern warrants further investigation as to the basis for, and the consistency of, the final decisions. It is natural for staff to feel frustrated when something in which they believe and on which they have worked diligently does not move forward and come to fruition as envisioned. The SCS debated this finding because other factors such as technological feasibility, economic impacts, enforceability, and political influence have always played, and must play, a role in final decisions. However, the SCS believes that a major factor in this concern could be inadequate communication back to the technical staff regarding the basis for the changes made to the original staff input.
- 5) **Similar work products (e.g., risk assessment, characterization of uncertainty) are not being developed in a consistent manner by the different BDOs, and, in some cases within, BDOs.** Many have expressed concerns about the quality and role of science in decision-making in terms of the process and consistency both at the intra-agency and inter-agency levels. Some scientific processes used to synthesize technical support for a regulation or influence a policy lack consistency in terms of: a) accuracy and interpretation, b) internal and external reviews, c) expertise and competency of supervisors providing oversight, and d) transparency in the process of developing a product and acting on it. Though the different mandates for each of the BDOs may be a reason for these differences, the comments imply that there are some fundamental common principles that are being overlooked or not strictly followed. Some of the respondents use the term “Risk Assessment” to identify the process and application of scientific information. Some are concerned with the interpretation aspects, others with review (internal and external) aspects, and others with process transparency.
- 6) **Higher scientific standards are needed when hiring and promoting staff and also when reviewing contractor work products.** A significant number of respondents recommended a review of existing promotional policies for both staff and management. Survey respondents especially questioned the ability of supervisors without a scientific background to effectively review, modify, or change the technical work products produced by the staff. Respondents also implied that work products from contractors were not consistently being held to reasonable scientific standards.
- 7) **More resources (e.g., time, focus groups) are needed for in-house interaction with peers to provide better planning of projects, better review of work, better dissemination of results, etc.** The lack of dedicated science/research focus groups with adequate resources is responsible for some of the problems faced. Some large databases used as baselines for developing and implementing regulations, as well as measuring the progress or success of programs, are not adequately documented for their accuracy and limitations.

Examples provided include the air pollutant emissions inventory and the pesticide use databases. Some respondents pointed out that the estimates can show 1–2 orders of magnitude difference, and yet the uncertainties are neither expressed nor evaluated. Should this aspect be true, the decision-making implications could be alarming.

- 8) **Staff is concerned about compensation inequities.** Pay parity with comparable workforces outside Cal/EPA, but also within and among BDOs, was the main issue.
- 9) **Time available to develop a sound and comprehensive scientific basis** for decisions is limited by heavy work loads and short deadlines.

5.7 E-Survey-Specific Suggestions

Following are more BDO-specific suggestions that may have significant implications on the quality and role of science in decision-making: The list is not exhaustive but highlights those having a common thread from several survey respondents or having critical implications for science in decision-making. These suggestions address the major potential issues (warning flags) raised by the BDO-specific survey responses. A suggestion listed under one BDO may be applicable to other BDOs. Prior to taking any action either at the Agency or at the individual BDO level, a team with adequate expertise needs to examine each of these suggestions.

5.7.1 Cal/EPA

- Bring in experts or expert panels as needed for consultation to enhance the quality and role of science in decision-making.
- Seek legal authority comparable to the level of responsibility in the Secretary's Office so that cross-media program goals can be met more efficiently.
- Create a science/research group in the Secretary's Office of Cal/EPA to serve as a resource for the BDOs.

5.7.2 ARB

- Evaluate and address concerns related to the development and application of Emission Inventory (e.g. EMFAC model).
- Reduce potential biases in data analyses and interpretation.
- Set research priority and agenda with clearly defined criteria and transparent process.

5.7.3 IWMB

- Strengthen scientific expertise and skills of the Board, executive, and technical staff.
- Reduce reliance of outside sources for proposed scientific projects.

- Consider technical people for promotion to positions requiring scientific expertise for review and oversight.
- Increase staff's scientific knowledge by providing more training and greater educational opportunities on scientific principles and methodologies, allowing more attendance at professional meetings and conferences to keep staff up to date, and sponsoring conferences and scientific seminars on scientific topics.

