REQUEST FOR PROPOSALS

CALIFORNIA REGIONAL
$PM_{10}/PM_{2.5}$ AIR QUALITY STUDY
(CRPAQS)

MODELING ANALYSES OF DATA CAPTURED DURING THE CRPAQS FIELD PROGRAM

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1. BACKGROUND

The California Regional $PM_{10}/PM_{2.5}$ Air Quality Study (CRPAQS or Study) is a multi-year program of meteorological and air quality monitoring, emission inventory development, data analysis, and air quality simulation modeling. CRPAQS objectives are to: 1) provide an improved understanding of emissions and dynamic atmospheric processes that influence particle formation and distribution; 2) develop and demonstrate methods useful to decision makers in formulating and comparing candidate control strategies for attaining the federal and State $PM_{10}/PM_{2.5}$ standards in central California; and 3) provide reliable means for estimating the impacts of control strategy options developed for $PM_{10}/PM_{2.5}$ on visibility, air toxics, and acidic aerosols and on attainment strategies for other regulated pollutants, notably ozone.

CRPAQS is composed of three phases: 1) planning and basic research; 2) field programs; and 3) modeling and data analysis. The planning phase began in 1993 and was completed at the end of 1999. Planning activities included technical support studies to address key planning issues, demonstration studies of possible control techniques, a pilot study conducted during winter 1995/96, known as the 1995 Integrated Monitoring Study (IMS95) (Solomon and Magliano, 1998, 1999), preliminary modeling, and development of detailed plans for each of the subsequent Study components.

The field programs phase of the Study consisted of 14 months of monitoring throughout the San Joaquin Valley (SJV) and surrounding regions, as well as intensive monitoring during fall- and winter-like conditions when PM_{10} and $PM_{2.5}$ concentrations are highest. A field-monitoring plan (Watson et al., 1998) describes the planned monitoring activities and network. This plan is currently being revised to reflect the actual network as it was implemented. Deviations from the plan were necessary owing to siting, budgetary, and technological limitations, but these deviations are minor and were documented. Tables 1-4 provide updates of the measurement systems deployed.

Air quality sampling locations in the annual network (December 1, 1999, through January 31, 2001) consisted of a combination of “anchor” monitoring sites measuring both gaseous and aerosol species, “satellite” sites measuring aerosol species using portable filter samplers and nephelometers, and a “backbone” network of Air Resources Board (ARB) and air pollution control district sites. Surface and aloft air quality and meteorological measurements were collected daily with a network of surface sites, radar profilers, sodars, and tall towers. “Supplemental” data were obtained from other networks, mostly meteorological, operated by more than a dozen other agencies in the region (Thuillier, 1995, Thuillier et al., 1994). The location and parameters available from supplemental data networks were considered in the study design and are an integral part of the integrated CRPAQS database. Additional measurements were taken as part of the Central California Ozone Study (CCOS, Fujita et al., 1999) during the summer of 2000. Although these data will be examined separately to attain CCOS objectives, they are also part of the CRPAQS database and available to answer the questions described below.

The CRPAQS winter episodic field study took place over a period of eight weeks on a forecast basis from December 1, 2000 through February 3, 2001. Special emphasis was placed on collection of continuous and species-specific particulate measurements to support both receptor and grid-based modeling approaches. Fifteen episode days were selected by forecast for additional monitoring to characterize the evolution of $PM_{2.5}$ episodes.

A fall study was conducted from October 8, 2000 through November 14, 2000 to better understand the effects of nearby emitters on high PM_{10} concentrations in the central portion of the San Joaquin Valley centered on Corcoran. This consisted of a temporary anchor site at the Corcoran backbone monitor plus 25 satellite sites within and surrounding the city. Minivol filter samples with high PM_{10} concentrations were submitted to chemical and microscopic analysis.

A summer study extended monitoring into the Mojave Desert to better understand transport from the San Joaquin Valley to the desert and the contributions to summertime haze in that region. Additional satellite sites were located along transport pathways and an anchor site was established at Edwards Air Force Base (AFB). In addition, twenty-four hour average measurements of particulate organic compounds were taken at the Fresno supersite every sixth day for contrast with wintertime organics monitoring.

With the completion of the field programs and the submission of data to a central data system (O'Brien, 2001, http://www.arb.ca.gov/airways/Datamaintenance/default.asp), work is to commence on Phase 3 data analysis and modeling. This will consist of three components that are related: 1) initial data analysis; 2) annual and episodic emissions, meteorological, and grid-based air quality modeling; and 3) post-modeling data analysis and conceptual model formulation. A Request for Proposals (RFP) was issued for the first component of initial data analysis and the work is already in progress. This RFP is for the second component of annual and episodic emissions, meteorological, and grid-based air quality modeling. Upon the completion of first two components, an RFP will be issued for the third component of post-modeling data analysis and conceptual model formulation.

The goal of this modeling effort is to better understand the fundamental physical and chemical processes that contribute to elevated particulate matter loading in central California. This knowledge will then be used for several different purposes, such as forecasting of episodes, network evaluation and planning, transport assessment, and preparing attainment demonstrations for State Implementations Plans (SIPs). We thus strongly urge the proponents to propose analysis beyond the level required by SIP analysis.

The episodes captured during CRPAQS are listed in Table 5. For the site codes please refer to Tables 2 and 4. The December 18, 2000 through January 8, 2001 episode has already been identified as the first priority for modeling. To include the buildup and the decay of the episode, a few additional days at each end of that episode may be included. There is no current priority for the other episodes; their priority will partly depend on the data analysis tasks now in progress.

2. MANAGEMENT STRUCTURE

The CRPAQS is a large-scale program involving many sponsors and participants. Three entities are involved in the overall management of the Study. The San Joaquin Valleywide Air Pollution Study Agency (JPA), a joint powers agency formed by the nine counties in the Valley, directs the fund-raising and contracting aspects of the Study. A Policy Committee comprised of four voting blocks: State, local, and federal government, and the private sector, provides guidance on the Study objectives and funding levels. The Policy Committee approves all proposal requests, contracts and reports. A Technical Committee parallels the Policy Committee in membership and provides overall technical guidance on proposal requests, direction and progress of work, contract work statements, and reviews of all technical reports produced from the Study.

On a day-to-day basis, the ARB is responsible for management of the Study under the direction of the Program Manager, Chief of the ARB Modeling and Meteorology Branch. The ARB writes and monitors contracts with the participants and is the primary interface between contractors, the Policy and Technical Committees, and the JPA. Members of the Technical Committee will be active participants in the modeling analysis and the review of proposals, reports, and publications.

3. SCOPE OF WORK

GUIDANCE

The CRPAQS modeling activities solicited here intend to answer specific questions that are of interest to scientists and decision-makers. As with all questions related to environmental concerns, the answers may differ by time and location. The answers contain uncertainties owing to limitations in available measurements and basic scientific understanding. While a comprehensive uncertainly analysis would be more appropriate during the third phase of post-modeling data analysis and conceptual model formulation, the proposed modeling activities must address variability and uncertainty and quantify it to the greatest extent possible using the available information. Modeling analysis activities should take cognizance of previous modeling and data analysis results and methods from central California and elsewhere. However, some modeling techniques previously used elsewhere may not be suitable or relevant to the modeling of CRPAQS data. In the evaluation of proposals, preference will be given to those containing state-of-the-science methods. For example, proposals that contain the chemical mechanism of the State-wide Air Pollution Research Center (SAPRC, or any other comparable mechanism) for grid-based photochemical modeling will be preferred over the Carbon Bond IV mechanism. The same is true for photochemical models with recent updates compared to those that have not been updated for several years.