5.7.4 DPR

- Ensure consistency, transparency and review (internal and external) of the Risk Assessment process and products.
- Acquire more and better pesticide exposure data. These could include increased data requirements for pesticide registrants.
- Evaluate and improve, as appropriate, the accuracy of the Pesticide Use Report database.
- Combine the pesticide exposure assessment and other risk assessment activities into one DPR group.

5.7.5 DTSC

- Ensure consistency, transparency, and review (internal and external) of the Risk Assessment process and products.
- Consult and communicate with technical staff prior to making decisions on site evaluation and cleanup issues involving science and technology.
- Conduct a department-wide review to establish standard protocols for site evaluation and mitigation target levels.
- Explore options (including placing them in one division) to develop cooperation among technical staff from different scientific disciplines.
- Ensure technical expertise in supervisory and executive staff levels.

5.7.6 OEHHA

- Improve intra- and inter-BDO communication on cross-cutting issues.
- Minimize duplication of effort.
- Develop standardized risk assessment protocols. Examine scientific basis for defaults and study selection. Give range of plausible values, not just the most conservative.
- Greater accountability for work products is needed.
- Author(s) should defend documents to review panels.
- Need community relations and science writing skills.
- Streamline and standardize internal and external peer review processes.
- Establish a Cal/EPA center for risk assessment.

- Measure effectiveness of programs.

5.7.7 Water Boards

- Improve scientific expertise in the Board Membership and staff at all levels.
- Re-examine the scientific basis for Basin Plans and effluent limits (including risk assessment) ensuring consistent and standardized approaches among the state and regional boards.
- Ensure consistent and standardized approaches for meeting CEQA requirements in all programs among the State and Regional Water Boards.
- Create a science/research division providing access for technical information and seeking data for the future needs.
- Develop more consistent protocols among the regional boards in adopting water quality regulations and reporting violations.
- Include original citations for all sources of scientific information in staff reports. Avoid the use of secondary sources (grey literature) as sole scientific basis.

6 External Review

6.1 External Review Process

SCS received comments from the following nine external review panelists.

Praveen Amar, Ph.D.

Dr. Praveen Amar is Director of Science and Policy at Northeast States for Coordinated Air Use Management (NESCAUM). NESCAUM is an interagency association of eight northeastern states (New York, New Jersey, Connecticut, Maine, Massachusetts, Vermont, Rhode Island, and New Hampshire). NESCAUM provides high-level scientific and policy-relevant input to its member states on regional air pollution issues. His key area of expertise is to “translate” the implications of findings of science and developments in technology into workable and cost-effective policy options for the states in the Northeast.

Susan Hackwood, Ph.D.

Dr. Susan Hackwood is Executive Director of the California Council on Science and Technology (CCST), Professor of Electrical Engineering at the University of California, Riverside, and Visiting Associate in Engineering at the California Institute of Technology. CCST, a not-for-profit sponsored by the academic and federal research institutions in the California, advises the state on matters related to science and technology. She has served as Department Head of Device Robotics Technology Research at AT&T Bell Labs and at University of California, Santa Barbara.

Kent Hoekman, Ph.D.

Dr. Hoekman is Executive Director of the Division of Atmospheric Sciences (DAS) at the Desert Research Institute (DRI). DRI is a state-wide division of the Nevada System of Higher Education. DAS consists of approximately 45 research faculty members, along with about 70 technologists, graduate students, post-docs, and other support staff. The division conducts fundamental and applied research in the natural atmosphere. Prior to joining DRI, he spent 21 years at Chevron, where his work focused on technical and regulatory issues pertaining to transportation fuels, mobile source emission controls, vehicle technology, and urban air quality.

Bryan M. Jenkins, Ph.D.

Dr. Bryan Jenkins is Professor in the Department of the Biological and Agricultural Engineering at University of California, Davis. His research in the Department’s Biomass Laboratory involves identifying means to improve the conversion and expand the beneficial use of biomass fuels. Research also includes the fundamental combustion behavior of biomass and the characterization of important fuel properties, small scale gasification systems for remote power applications, and energy utilization in controlled environments.

Anne Katten, MPH

Ms. Anne Katten works for the California Rural Legal Assistance Foundation which is a non-profit organization working to improve the lives of farm workers and other low income rural Californians through advocacy and education. Serving in the Foundation's Pesticide and Work Safety Project, she has 15 years of experience conducting oversight on pesticide and work health policy development, implementation, and enforcement; and advocating for farm workers.

Arthur Lawyer, Ph.D.

Dr. Lawyer is Managing Director of Technology Sciences Group Inc. (TSG), an environmental consulting group with primary offices in Washington DC, England, and Sacramento. Much of his efforts have focused on the science and public policies involving the use of toxic materials. TSG assists both the manufacturers and users of these compounds and has recently become the industry leader in gaining registrations of the new generation of softer pesticides such as microbial and biochemical products. Particular focuses of the TSG's California staff are the regulation of pesticides and compliance with California's Proposition 65.

F. Jay Murray, Ph.D., DABT

Dr. F. Jay Murray is a toxicologist who heads the environmental health consulting firm of Murray & Associates in San Jose, California. He has over 30 years of experience in toxicology, environmental health and safety management, regulatory affairs, risk assessment and risk communication. A number of industries, trade associations, and government regulatory agencies rely on his technical expertise. He was formerly employed by the Dow Chemical Company, and Syntex Corporation (currently Roche Biosciences).

James N. Seiber, Ph.D.

James N. Seiber is Director of the Western Regional Research Center of the Agricultural Research Service of U.S. Department of Agriculture (USDA) in Albany, California. The Center has mission areas in food safety/healthfulness, biobased products and biofuels, new uses for agricultural produce, and environmental quality enhancement. Prior to joining USDA, his career was largely in academia serving his professorship at the University of Nevada Sierra, and University of California, Davis.

Garrison Sposito, Ph.D.

Dr. Garrison Sposito is a professor jointly appointed in the Department of Civil and Environmental Engineering and the Department of Environmental Science, Policy and Management of the University of California at Berkeley. He is also a Principal Investigator jointly appointed in the Geochemistry Department and the Geophysics Department of the Earth Science Division at Lawrence Berkeley National Laboratory. His areas of expertise are environmental chemistry and terrestrial hydrology, with primary media emphasis on water and soils.

6.2 External Review Summary

Most comments supported the findings of the SCS. Some raised issues that resulted in changes in the report, while others may be considered in the future. Their principal comments are categorized as follows.

Emerging Issues and Environmental Technology

- Take the leadership role in defining and refining the role of science in management of breakthrough environmental technology developments and other emerging environmental issues.

Staff Recruitment/Retention

- Establish awards to recognize scientists with outstanding performance in applying science in their assignments.
- Take advantage of temporary employees, student interns, outside consultants, and experts from academia; use cross-training of existing staff to cover more than one area of responsibility.
- Establish pay parity and opportunities for promotion.

Staff Expertise

- Provide training and development opportunities.
- Improve web access to scientific journals and information.

Communication and Transparency

- Establish a transparent and open science-driven process.
- Discuss the role of, and the distinction between, science and policy.
- Provide better communication regarding the basis for decisions.
- Present a range of results in risk assessments, with uncertainty identified and quantified.
- Improve transparency in science at Cal/EPA.
- Inform the Legislature about legislation that fails on scientific grounds.
- Recognize that acceptance of minor environmental degradation may be prudent in order to avoid much greater harm. Consider the need to balance short-term and long-term risks and the need to incorporate probability considerations.

Consistency

- Improve consistency in risk assessment and its application to decision-making within and among BDOs.

Scientific Advice and Peer Review

- Provide means to seek help from experts, either in-house or outside.
- Re-examine the Risk Assessment Advisory Committee's recommendations to determine whether they have been put into practice and with what results.
- Work with UC Office of the President to resolve difficulties in contracting with UC for expeditious peer review.
- Adopt more routine review procedures for improving communication between appropriate faculty and staff, and tailor review panel expertise to the subject of interest.
- Expand outside review beyond the University systems of California.
- Need a hierarchy of reviews.