In one form or another, the questions outlined below have guided the design of the CRPAQS 1999-2001 field program, the IMS95 pilot program, and the compilation of a long-term integrated database for central California dating from 1986. Data from all of these programs will be available to modelers. Data analysis, currently in progress, of

the data collected as part of the 1999-2001 field programs is intended to build upon, revise, and expand this previous knowledge. This data analysis will be coordinated with emissions, meteorological, and grid-based air quality modeling efforts to the extent feasible. There are several tasks that may depend on the completion of related data analysis tasks. Work on these tasks may not commence until data analysis is completed in early 2004. Some questions are pertinent to the entire field study period, while others are focused on specific episodic periods. Proponents should discuss which study periods are being addressed and the availability of data to support each proposed modeling analysis.

The entire set of questions to be answered during initial modeling analysis is listed in the following section for completeness, although only those labeled with **RFP** are the subject of this solicitation. The others are being accomplished by in-kind support of the participating agencies or as part of existing contracts. The two major in-kind contributions of the Air Resources Board that will impact this solicitation are in the areas of emissions and meteorological modeling. Appendix A outlines the details of the products of ARB in-kind contributions. Appendix B contains references to previous modeling work that can be reviewed by proponents to prepare their proposals and to conduct their modeling. All participating modelers are expected to make contributions to conceptual models being formulated for $PM_{2.5}$ and PM_{10} in central California (e.g., Pun and Seigneur, 1999; Watson and Chow, 2001).

The CRPAQS modeling effort intends to create a collegial team of knowledgeable scientists that can interact with and complement one another while providing a solid scientific basis for the conclusions in each topic area. This RFP is structured as nine major questions with a grouping of tasks (posed as questions) under each major question. The minimum scope of work needed to answer the questions posed is outlined after the list of tasks. The bidders should propose to expand the scope of work if the minimum scope of work outlined is deemed insufficient to answer the questions fully. While it is encouraged to bid for each major question as a whole, proponents may submit proposals for any combination of activities specified by this RFP. In either case, a clear breakdown of cost for each task must be a part of the bid. Submissions for multiple activities are encouraged when synergies, cost-savings, and leveraging with other projects is demonstrated in the proposal. This is discouraged when the needed expertise is diluted, management overhead is higher, and diversity is compromised. Proposals from individual investigators are preferred to those with many sub-contractors except when the case is made that such arrangements are needed for a specific activity. Independent modeling projects addressing the same task may be awarded when the approaches are sufficiently different and novel. Separate proponents may be asked to collaborate on certain tasks when synergies are useful. Management and coordination of the modeling phase of CRPQS will be provided by members of the Technical Committee and is not the subject of this solicitation.

TASKS

Question 1: WHAT ARE THE AVAILABLE TOOLS FOR PARTICULATE MATTER AND VISIBILITY MODELING AND WHAT ARE THEIR STRENGTHS AND WEAKNESSES? **- In Progress (ARB/UCD)**

Task 1.1: What are the available diagnostic and prognostic meteorological models? Are they adequate/suitable for CRPAQS modeling? If not, what additional research and/or development are needed?

Task 1.2: What are the available emissions models? What is the resolution of emissions data needed to drive these models? What are the current efforts in California and elsewhere to update emissions data? What additional efforts are needed?

Task 1.3: What are the available air quality models? Are they adequate/suitable for our purpose? If not, what additional research and/or development are needed? What is the level of information needed to derive boundary conditions, deposition velocities, actinic flux, etc., to drive these models?

Task 1.4: What are the methods available to model regional visibility? Do current air quality models provide sufficient information (chemistry, particle size, etc.) to support these methods?

Minimum Scope of Work: Conduct a thorough review of the peer-reviewed literature and other documentation available from various PM modeling efforts in the United States and elsewhere. Critically evaluate the information to answer the task questions. Prepare a concise document of findings.

Question 2: TO WHAT EXTENT CAN WE DRIVE AND EVALUATE DIAGNOSTIC/PROGNOSTIC METEOROLOGICAL MODELS USING THE METEOROLOGICAL DATA COLLECTED? DO SIMULATED METEOROLOGY FIELDS REPRESENT REALITY? - **RFP and In Progress (ARB)**

Task 2.1: From a modeling perspective, how adequate and valid are current methods for measuring meteorological variables at the surface and aloft? Did the meteorological methods used provide adequate horizontal and vertical resolution?

Task 2.2: To what extent are the precision, accuracy, bias, consistency, and time-resolution of measured meteorology data sufficient to determine initial and boundary conditions, to perform data assimilation, and to evaluate model performance?

Task 2.3: How well do simulated meteorological fields represent the following phenomena: 1) transport and dispersion under low wind speed/stagnation

conditions; 2) frequency, spatial extent, and intensity of fogs and rain; 4) down-valley and cross-valley flows; 5) up-slope and down-slope flows; 6) mixing-layer depths, vertical distributions of winds, temperature, and relative humidity; 7) marine layer intrusion; 8) large-scale eddies; and 9) wind gusts above suspension thresholds?

Task 2.4: The ability of models to reproduce the above-mentioned large-scale physical features of the meteorological fields was not evaluated rigorously in the past except for limited attempts for summer-time simulations. What techniques are capable of such evaluations and how much development do they require?

Task 2.5: To what extent can simulated meteorological fields provide a qualitative understanding of the "zone of influence" of a source and "zone of representation for monitoring of various pollutants?

Task 2.6: What are the transport pathways (surface and aloft) within and between air basins in central California? When is transport between air basins associated with elevated ground-level PM concentrations? When does transport shut down, and how cohesive is the transport under various meteorological scenarios? What is the role of the nocturnal jet and eddy structures in transport of pollutants? What is the role of advection versus diffusion?

Minimum Scope of Work: At present, the December 18, 2000 to January 8, 2001 episode is the only one identified for modeling; other episodes have not yet been prioritized. Using more than one diagnostic/prognostic/statistical meteorological model, simulate meteorological fields necessary to answer the task questions above. The vertical and horizontal extents of domain(s), grid and temporal resolutions, and the length of the simulation will depend on the task. As a parallel effort, ARB may conduct MM5 simulations with and without data assimilation for selected periods discussed at the end of Section 1 and listed in Table 5. Results and the base information (such as land use, terrain etc.) used to conduct these simulations will be available to contractors. If contractors choose to use ARB results, ARB will work with those contractors to prioritize time periods for meteorological simulations. The prioritizing of time periods will involve data analysis as well. As a general rule, time periods representing the winter will have higher priority than those representing the summer. If a contractor chooses to conduct independent meteorological simulations, the proposed methodology should be significantly different from that used by ARB. We also request that the contractor conduct simulations, to the extent possible, using the same base information used by ARB. This would facilitate inter-comparison of meteorological fields derived using different methods.

Question 3: HOW WELL DO MODELING EMISSION INVENTORIES REPRESENT REALITY? WHAT QUALITY ASSURANCE AND VERIFICATION PROCEDURES ARE NEEDED? - **RFP and In-kind (ARB)**

Task 3.1: To what extent are chemical source profiles and activity data adequate for a speciated emissions inventory? Using the measurements conducted during CRPAQS how do we evaluate and improve existing source profiles and activity data and fill significant gaps if they exist?

Task 3.2: What is the minimum grid size for emissions supported by the current resolution of activity, surrogates, road network, etc.?

Task 3.3: Do different methods of data processing yield significantly different modeling inventories?

Task 3.4: How do we verify emissions estimates from a modeling perspective? What are the complications due to secondary PM formation? How rigorous/appropriate are the methods available for the verification of emissions estimates?