Leadership

- Recruit scientists to management positions.
- Establish 1) a Senior Scientific Advisor, 2) an Agency-wide coordinating committee that can set goals, and 3) an outside standing committee of advisors that can advise on those goals and steps that can be taken to fulfill them.
- Identify and empower a Chief Scientist in each BDO. Establish a Cabinet of Chief Scientists to advise Cal/EPA Secretary on emerging and multi-media environmental issues.

Research

- Seek opportunities to leverage their research resources with other BDOs, federal, state, and local governmental agencies, industry, and other stakeholders.
- Develop a strategic research plan prepared with outside input.
- Collaborate with the California Energy Commission and the U.S. DOE in cases where there is a significant nexus of energy and environmental issues.

Environmental Indicators

- Design an environmental monitoring program to monitor environmental improvement or degradation to support environmental indicators.
- Implement recommendations.
- Ensure the implementation of the recommendations by including a discussion in the report.

7 SCS Recommendations

In consideration of the comments received by the external reviewers, executive staff from all BDOs and the findings made from the E-survey, SCS unanimously agreed on the following set of recommendations.

7.1 Consistency

Issue: Lack of consistency in work products between, and sometimes within, BDOs was a frequent observation in both the web survey and the BDO questionnaire. Lack of consistency in work products and decision-making undermines the credibility of Cal/EPA. This was stated in a variety of ways by questionnaire and survey respondents and peer reviewers.

Recommendation: Cal/EPA should enhance consistency in risk assessment and in the application of scientific findings to decision-making throughout the Agency.

Rationale: Guidelines or principles are needed to direct risk assessment and other scientific applications throughout the Agency. Perhaps more specific guidelines and procedures at the BDO level could adapt and interpret the Agency-wide guidelines to the specific BDO programs. A Cal/EPA Science Cabinet (see recommendation 6.2) reviewing such guidelines could help to ensure consistency within Cal/EPA to the extent possible, given differing authority statutes for various programs.

Cal/EPA has centralized the development of chemical toxicity and carcinogenicity criteria, promoting consistency among the BDOs. This model could be followed for other aspects of risk assessment such as environmental fate and transport of chemicals, human exposure assessment, and ecological exposure and effects assessment. This approach could be more efficient as well as promoting consistency.

Implementation: The SCS proposes a team of internal and external scientists be formed to evaluate the laws, protocols and procedures followed by individual BDOs in their risk assessment approaches. The team will consider all major risk assessment sub-disciplines, including site characterization, sampling, fate and transport, exposure assessment, and toxicity assessment. They will identify areas of similarity and difference, and recommend how consistent and uniform protocol could be followed by all BDOs. The effort will require 9-12 months. This recommendation can be implemented immediately.

Recommendations 7.2 and 7.3 support and enhance this effort. The Cal/EPA Science Cabinet to be formed could oversee this activity, providing the leadership and oversight to ensure that the product is comprehensive, reasonable, and practical. The findings of the team on consistency will provide input for recommendation 6.3 where structural reorganization may further facilitate consistency.

Fiscal impacts: External contract support (with three external scientists) for the team is estimated at \$250-300K. These costs and internal staff time can be redirected within the BDOs' existing budgeted resources.

7.2 Leadership

Issue: Scientific rationale and technical support play a key role in developing regulations and in influencing policies. However, the survey identifies a lack of consistency in applying science in terms of: a) accuracy and interpretation; b) internal and external reviews; and c) expertise and competency of supervisors providing oversight. Many of the external reviewers concur with this observation. However, it should be noted that these issues might be a greater concern in a particular BDO than in others. The SCS discussed the issue in detail and concluded that: a) there is room for improvement in almost all BDOs; and b) increasing the scientific expertise in management positions will bring about the needed credibility as well as improve the confidence of the staff and the public-at-large in the organization.

Recommendation: Cal/EPA should designate a “Chief Scientist” within the executive management team of each BDO. Cal/EPA should also establish a “Science Cabinet”, comprised of these Chief Scientists and four external scientists. The Science Cabinet would make recommendations to the Secretary on scientific matters and research needs. The Cabinet members could also provide input for major programs of scientific importance.