Task 3.5: Some of the compounds that received less attention in ozone modeling emission inventories due to their negligible reactivities (e.g., large organic molecules) may be important in secondary organic particulate matter formation. How do we ensure that compounds important to particulate matter formation are not excluded from the inventory? How sufficient are field measurements for this process?

Task 3.6: To what extent do current emission estimates represent sub-grid scale phenomena such as condensation, deposition, chemical transformation, and phase partitioning (e.g. from sources such as tail-pipe emissions and fugitive dust)? How would emission estimates change as a function of grid size owing to removal, phase change, and chemical change? To what extent and how should sub-grid scale emission phenomena be treated in the inventory and/or in the air quality model?

Task 3.7: To what extent do the reactivity and particle formation propensities of emissions correspond with ambient measurements?

Minimum Scope of Work: The extent of the emissions inventories prepared by ARB is outlined in Appendix A. Evaluate and/or further refine ARB inventories to answer the task questions above. Proposals to regenerate emissions inventories are discouraged.

Question 4: WITH THE PRECISION, ACCURACY, BIAS, CONSISTENCY, AND TIME-RESOLUTION OF AVAILABLE AIR-QUALITY MEASUREMENTS, TO WHAT EXTENT CAN WE DETERMINE INITIAL AND BOUNDARY CONDITIONS? - **RFP**

Task 4.1: How much air-quality model spin-up is needed to minimize the influence of initial conditions? What other methods can minimize the influence of initial

conditions besides spin-up? How does one handle residual initial conditions if they cannot be removed completely?

Task 4.2: How large should the modeling domain be to minimize the influence of boundary conditions? At what size is the domain too large?

Task 4.3: If the modeling domain extends far into the Pacific Ocean, what oceanic background levels can be used as boundary conditions? What boundary condition values are appropriate for non-oceanic boundaries?

Task 4.4: Should the boundary conditions be static or dynamic? If dynamic, to what extent would available measurements support such a choice?

Task 4.5: In lieu of appropriate measurements, how relevant are the effects of alleged trans-boundary effects (such as long-range transport from Asia) during episodic conditions? (e.g., increased values for upper air boundary conditions etc.) Or, are these effects too small (~1 μgm^{-3}) to be considered? What are the findings of the scientific investigations that explored this transport phenomenon?

Minimum Scope of Work: Using available CRPAQS and other routine data, derive appropriate initial and boundary conditions. Use of one or more air quality models may be needed to answer some of the tasks above. Thus, collaboration with the contractor performing work to answer Question 5 may be needed.

Question 5: HOW WELL DO AIR-QUALITY MODELS ESTIMATE MEASURED POLLUTANT CONCENTRATIONS (GASEOUS CONCENTRATIONS, TOTAL MASS OF PM_{10} AND $PM_{2.5}$, AND MASS OF COMPONENTS OF PM ETC.)? - **RFP**

Task 5.1: What are the qualitative and quantitative criteria for model performance, so that the models can be used in a predictive mode for control strategy and transport assessment?

Task 5.2: What are the appropriate spatial and temporal scales for modeling various particle sizes?

Task 5.3: To what extent does the performance of an air quality model depend on the grid size used? If so, what is the optimal grid size?

Task 5.4: To what extent should all air quality models satisfy the same set of performance criteria? Should there be model-specific criteria? (For example, should the models using the modal approach to PM be subjected to the same performance criteria as those using the size segregation approach?)

Task 5.5: During performance analysis, how much emphasis should be placed on the model's ability to predict observed peak values? What other features of the

measured field (e.g., the spatial extent of the episode etc.) should receive equal attention? How do current performance metrics allow for such evaluations and, if they don't, how can we improve them?

Task 5.6: How well do models estimate vertical concentrations of PM and PM precursor species? (There is an issue of comparing a volume average predicted by the model with a point measurement.) Is this acceptable? How does the quality of available measurements to assess vertical variation limit this evaluation?

Task 5.7: To what extent do modeling results indicate the need for more/less frequent measurements and shorter/longer duration? If so, what duration best represents changes in mass and chemical concentrations throughout the day? How should temporal resolution be balanced with spatial resolution?

Task 5.8: How well does the modeled size distribution represent the measured distribution? To what extent does this relationship change by measurement site and season? How accurately can $PM_{2.5}$ concentrations be deduced from modeled PM_{10} concentrations?

Task 5.9: During performance analysis, how much emphasis should be placed on the model's ability to simulate regional visibility? (i.e., How sensitive is the simulated regional visibility to the model's predictions of chemistry and size of PM?)

Task 5.10: To what extent do models simulate the overall observed spatial and temporal trends in concentrations of pollutants? How do disagreements between simulated and observed trends in concentrations provide insight for the conceptual model?

Task 5.11: What are the uncertainties in deposition velocities for all modeled species and how can they be reduced? How well does the current model for deposition, based on an analogy to resistance in electrical circuits (Wesely and Hicks, 2000), represent reality, especially in light of recent challenges to it (Venkatramn and Pleim, 1999)?

Task 5.12: What are the other uncertainties associated with the model predictions and what are their magnitudes? To what extent can we minimize these uncertainties? How do we account for residual uncertainties in formulating model performance criteria?

Task 5.13: What is the minimum set of air quality measurements (location, species, duration) needed to provide sufficient data for model application and model performance evaluation?

Minimum Scope of Work: Exercise one or more air quality models to answer the above questions. The vertical and horizontal extents of domain(s), grid and temporal resolutions, and the length of the simulation will depend on the task. Extract from the CRPAQS database and format air quality data for model performance analysis. Conduct model performance analysis for one or more base cases. Use the available guidance for model performance evaluation as appropriate (Seigneur, 1999; U.S. EPA 1999; Roth 1999). Refine this guidance or develop additional guidance as needed. When applying more than one air quality model to a given episode, use the same base inputs to the extent possible. This would facilitate the inter-comparison of results obtained with different air quality models. While the ultimate use of these results will be in the development of attainment demonstrations for SIPs, the focus of this exercise is to understand, in detail, the limitations of air quality models and ways to improve them. Thus, scrutiny of results beyond the level required by SIP applications is strongly encouraged.

QUESTION 6: HOW DO WE CONDUCT DIAGNOSTIC/MECHANISTIC EVALUATIONS OF PARTICULATE MATTER AIR-QUALITY MODELS? - **RFP**

Task 6.1: To what extent would the stress-testing methods developed for ozone models be applicable for particulate-matter models? What additional stress-testing methods are needed?

Task 6.2: What are the various process analysis techniques available and which of those should be installed in particulate-matter air quality models? Which techniques would facilitate quantification of interbasin transport and how should they be used to do so?

Task 6.3: How can we ensure that models are performing adequately for correct reasons?

Task 6.4: How can one assign realistic uncertainty values to model estimates?

Minimum Scope of Work: Obtain one or more complete base-case runs produced to answer Question 5 and perform additional simulations to answer the tasks above. This may also require installation of available process analysis and other diagnostic techniques in certain air quality models or development of novel diagnostic approaches.

Question 7: HOW DO WE USE AIR-QUALITY MODELS TO PROPOSE AND/OR EVALUATE EMISSION CONTROL STRATEGIES? - **RFP and In-kind (ARB)**

Task 7.1: To what extent are the ozone-based methods to propose/evaluate control strategies valid for particulate/ozone multi-pollutant control strategies? What methods might be more efficient for PM?

Task 7.2: What are the limiting precursors for components of secondary particulate matter and how do we quantify their effects on PM concentrations? To what extent are these precursors the same limiting precursors for ozone? If not, how do we reconcile the differences in terms of emission reduction strategies?