Rationale: Some staff technical work products are reviewed by supervisors who may lack the requisite scientific expertise. The SCS recommends technical expertise at different levels of management to enhance discussions among peers. Having the scientific expertise at all levels will eventually change the culture into constantly striving to improve the role and quality of science at Cal/EPA.

The authorizing statutes set forth specific requirements for education and expertise for particular members of Boards and for one director. Ensuring a “voice” for science in each management team will assist in policy-making. Bringing about such changes will take time, but Cal/EPA should commit to this change. The concept of a Cabinet of Chief Scientists, or something similar, was suggested by several members of the peer review panel. The SCS concurs with their suggestions.

Implementation: The SCS recommends that each BDO designate a “Chief Scientist” within six months, and that a mechanism for bringing together external scientists to form the Science Cabinet be developed by the Office of Secretary.

Fiscal impacts: This recommendation can be implemented, and any incremental costs associated can be absorbed within existing budgeted resources. When a mechanism for external scientific expertise as part of this “Cabinet” is developed, the organizations can submit that proposal as part of the normal budget and/or legislative processes.

7.3 Organizational Structures

Issue: A majority of BDOs (and the Office of Secretary for Environmental Protection to a smaller extent) have implemented new programs during recent years, with increasing responsibility and number of staff. In addition, their functions have changed, requiring highly qualified scientific and technical personnel as well as multidisciplinary teams. Some BDOs have made attempts to organize the scientific and technical staff under one or more divisions (based on program-specific needs, expertise, and functional

roles). However, some dissatisfaction among staff is present. Their concerns include a lack of the following:

a) technical expertise among supervisory ranks; b) consistency in risk assessment and its application within and among BDOs; c) consistency in internal and external review of technical documents; d) capability to identify and address emerging issues; and e) research needed to respond to critical questions associated with program development. Although some specific recommendations have been made to address these concerns, the SCS concluded that critically examining the organizational structures could also be beneficial to maximize the use of fiscal and personnel resources and ensuring effective and efficient program delivery.

Recommendation: Organizational structures Agency-wide should be reviewed with respect to their effectiveness, efficiency, and use of science in decision-making.

Rationale: The SCS is of the opinion that a top-down approach is critical to improve both the role and quality of science. While establishing a Science Cabinet will enhance the leadership role and show the commitment, it may also be necessary to change the organizational structures. Changes in organizational structures may also complement implementation of other recommendations related to consistency, transparency, and emerging issues.

Implementation: The SCS proposes a team be formed with external consultants and internal executive managers to evaluate the organizational structure of Cal/EPA and its BDOs to improve the quality and role of science in decision making in their mandates and programs. The team will identify areas where the organizational structures are not conducive to optimization of scientific integrity and the effective incorporation of scientific findings in decision-making processes. Some of the ideas that were generated during the earlier California Performance Review process can also be considered. The team will recommend changes in the organizational structures that will facilitate better application of science at Cal/EPA. The effort can be synchronized with the annual budget development processes. Implementation of the team's findings will take a longer-term effort.

Fiscal impacts: The Cal/EPA organizations can absorb the costs to conduct this review. However, the costs of implementing the team's recommendations are unknown pending completion of a review. Changes to organization structures may require budgetary and legislative changes that could be accomplished through the normal processes.

7.4 Communication and Transparency

Issue: In the e-survey, respondents raised a concern that science was not given sufficient weight in the decision-making process. Staff and others perceived that decisions were politically based and ran counter to scientific evidence. This may be because the role of science and other factors that were the basis for the decision were not adequately communicated to them. In addition, some BDOs expressed a concern about the transparency of the decision-making. For other BDOs, transparency of decision-making is less a concern, since all policy and regulatory decisions are made in an open and transparent manner at a publicly noticed meeting. These BDOs use web-

based agenda posting systems where the public can view or download pertinent information prior to the meeting.

Recommendation: Decision-making processes, including the role of science and other factors in the final decision, must be documented, be transparent, and be accessible in order to improve credibility and communication within and among BDOs and outside the Agency.

Rationale: To increase the level of confidence among the technical and scientific staff that the science is applied in a fair and transparent manner, clear communication must exist between management and scientific personnel. Staff, along with external stakeholders, must understand that science is not the only consideration when making the decision, even though it is very important one. Cost-benefit analysis, technological feasibility, and legal mandates are some additional important considerations in setting policy.

Others include societal goals such as public acceptance of decisions, resource conservation, aesthetic values, undue adverse effects on certain portions of population or regions, and perceived fairness. A balanced consideration of all factors will sometimes lead to more moderate regulatory actions than science alone might suggest. The public record should be sufficiently clear that it is possible to reconstruct the decision-making process, including the factors that were considered and how each of the various factors influenced the final decision.

Implementation: The SCS proposes that the Science Cabinet look into this issue and provide recommendations to enhance documentation and transparency in BDO decision-making processes. Additionally, Cal/EPA has already initiated efforts to enhance public participation across all programs and organizations.

Fiscal impacts: The estimated costs to implement are minor and absorbable.

7.5 Scientific Advice and Peer Review

Issue: An effective Cal/EPA scientific program depends upon mutually strong internal and external scientific advice and review. The extensive scope of science-based projects and rules proposed by Cal/EPA organizations requires an easier, more efficient means of acquiring external scientific advice and peer review than currently exists. Depending on the circumstance, the need could begin at the project or rule concept stage.

Recommendation: Increase opportunities and provide an expedited process for seeking internal and external scientific and technical advice, ensuring that all major scientific work products affecting regulations or policy receive internal and external peer review.

Rationale: A key to successful implementation of strengthened scientific programs in all Cal/EPA organizations is balance. Strengthening the scientific programs with a reliance mostly on increased external advice and review would be a half-measure. The survey response from Cal/EPA staff and organizations and from the external scientific peer reviewers strongly emphasized the need for a stronger scientific presence through the organization's ranks—including the policy level—as well as increased access to scientific expertise from outside.

Internal advice would include engagement of, and requests from, all appropriate Cal/EPA organizations for interaction on all significant cross-media issues and proposals. External advice would include similar interaction between Cal/EPA organizations and academic researchers; and experts outside the academic community including State, federal, private, and regulated organizations. For regulations and policies that are based on science, the external peer review would follow the provisions of HSC Section 57004.

Options for addressing the need for enhanced internal and external scientific advice and review include: 1) increasing cross-media and cross-program collaboration, in part by using the “Science Cabinet” on an on-going basis, and 2) streamlining the administrative processes and expanding the “pool” of external scientific experts who provide external scientific peer review.

Implementation: The Cal/EPA organizations are collaborating on a new Interagency Agreement with the University of California. The new agreement will incorporate more efficient administrative procedures (based on SWRCB’s model) and expand peer review to other institutions.

Fiscal impacts: No additional resources are required. The BDOs can allocate appropriate funds from existing budgets to the new agreement.

7.6 Research

Issue: Research is an integral component of scientific endeavors. Cal/EPA needs fundamental, new information to better understand emerging issues and, as appropriate, to develop sound new programs. In order to ensure that emission control efforts are effective and efficient, we need an improved understanding of relationships between pollutant-generating human activities and public health and the environment. Whether basic or applied in nature, research is needed to ensure that a solid scientific foundation guides environmental analyses, policies, and actions. Unfortunately, limited funding, short regulatory timelines, and poor coordination with research community limit research that supports environmental regulatory programs.

Recommendation: Increase research that addresses scientific questions that arise during program development and implementation.

Rationale: Research is needed at multiple levels to bridge gaps in scientific knowledge that guides and supports environmental policies and regulatory programs. Research runs the gamut from literature searches and reviews of current information, to in-house data collection and analysis, to contracts with persons or groups having expertise in the subject. It requires commitment and creativity from management to solidify and enhance research as the scientific basis of activities.

Some of the external reviewers of this report recommended formal research programs, similar to Air Resources Board’s, for all the BDOs to elevate and enhance the role of scientific research in BDO activities. However, such prominence has historically led to serious cuts in funding on occasion during budget crises. When funding does not keep pace with program requirements, the research and development sectors are often the first to experience budget cuts. Alternatively, research conducted in universities,

national laboratories, and in private sector could be coordinated better with the need of the regulatory programs.