Task 7.3: What is the zone of influence of a source with respect to PM? How does this vary by source characteristics such as chemical constituent and particle size? What are the temporal and spatial variations in the zone of influence? How does the finding of this task compare with receptor data analysis?

Task 7.4: To what extent can "particle forming potentials" (or "reactivities") be assigned to various precursors? How do these reactivities vary by time, location, and presence/absence of other pollutants? How can we generate a reactivity-based inventory for control strategy purposes?

Minimum Scope of Work: Obtain one or more complete base-case runs produced to answer Question 5 and perform additional sensitivity simulations to answer the tasks above.

Question 8: HOW DO WE MODEL LONG-TERM (SEASONAL, ANNUAL) AVERAGES? - **RFP**

Task 8.1: What are the methods currently used for modeling long-term averages? How can we improve them?

Task 8.2: What are the input data needs? Can we extend the length of a modeling period (that includes one or more episodes) using data from long-term measurement networks? What should be the nature of such long-tem networks?

Task 8.3: How can long-term modeling results provide guidance for control strategy development and be reconciled with episodic modeling in regulatory applications?

Task 8.4: What are the computational needs for long-term modeling? To what extent can we make computer codes more efficient? What are the possible simplifying assumptions to models needed to conduct long-term modeling?

Minimum Scope of Work: Prepare a critical review of long-term PM modeling to date. Obtain one or more complete base-case runs produced to answer Question 5 and extend beyond intensive operational periods into periods with routine measurements. Evaluate model performance for extended days. Critically review computational paradigms suitable for long-term modeling with a cost-benefit

analysis. This may also include adaptation of codes to run on various massively parallel computer platforms.

Question 9: TO WHAT EXTENT DO WE UTILIZE THE U.S. EPA'S MODELING GUIDANCE FOR PM AND REGIONAL HAZE? - **RFP**

Task 9.1: Where and when might improvements in visibility occur in Class I areas and the Mojave Desert owing to attainment of $PM_{2.5}$ national ambient air quality standards?

Task 9.2: Recognizing that California's air pollution problem is different from those of the Eastern United States and other western states, what aspects of the U.S. EPA's Draft Modeling Guidance for PM and Regional Haze are consistent with the results of the technical analysis outlined in this RFP? What are the suggested revisions to the modeling guidance that are not consistent with the technical analysis?

Minimum Scope of Work: Using all the information available from the various tasks of this solicitation, critically evaluate the US-EPA's Modeling Guidance for PM and Regional Haze.

4. SCHEDULE

Modeling contractors will be expected to meet the following milestones. Three meetings with project participants will be held, one at the initiation of the contract to discuss workplans and use of the CRPAQS database, one at the midpoint to discuss preliminary findings and pursue interactions with other work elements, and one at the end of the contract to share results and provide input into the development of the conceptual models. In addition, contractors should plan on preparing at least one peer reviewed paper and participating in one conference to present results. Shown below is an approximate time line for the various stages of this contract. Contractors can assume that comments on draft documents will be received within 45-days following submittal.

• Release of the RFP	July 2003
• Submission of bids	6 weeks after release
• Contract Initiation	3 months after release
• Submit draft workplan	4 months after release
• First Modeling Workshop (Preferably in conjunction with a Data Analysis Workshop)	4½ months after release

- Submit revised workplan — 5 months after release
- Second modeling workshop — 12 months after release
- Submit draft final report — 21 months after release
- Final Modeling workshop — 22 months after release
- Submit final report — 24 months after release
- Present findings and peer-reviewed papers — 24 months after release

5. BUDGET

A budget maximum of $750,000 has been established for the combined set of tasks contained in the scope of work presented in this RFP. Costs will be a factor in evaluating proposals. While proponents should be mindful of this, they should also endeavor to avoid underestimating costs. A clear breakdown of cost per each task must be included in the bid. In-kind and co-funding sources should be specified and will be made part of a final agreement. A careful review of the credibility of estimated costs will be conducted before an award decision is made.

6. ADMINISTRATION

The groups selected to conduct this work will report to the ARB Program Manager. The period of performance of this contract will be about 24 months with work expected to commence in approximately November of 2003. Contract performance is not to begin until a contract is fully approved by the San Joaquin Valleywide Air Pollution Study Agency.

7. CONTRACT REQUIREMENTS

A. Reporting and Other Requirements

The contractor shall deliver a draft workplan, typically based on the submitted proposal, and respond to recommended revisions.

The contractor will attend three one-day meetings at the beginning, the midpoint, and near the end of the project (assume meetings in Sacramento, California).

The contractor shall deliver at minimum quarterly written progress reports to the ARB Program Manager. Payment to the contractor will not be made until receipt of the associated progress report.

The contractor shall deliver to the ARB Program Manager a periodic invoice. With respect to the payment period completed, the invoice shall set forth in detail by task, in accordance with the contract budget, charges for time expended on the project,

including classification of personnel involved in such time expenditure, and the monthly, weekly, or hourly rates for such personnel, as appropriate. The invoice shall also contain an itemization of all materials used for the project, including the purpose of its use and its cost. All work billed for in an invoice must be covered in an associated progress report. Therefore, if invoicing is done more frequently than quarterly, progress reports coincident with the payment period must also be provided.

The contractor shall deliver a draft final report, with one hard copy, one electronic copy in Adobe Acrobat (PDF), and one in Microsoft Word (DOC). The contractor will receive comments on this report within 45 days of submission, with revisions in the final report due within 45 days after receipt of review comments (also with 10 hardcopies, PDF, and DOC versions).

The contractor shall present results at a national conference and prepare and submit to an appropriate peer-reviewed journal at least one technical article outlining the methods and findings for each modeling task. Contractors preparing these papers should commit to making appropriate contacts with CRPAQS measurement and data analysis investigators to discuss co-authorship and acknowledgements prior to publication.

B. Correspondence

All technical correspondence regarding this contract should be sent to the Program Manager at the address listed below:

Mr. John DaMassa, Chief
Modeling & Meteorology Branch
Planning and Technical Support Division
California Air Resources Board
Program Manager
California Regional PM10/PM2.5 Air Quality Study
1001 “I” Street
Sacramento, California 95814

C. Contract Language

A copy of the contract language is presented in Appendix C. Any proposed revisions to the contract language **must** be included as part of the proposal. Questions regarding the contract should be directed to the JPA attorney at the address provided below:

Mr. Philip Jay
San Joaquin Valleywide Air Pollution Study Agency Counsel
San Joaquin Valley Unified Air Pollution Control District
1990 East Gettysburg Avenue
Fresno, California 93727
(559) 230-6033

8. PROPOSAL PREPARATION AND EVALUATION GUIDELINES

A. Proposal Contents

Proposals should convey a maximum of technical content related to the relevant task with a minimum of extraneous material. Proposals should convey a high degree of technical understanding and innovation while demonstrating the ability to present complex scientific results to technically qualified decision-makers. Vague references to "standardized", "EPA", "ARB", or other unexplained and non-documented methods will be considered unresponsive and rejected.

The proposal should be clear and concise (typically not more than 30 pages maximum for each question, and preferably exclusive of resumes and proponent facilities/experience, which should also be minimal and can be incorporated by reference to a corporate web site). The proposal should address the following issues:

1. The technical approach for answering each question/task. The technical approach should build upon, verify or challenge, and add to existing knowledge. The technical approach should include re-formulation or better articulation of the tasks, a brief summary of current knowledge on the topic from central California and elsewhere (where relevant), available methods to answer the questions and a rationale for selecting the proposed method(s), a description of the analysis approach and the data to be used, methods to verify the generality of the results, methods to qualify the conclusions, and a brief outline for the final report and publication.

2. Staffing, management oversight, and data management. Proponents may assume that desired subsets of measurements may be obtained from the CRPAQS data system in common formats (e.g., comma delimited, Excel). The necessity for specialized formats and arrangements should be specified in the proposal. Extensive management oversight is not solicited or encouraged, as it is expected that each task will require substantial commitment and participation of an experienced specialist in the area with appropriate delegation to support personnel.

3. A brief statement of qualifications for the proposed participants and a description of the duties they will perform, including a specific discussion of relatively recent project experience. Greater detail may be incorporated by reference to a corporate website (preferred) or as a standard package. Extensive corporate experience is not as important as the qualifications of the principals who will be dedicated to the proposed task.

4. The estimated budget for each question (or task(s) if bidding upon a subset of task(s) within a question) should be summarized on the cost reporting form shown in Table 6. This cost summary form should be supplemented with appended documentation detailing:

a. Commitments and hourly rates for personnel.

b. Types and costs for travel, equipment or supplies procured as part of the project.

c. One-time costs that apply to all questions/tasks, but that are only listed in one (identify the costs and the tasks in which they are included or excluded).

d. Expected cost increases such as annual salary adjustments should also be specified. It is anticipated that this contract will be awarded on a time and materials basis with a maximum (not to exceed) value.

5. The management approach for dealing with routine operations, unexpected problems, and changes in work scope.

4. A project schedule, describing the start and end dates for each task, and the completion date for each deliverable specified in the scope of work.

B. Guidelines and Criteria for Proposal Evaluation

The contractor should demonstrate knowledge of aerosol data as it relates to analysis of monitoring methods, spatial and temporal variability, atmospheric formation, emissions, dispersion, transport and deposition. The contractor should also have relatively recent project experience in conducting modeling activities. The following specific criteria will be used to evaluate the proposals:

1. Technical approach for modeling, project management, data management and reporting. (30 points)

2. The experience, competence, capability, and commitment of the proposed personnel to be assigned to the project. (30 points)

3. The proponent's technical performance on similar, past projects and the extent to which the participant can draw directly on past experience in meeting the requirements of the RFP. (25 points)

4. The overall proposed cost of the work as well as cost-effectiveness, and the proponent's willingness to enter into a contractual agreement that minimizes the risk of cost overrun. (15 points)

C. Conflict of Interest Requirements

Government Code Section 1090 generally prohibits a public official from being financially interested in a contract which he or she has made or participated in an official capacity. Under certain circumstances, persons who perform work pursuant to a

contract with a government agency may be subject to the restrictions of Government Code Section 1090.

With respect to CRPAQS, this means that based on participation in the planning of the Study, certain consultants are precluded from participating in all or some of the post-planning contracts. This preclusion would apply to these consultants as either a prime contractor or a subcontractor. In most cases, whether a particular consultant is eligible to bid will depend on an analysis of all of the circumstances surrounding the consultant's earlier participation in CRPAQS and the work that the consultant now proposes to perform.

Any response to this RFP which includes a paid participant who is ineligible based on Government Code Section 1090 will be rejected during the format review of the proposals.

Questions concerning the eligibility of a potential bidder must be directed to the JPA attorney at the address provided below prior to the preparation of a proposal:

Mr. Philip Jay
San Joaquin Valleywide Air Pollution Study Agency Counsel
San Joaquin Valley Unified Air Pollution Control District
1990 East Gettysburg Avenue
Fresno, California 93727
(559) 230-6033

D. Submittal Requirements

An original and ten (10) hardcopies of your proposal and an electronic PDF file of the proposal shall be sent with a cover letter to the ARB Program Manager, Mr. John DaMassa, at the address listed in the Contract Requirements section. Hand carried or express mail packages may be delivered to Mr. John DaMassa at the California Air Resources Board, 1001 “I” Street, Sacramento, California 95814. Proposals must be received no later than the date and time shown in the attached cover letter.

Table 1
CRPAQS Anchor Site Measurement Methods

Code	Observable and Method	Frequency	Avg Time
A	Light scattering/PM2.5 mass (Radiance nephelometer)	Annual daily Winter 15 Ep days	5-min
D	PM2.5 Organic compounds (Minivol-Teflon coated glass fiber & GC/MS)	Annual 6th day Winter 15 Ep days	24-hr
G	Light absorption/elemental carbon (aethalometer). Single and seven-wavelength units used at different sites.	Annual daily	5-min
H	PM2.5 organic and elemental carbon (R&P 5400)	Annual daily	1-hr
I	Particle size distribution (TSI SMPS, LASAIR OPC, Climet OPC)	Annual daily	~5-min
J	PM10 mass (BAM)	Annual daily	1-hr
K	PM2.5 mass (BAM)	Annual daily	1-hr
L	PM2.5 mass and elements (sequential sampler with Teflon filter)	Annual daily Winter 15 Ep days	24-hr 3-8-hr
M	PM2.5 ions and carbon (sequential sampler with denuder –quartz--NaCl cellulose)	Annual daily Winter 15 Ep days	24-hr 3-8-hr
N	NO2 & PAN (UCR Luminol)	Summer & Winter daily	5-min
O	NOy (TEI 42 with external converter)	Annual daily	5-min
P	O3 (ultraviolet absorption monitor)	Annual daily	5-min
Q	PM2.5 nitrate (R&P 8400N flash volatilization)	Winter daily	10-min
R	Nitric acid (TEI 42 with paired external converters) (Filter denuder difference)	Annual daily Winter 15 Ep days	5-min 3-8 hr
S	Ammonia (Filter denuder difference)	Winter 15 Ep days	3-8 hr
T	PM2.5 sulfate (intended but only partially implemented during field program)	Winter	5-min
U	Light hydrocarbons (canister & GC/FID)	Winter 15 Ep days	5 to 8-hr
V	Heavy hydrocarbons (TENAX & GC/TSD/FID)	Winter 15 Ep days	5 to 8-hr
W	PM2.5 organic compounds (Teflon coated glass fiber/PUF/XAD & GCMS)	Winter 15 Ep days	5 to 8-hr
X	Aldehydes (DNPH & HPLC)	Winter 15 Ep days	5 to 8-hr
Y	SO2 (TEI 43c pulsed fluorescence)	Annual daily	5-min
Z	Hydrogen peroxide (peroxydaze enzyme)	Winter 15 Ep day	30-min
b	Elemental & mass size distribution (MOUDI with Teflon & XRF & Gravimetric analysis	Winter 15 Ep days Every third period	6-hr
c	Ion size distribution (MOUDI with Teflon & IC, AC)	Winter 15 Ep days Every third period	6-hr
d	Carbon size distribution (MOUDI with aluminum & TOR)	Winter 15 Ep days Every third period	6-hr
e	Aerosol Time of Flight Mass Spectrometer	Winter	5-min