One important research aspect is to maintain a good library system that allows staff to electronically access the principal journals in a variety of environmental fields. Enhancing and facilitating access to scientific information helps to maintain staff expertise and to ensure that the latest science is integrated into the activities and policies of the BDOs. In many instances, staff expertise may be sufficient to efficiently conduct and peer review some research in-house; however, workloads (time and number of staff) frequently limit the feasibility of such reviews. Cal/EPA should seek opportunities to leverage resources with other federal, state, and local agencies as well as industry and stakeholders to enhance research efforts. For example, BDOs should participate in the federal Small Business Innovation Research and similar research investment programs.

Whatever mechanisms are established to meet the various research needs within each BDO, they should be efficient, transparent, and flexible to permit sound planning and review (not only of the scientific principles but also of the wise use of funds, staffing, and expertise). The Cal/EPA Science Cabinet could serve as an oversight body to ensure that research efforts (whenever these are conducted) are coordinated with program needs and cost effective.

Implementation: The ARB has a formal research program which awards funds for external contracts and grants. Other BDOs obtain research through contract on an ad hoc basis. The SCS proposes that it be left for each BDO to determine if an ongoing research program will benefit their program efforts in a cost efficient manner. No specific timeline is assigned to this recommendation.

Fiscal impacts: Increased coordination with external research (e.g., by academia, federal agencies, and etc.) can enhance environmental regulatory programs without substantially increase in state costs. Where the state directly funds research activities, better coordination will enhance the utility of these investments.

7.7 Emerging Issues

Issue: Cal/EPA addresses emerging environmental issues in an *ad hoc* manner. Generally staff become aware of emerging issues through media, journal or other external sources. These issues are brought to the attention of management, and, if deemed worthy of further attention, they may be assigned some level of support (e.g. contract research, time, and supplies for internal investigations). This approach may prove to be shortsighted. Without a coordinated effort, it may be difficult to determine which emerging issues will become significant and which will not. The public expects public officials to anticipate environmental problems so that they can be prevented or minimized. The process to address emerging issues needs to be streamlined. To address the issue, a bottom-up and a top-down approach are needed.

Recommendation: Institute a systematic approach for BDOs to address newly identified environmental challenges and cross-media issues. The Cal/EPA Science Cabinet should serve as the forum for discussion and making recommendations related to emerging issues on an ongoing basis.

Rationale: For most of their history, environmental protection programs have been monitoring, investigating, and remediating pollution in the environment and imposing new and stringent regulations in an attempt to prevent similar occurrences in the future. With new technology and human activity come new threats to the environment. Identifying and preventing emerging environmental challenges early would greatly reduce the cost and resources for remediation.

Each BDO should establish a mechanism for staff to submit ideas on potential new emerging issues. These ideas would be reviewed by the BDO or Cal/EPA chief scientist, who would decide whether or not the idea needs further evaluation and definition. The chief scientist would recommend that the idea either be dropped or moved on for consideration by the Cal/EPA Science Cabinet. The Science Cabinet will decide what further steps to take.

Implementation: The SCS proposes that Cal/EPA designate the Science Cabinet as the forum for emerging challenges. They would consider and make appropriate recommendations to executive management.

Fiscal impacts: The Science Cabinet can function with existing budgeted resources. As major new threats are identified, policy and program actions can follow the normal budget process.

7.8 Environmental Indicators

Issue: Environmental indicators are an objective and scientific way to measure the health of the environment and to evaluate the effectiveness of environmental programs. In April 2002, Cal/EPA published “Environmental Protection Indicators for California” (EPIC), which established a process and criteria for indicator selection and an initial set of 84 environmental indicators. The EPIC project, a collaborative effort among Cal/EPA and its boards and departments, the Resources Agency, and DHS, is intended to develop and maintain “environmental indicators” (measurements of environmental conditions) to improve our understanding of the health of California’s environment and to aid in policy and budgetary planning. Public Resources Code Sections 71080–71082 mandate this activity, but state budgetary problems have curtailed full implementation of the program. BDOs continue implementing indicators with existing resources.