Table 2
CRPAQS Anchor Site Air Quality Measurements

Site ID	Name	Annual (12/1/1999-1/31/2001)	Winter Additions (days during 12/1/2000-2/3/2001, 15 Episode Days)
ANGI	Angiola-ground level	ADGHIJKLMNOP	QRSTUVWXZe (bcd 15 Ep Days)
ANGI4	Angiola tower-50 m agl	AI(Climet OPC)	
ANGIT	Angiola tower-100 m agl	AI(CLIMET OPC)	GOPQ
BODG	Bodega Bay	ABCU	G (BCUbcd 15 Ep Days)
BAC	Bakersfield-5558 California Street	ADGHJKLMNOP	QRTY (bcd 15 Ep Days)
BTI	Bethel Island	ABCD	GHIJKLMNOPQRSUVWX
COP	Corcoran Patterson	BCD gh (6^{th} day lag)	GJKQgh (fall only) ABCD (15 Ep Days)
EDW	Edwards Air Force Base	ABCD	GJK (summer only) (BCD 15 Ep Days)
FSF	Fresno-3425 First Street	ADGHIJKLMNOP	QRSTUVWXe (bcd 15 Ep Days)
M14	Modesto-14^{th} Street	BCDgh (6^{th} day lag)	AGQRS (BCDbcd 15 Ep Days)
SDP	Sacramento-Del Paso Manor	ADG	JKQR (bcd 15 Ep Days)
SJ4	San Jose-4th Street	ADG	JKQRS
SNFH	Sierra Nevada Foothills	ABCD	AGHJKLMNOPQRSUVWX
WAG	Walnut Grove-ground level	A	AGOQ
WAGT	Walnut Grove tower-300 m agl	none	AGOQ

Table 3
CRPAQS Satellite Site Measurement Methods

Code	Observable and Method	Avg Time
A	Light scattering/PM2.5 mass (portable nephelometer)	5-min
B	PM2.5 mass, elements, ammonia (Minivol with Teflon/citric acid & Grav, XRF, AC)	24-hr
C	PM2.5 ions, carbon, nitric acid (Minivol with –quartz-NaCl & IC, AC, AA & TOR)	24-hr
D	PM2.5 Organic compounds (Minivol-Teflon coated glass fiber & GC/MS)	24-hr
U	Light hydrocarbons (canister & GC/FID)	24 hr
g	PM10 mass, elements, ammonia (Minivol with Teflon/citric acid & Grav, XRF, AC)	24-hr
h	PM10 ions, carbon, nitric acid (Minivol with –quartz-NaCl & IC, AC, AA & TOR)	24-hr

Table 4
CRPAQS Satellite Sites Measurements and Purposes

Site ID	Name	Purpose	Annual Measurements (12/1/1999-1/31/2001)	Supplemental Winter Measurements (15 Episode Days during 12/1/2000-2/3/2001)
ACP	Angles Camp	Intrabasin Gradient	Sat-BC	Sat-ABC on 15 Ep Days
ALT1	Altamont Pass	Interbasin Transport	Sat-ABK	Sat-B on 15 Ep Days
BARS	Barstow	Visibility	Sat-A	
BEL	Bell Street	Fall Western Boundary	Sat-A (fall only)	
BGS	Bakersfield-1120 Golden State	Community Exposure	Sat-gh (6^{th} day lag)	
BQUC	Bouquet Canyon	Interbasin Transport Visibility	Sat-A (summer only)	
BRES	Residential area near BAC	Source-woodburning	Sat-BC	Sat-A (BC on 15 Ep Days)
CAJP	Cajon Pass	Interbasin Transport Visibility	Sat-A (summer only)	
CANL	Canal	Fall Sub-Regional Gradient	Sat-A (fall only)	
CANT	Cantil	Intrabasin Gradient Visibility	Sat-A (summer only)	
CARP	Carrizo Plain	Intrabasin Gradient Visibility	Sat-AB	Sat-B on 15 Ep Days
CHL	China Lake	Visibility	Sat-ABCD	Sat-BCD on 15 Ep Days
CLO	Clovis	Community Exposure	Sat-BC	Sat-A (BC on 15 Ep Days)
CO5	Corcoran Railroad Shoulder	Fall Source – Railroad/ Unpaved Shoulder	Sat-Agh (fall only)	
COPE	Corcoran Patterson East	Fall Neighborhood Zone of Representation	Sat-A (fall only)	
COPN	Corcoran Patterson North	Fall Neighborhood Zone of Representation	Sat-A (fall only)	
COPS	Corcoran Patterson South	Fall Neighborhood Zone of Representation	Sat-A (fall only)	
COPW	Corcoran Patterson West	Fall Neighborhood Zone of Representation	Sat-A (fall only)	
COV	Corcoran Van Dorsten	Fall Neighborhood Zone of Representation	Sat-A (fall only)	

Table 4 Continued
CRPAQS Satellite Sites Measurements and Purposes

Site ID	Name	Purpose	Annual Measurements (12/1/1999-1/31/2001)	Supplemental Winter Measurements (15 Episode Days during 12/1/2000-2/3/2001)
DAIP	Dairy Road - Paved	Fall Source - Paved Road	Sat-Agh (fall only)	
DAIU	Dairy Road - Unpaved	Fall Source- Unpaved Road	Sat-Agh (fall only)	
DUB1	Dublin	Intrabasin Gradient	Sat-A	
EDI	Edison	Intrabasin Gradient	Sat-B	Sat-A (B on 15 Ep Days)
FEDL	Dairy	Source- Animals	Sat-ABCD	Sat-BCD on 15 Ep Days
FEL	Fellows	Source- Oilfields	Sat-ABCD	Sat-BCD on 15 Ep Days
FELF	Foothills above Fellows	Intrabasin Gradient	Sat-ABC	Sat-BC on 15 Ep Days
FREM	Fresno Motor Vehicle	Source - Motor Vehicle	Sat-ABC	Sat-BC on 15 Ep Days
FRES	Residential area near FSF	Source - Woodburning	Sat-ABCD	Sat-BCD on 15 Ep Days
FSD	Fresno Drummond	Community Exposure	Sat-gh (6^{th} day lag)	
GRA	Grain Elevator	Fall Source -Grain Elevators	Sat-Agh (fall only)	
GRAE	Grain Elevator East	Fall Source Zone of Influence	Sat-A (fall only)	
GRAN	Grain Elevator North	Fall Source Zone of Influence	Sat-A (fall only)	
GRAS	Grain Elevator South	Fall Source Zone of Influence	Sat-Agh (fall only)	
GRAW	Grain Elevator West	Fall Source Zone of Influence	Sat-A (fall only)	
H43	Highway 43	Fall Southern Boundary	Sat-Agh (fall only)	
HAN	Hanford-Irwin Street	Community Exposure and Fall Northern Boundary	Sat-gh (6^{th} day lag) Sat-Agh (fall only)	
HELM	Helm-Central Fresno County	Intrabasin Gradient	Sat-BCD	Sat-A (BCD on 15 Ep Days)
KCW	Kettleman City	Intrabasin Gradient	Sat-B	Sat-A (B on 15 Ep Days)
KRV	Sierra Nevada Foothills-Kings River Valley	Interbasin Transport	Sat-A	
LATN	Laton	Fall Sub-Regional Gradient	Sat-A (fall only)	
LVF1	Livermore Rincon Street	Interbasin Transport	Sat-BCD	Sat-A (BCD on 15 Ep Days)
MOP	Mojave Poole Street	Community Exposure	Sat-BC	Sat-A (BC on 15 Ep Days)
MRM	Merced Midtown	Community Exposure	Sat-BC	Sat-A (BC on 15 Ep Days)

Table 4 Continued
CRPAQS Satellite Sites Measurements and Purposes

Site ID	Name	Purpose	Annual Measurements (12/1/1999-1/31/2001)	Supplemental Winter Measurements (15 Episode Days during 12/1/2000-2/3/2001)
NIL	Niles Street	Fall Corcoran Northern Boundary	Sat-A (fall only)	
OLD	Oildale-Manor	Community Exposure	Sat-BC gh (6th day lag)	Sat-A (BC on 15 Ep Days)
OLW	Olancha	Background	Sat-ABCDU	Sat-BCDU on 15 Ep Days
ORE	Oregon Avenue	Fall Neighborhood Exposure	Sat-Agh (fall only)	
OTT	Ottowa Avenue	Fall Source Zone of Influence	Sat-A (fall only)	
PAC1	Pacheco Pass	Interbasin Transport	Sat-AB	Sat-B on 15 Ep Days
PATT	Patterson Pass	Intrabasin Gradient	Sat-A	
PIXL	Kern Wildlife	Rural, Intrabasin Gradient	Sat-ABCD	Sat-BCD on 15 Ep Days
PLE	Pleasant Grove (north of Sacramento)	Intrabasin Gradient	Sat-BC	Sat-A (BC on 15 Ep Days)
S13	Sacramento-1309 T Street	Community Exposure	Sat-BCD	Sat-BCD on 15 Ep Days
SELM	Selma	Community Exposure	Sat-ABC	Sat-BC on 15 Ep Days
SFA	San Francisco-Arkansas Street	Community Exposure	Sat-BC	Sat-A (BC on 15 Ep Days)
SFE	Santa Fe Street	Fall Source - Cotton Handling	Sat-Agh (fall only)	
SHE	Sherman Street	Fall Neighborhood Gradient	Sat-A (fall only)	
SLDC	Soledad Canyon	Interbasin Transport Visibility	Sat-A (summer only)	
SOH	Stockton Hazelton	Intrabasin Gradient	Sat-BC	Sat-A (BC on 15 Ep Days)
SPE	Spear Avenue	Fall Neighborhood Gradient	Sat-A (fall only)	
SWC	SW Chowchilla	Interbasin Transport	Sat-BC	Sat-A (BC on 15 Ep Days)
TEH2	Tehachapi Pass	Interbasin Transport Visibility	Sat-AB	Sat-B on 15 Ep Days
TEJ	Tejon Pass	Interbasin Transport Visibility	Sat-A	
VCS	Visalia-North Church Street	Community Exposure	Sat-BC gh (6th day lag)	Sat-A (BC on 15 Ep Days)
WLKP	Walker Pass	Interbasin Gradient Visibility	Sat-A (summer only)	

Table 4 Continued
CRPAQS Satellite Sites Measurements and Purposes

Site ID	Name	Purpose	Annual Measurements (12/1/1999-1/31/2001)	Supplemental Winter Measurements (15 Episode Days during 12/1/2000-2/3/2001)
YOD	Yoder Street	Fall Northern Edge of Source Area	Sat-Agh (fall only)	
YOT	Yosemite NP-Turtleback Dome	Background	Sat-DU	Sat-DU on 15 Ep Days

Table 5
Summary of the Strength and Duration of CRPAQS PM Episodes

Episode Dates	Peak Concentration (ug/m3)		SJV Days Above 24-hr NAAQS		Peak Site	
	PM10	PM2.5	PM10	PM2.5	PM10	PM2.5
12/1/99 – 12/8/99	90	73	0	1	COP	FSF
12/10/99 – 12/13/99	134	63	0	0	BGS	FSF
12/14/99 – 1/2/00	174	129	2	18	COP	FSF
1/2/00 – 1/12/00	147	138	0	6	VCS	FSF
11/15/00 – 11/29/00	145	112	0	8	BGS	CLO
11/30/00 – 12/13/00	127	99	0	7	VCS	FSF
12/18/00 – 1/8/01	208	179	3	15	BGS	EDI
1/12/01 – 1/24/01	127	120	0	7	BAC	BGS
1/26/01 – 2/7/01	101	110	0	4	BGS	FSF

TABLE 6
PROPOSAL BUDGET SUMMARY

DIRECT COSTS:

1. Labor & Employee Fringe Benefits (provide detailed breakdown by task and employee on separate sheet [including subcontractors]) $_____

2. Equipment (provide detailed breakdown on separate sheet) $_____

3. Travel & Subsistence
   $_____

4. Electronic Data Processing $_____

5. Photocopying/Printing/Mail/Telephone/FAX $_____

6. Materials and Supplies $_____

7. Miscellaneous (please specify) $_____

TOTAL DIRECT COST: **$**_____

INDIRECT COSTS:

8. Overhead (specify rate) $_____

9. General & Administrative Expenses (specify rate) $_____

10. Other Indirect Costs (please specify) $_____

11. Fee or Profit (specify rate) $_____

TOTAL INDIRECT COST: **$**_____

TOTAL DIRECT AND INDIRECT COST: **$**_____

APPENDIX A

Emissions Modeling

In order to provide inputs to air quality modeling, it is necessary to develop temporally and spatially resolved emissions estimates. Emissions are broadly categorized into major stationary or point sources, area sources (which include off-road mobile sources), on-road mobile sources, and biogenics. In the following sections, we will describe how the emissions data are estimated and how they will be used to develop base case and future year emissions estimates.

A. Background

California's emission inventory is an estimate of the amounts and types of pollutants emitted from thousands of industrial facilities, millions of motor vehicles, and of hundreds of millions of applications of other products such as paint and consumer products. The development and maintenance of the inventory is a multi-agency effort involving the ARB, 35 local air pollution control and air quality management districts (districts), metropolitan planning organizations (MPOs), councils of governments (COGs), and the California Department of Transportation (Caltrans). The ARB staff is responsible for the compilation of the final, statewide emission inventory, and maintains this information in a complex electronic database. Each emission inventory reflects the best information available at the time.

To produce regulatory, county-wide emissions estimates, the basic principle for estimating emissions is to multiply an estimated, per-unit emission factor by an estimate of typical usage or activity. For example, estimated emission factors for a specific vehicle type and model year are based on dynamometer tests of a small sample of that vehicle type and applied to all applicable vehicles. The usage of those vehicles is based on an estimate of such activities as a typical driving pattern, number of vehicle starts, typical miles driven, and ambient temperature. It is assumed that all vehicles of this type in each region of the state are driven under the similar conditions.

Developing emission estimates for stationary sources involves the use of per unit emission factors and activity levels. Under ideal conditions, facility-specific emission factors are determined from emission tests for a particular process at a facility. More commonly, a generic emission factor is developed by averaging the results of emission tests from similar processes at several different facilities. This generic factor is then used to estimate emissions from similar types of processes when a facility-specific emission factor is not available. Activity levels from point sources are measured in such terms as the amount of product produced, solvent used, or fuel used.

As mentioned previously, ARB maintains an electronic database that stores emissions and other useful information. Annual average emissions are stored for each county, air basin and district. The database is called the California Emission Inventory Development and Reporting System (CEIDARS). Emissions are stored in CEIDARS for criteria and toxic pollutants. The criteria pollutants are total organic gases (TOG), carbon monoxide (CO), oxides of nitrogen (NOx), oxides of sulfur (SOx), and total particulate matter (PM). Reactive organic gases (ROG) and particulate matter 10 microns in diameter and smaller (PM_{10}) are calculated from TOG and PM, respectively. More information on emission inventories can be found at http://www.arb.ca.gov/emisinv/eib.htm.

B. Point and Area Sources

B.1 Base Year Emissions

First, let us define the terms "point sources" and "area sources". By tradition, these terms have two different meanings to the developers of emissions inventories and the developers of modeling inventories. The following table shows the difference in the terms. In the context of this document, "point sources" refers to emission sources that exit from a stack and have a potential plume rise. "Area sources" refers collectively to area-wide sources, stationary-aggregated sources and other mobile sources.