Recommendation: Cal/EPA should systematically evaluate the effectiveness of Cal/EPA programs in the protection of public health and the environment by continuing to support an Environmental Indicators Program.

Rationale: A wide variety of nonprofit, local, state, and federal agencies, including US EPA, have developed environmental indicators to assess the status of their particular environmental concerns. During the development of the EPIC report, there was wide-ranging interest and cooperation by government, nonprofit and business organizations. The report used data collected by the BDOs and others and identified data gaps and the need to collect additional scientifically useful data. Hence, BDOs must continue to collect necessary environmental indicators, to update their current indicators and establish new indicators.

Implementation: BDOs should continue implementing indicators as mandated. The Cal/EPA Science Cabinet can oversee the progress of Environmental Indicators Program and make appropriate recommendations to improve the program.

Fiscal impacts: The Science Cabinet can function with existing budgeted resources.

7.9 Staff Expertise

Issue: The scientists from the various BDOs within Cal/EPA recognize that the science they practice continually evolves. They are confronted on a daily basis with state-of-the-art proposals, recommendations, environmental evaluations, changes in law or regulation, and information from within the worldwide scientific community. They must evaluate these and make recommendations to management. In order to provide a sound basis for decision-making and ensure environmental protection, they must keep their knowledge and expertise current.

Recommendation: Cal/EPA should encourage staff attendance at scientific seminars, conferences, symposia and workshops, and improve access to scientific resources such as analytical, measurement, and modeling tools, and scientific information. Staff should have access to up-to-date information in order to use the latest science in the development of policies and regulations.

Rationale: Cal/EPA employees are the cornerstone of the scientific resources that fulfill scientific obligations to California. The responsibilities of agencies that are involved in human health and environmental protection extend to the entire community of stakeholders, including regulated industries, concerned citizens, state and local governments, and their own employees. Knowledgeable scientific support is essential to maintain credibility with these diverse groups in order to achieve a consensus on decisions, regulations, and law. Scientists have identified continuing education, professional development, and peer interaction as key to this goal. As program priorities change, however, fewer professional development opportunities may be available.

An important aspect of maintaining staff expertise is to have a good library system, allowing staff electronic access to environmental journals. Making these journals available to the staff in a timely manner would ensure that the latest science is considered in the development of policies and programs. In this way new research and information is efficiently integrated into board and departmental activities.

Implementation: Cal/EPA is now coordinating scientific journal subscriptions and making those available on intranets Agency wide. Managers are encouraged to support appropriate professional development and continuing education.

Fiscal impacts: Additional professional development, continuing education, and related topics can be addressed as part of normal collective bargaining processes.

7.10 Staff Recruitment and Retention

Issue: Questionnaire respondents noted that, twenty years ago, State scientists' salaries were less than those in industry, but generally commensurate with academia and the federal government. However, staff perceive that a compensation disparity now exists between state scientists and those doing similar work at other regulatory bodies,

industry, and academia. As current staff tenure increases, maintaining scientific expertise becomes an added challenge.

Recommendation: Cal/EPA should enhance the ability to hire and retain well-trained scientists by encouraging professional development, increasing promotional opportunities, addressing the loss of the “knowledge base” due to retirements, and review the multitude of scientific classifications across the Agency.

Rationale: Maintaining scientific expertise is an on-going focus for Cal/EPA management. The long-term quality of the science at Cal/EPA and the ability to appropriately assess and protect the environment will come from meeting this challenge. A BDO executive officer should be assigned to lead a management review of scientific classifications and compensation. These steps should be developed on an expedited basis in order to take advantage of the upcoming collective bargaining cycle.

Implementation: The Chief Deputy Director of DPR led an Agency wide effort to assess how scientific classifications are used in the various programs and organizations. This effort also examined potential options to be considered that would unify and bolster the scientific knowledge base. Some of these options may be addressed in the future collective bargaining process. Harmonizing the number and variety of existing classifications and developing a succession management plan are also underway via collaboration between the Cal/EPA organizations. These are on-going, long term efforts.

Fiscal impacts: Existing efforts are conducted within current budgeted resources. If collective bargaining results in additional costs for employee compensation, the Cal/EPA organizations can address those fiscal pressures through the normal budgetary process.