Emission Inventory Term	Examples	Modeling Term
On-Road Mobile	Automobiles	MV
Off-Road Mobile	Farm Equipment, Construction Equipment, Aircraft, Trains	Area
Area-wide	Consumer Products, Architectural Coatings, Pesticides	Area
Stationary - Aggregated	Industrial Fuel Use	Area
Stationary – Point Facilities	Stacks at Individual Facilities	Point
Biogenic	Trees	Biogenic

The stationary source component is comprised of more than 11,000 individual facilities, called "point sources" and over 100 categories of "aggregated point sources". Aggregated point sources are many small point sources that are grouped together and reported as a single source category (gas stations, dry cleaners, and print shops are some examples). These emission estimates are based mostly on area source methodologies or models. Thus, the aggregated point sources include emissions data for the entire category of point sources, not each specific facility. Some districts include only the larger stationary sources in

the inventory as point sources and include the smaller sources as aggregated point sources, whereas other districts include all stationary sources as point sources.

The area-wide source component includes emissions data only at the aggregated level. Examples of the categories are emissions from consumer products, pesticide applications, and wind-blown dust from agricultural lands. There are about several hundred categories of area-wide sources. The emissions for these categories, which are associated with human activity, are located mostly within major population centers. Some of the emissions in these categories come from agricultural centers and from oil production complexes.

The off-road mobile sources are an estimate of the population, activity, and emissions estimate of the varied types of off-road equipment. The major categories of engines and vehicles include agricultural, construction, lawn and garden and off-road recreation, and includes equipment from hedge trimmers to cranes. The OFF-ROAD model estimates the relative contribution of gasoline, diesel, compressed natural gas, and liquefied petroleum gas powered vehicles to the overall emissions inventory of the state. For more information, see http://www.arb.ca.gov/msei/off-road/off-road.htm

Local air districts estimate emissions from point sources. Estimating emissions from area sources is a cooperative effort between ARB and air district staffs. The emission inventory for CRPAQS will be developed from the 1999 CEIDARS inventory for TOG, NOx, SOX, CO and PM.

B.2 Forecasted Emissions

Air pollution programs have always depended on predictive models for gaining a better understanding of what the emissions will be in the future-- these predictions are based on expectations of future economic conditions, population growth, and emission controls.

ARB's model to forecast emissions is known as the California Emission Forecasting System (CEFS). A major feature in the model is its ability to track the effects of emission control rules and growth activity for stationary and other mobile sources by linking these factors directly to the emission categories. A key component of the new model is the Rule Tracking Subsystem (RTS), which was developed to link emission control rules to the emission process level (identified by Source Classification Code (SCC) and Standard Industrial Classification (SIC) or Emission Inventory Code (EIC)--which comprises more than 30,000 possible emission process/industry categories statewide).

Reports of forecasted emissions are available on-line. The reports can be generated for a variety of years, pollutant, source type, season and geographical

area. The forecasted reports can be accessed at: http://www.arb.ca.gov/emisinv/emsmain/reportform.htm.

B.2.a Growth Factors

Growth factors are derived from county-specific economic activity profiles, population forecasts, and other socio/demographic activity. These data are obtained from a number of sources: data from districts and local COGs are used when they are available; economic activity studies contracted by the ARB; and demographic data (e.g. population survey data from DOF, and VMT data from CALTRANS). Growth profiles are typically associated with the type of industry and secondarily to the type of emission process. For point sources, economic output profiles by industrial sector are linked to the emission sources via SIC. For area-wide and aggregated point sources, other growth parameters such as population, dwelling units and fuel usage may be used.

B.2.b Control Factors

Control factors are derived from adopted State and federal regulations and local district rules which impose emission reductions or a technological change on a particular emission process. These data are provided by the agencies responsible for overseeing the regulatory action for the particular emission categories affected. For example, the ARB staff develops the control factors for sectors regulated by the ARB, such as consumer products and clean fuels; districts develop control factors for locally enforceable stationary source regulations that affect emissions from such equipment as IC engines or power plant boilers; the Department of Pesticide Regulation (DPR) supplies control data for pesticides. In general, control factors account for three variables: *Control Efficiency* which estimates the technological efficiency capable of the abatement strategy; *Rule Effectiveness* which estimates the “real-world” application of the strategy taking into account factors such as operational variations, and upsets; and *Rule Penetration* which estimates the degree a control strategy will penetrate a certain regulated sector taking into account such things as equipment exemptions. Control factors are closely linked to the type of emission process and secondarily to the type of industry. Control levels are assigned to emission categories, which are targeted by the rules via emission inventory codes (SCC/SIC, EIC etc.) that are used in CEIDARS.

B.3 Day-specific Emissions

Day-specific emissions were estimated for selected facilities and area source categories. Day-specific emissions replace emissions estimated from CEFS.

B.4 Temporally and Spatially Resolved Emissions

In addition to forecasting emissions, CEFS can create temporally-resolved inventories for modeling purposes for the base year and future years. The annual average emissions are adjusted to account for monthly and weekly variations. CEFS will generate an inventory for point and area sources (including off-road mobile sources) for a weekday and weekend day in the year and months needed for the CRPAQS episodes (e.g. December 2000 and January 2001). Emissions will be estimated for each county, air basin and district combination.

ARB will use an emissions processor, such as the EMS-95 emissions modeling system, to resolve the emissions both spatially and temporally. ARB will chemically speciate the VOC component of the point and area emissions. ARB will then reformat the emissions estimates for input to air quality models.

Other data are necessary to prepare emissions estimates for input to air quality models. These data include the following:

- Spatial surrogates
- Assignment of spatial surrogate to area source category
- Hydrocarbon speciation profiles
- Assignment of hydrocarbon speciation profile to source category

The spatial surrogates are used to spatially allocate countywide area source emissions to individual grid cells. In this context, “area source emissions” refers to all source categories that are not point sources, biogenics or on-road motor vehicles. Each area source category is assigned a spatial surrogate.

The hydrocarbon speciation profiles are used to separate the TOG emissions into the individual hydrocarbon components that are modeled within the chemistry processes of the air quality model. Hydrocarbon speciation profiles exist for both the CB-IV and SAPRC99 chemical mechanisms. Each source category, including area, point, biogenics or on-road motor vehicles is assigned a hydrocarbon speciation profile.

C. On-road Motor Vehicle Emissions

C.1 Introduction

EMFAC is the ARB approved on-road motor vehicle emission inventory model. The current version is EMFAC2002. This model gives emission estimates for 13 classes of vehicles for exhaust, evaporation, and PM emissions from tire wear and brake wear. EMFAC also produces estimates of fuel consumption, vehicle miles traveled (VMT), and the number of vehicles in use. EMFAC does not output a gridded emission file. However, EMFAC will also produce a file of emission rates that can be used with DTIM4 or other external on-road motor

vehicle emission gridding programs. These same emission rates are part of the information used by EMFAC to produce emission estimates for California counties or air basins.

It is important to recognize that EMFAC (and the associated activity), and not DTIM, is used to calculate county-specific emissions. DTIM output, using the Integrated Transportation Network (ITN) activity as inputs, will be used to create hourly emission *ratios* for each grid-cell in a county. These ratios will be used to distribute county-specific, daily EMFAC emissions to each hour and grid-cell.

With regard to the spatial accuracy of the ITN, it is important to recognize that current modeling efforts in the region utilize square grid cells that are four kilometers on each side. Thus, the spatial accuracy of the statewide or local components of the ITN only requires enough resolution to distribute EMFAC emissions into the proper four by four kilometers grid cell. Given that the intended purpose of the ITN is for use in estimating on-road mobile source emissions for photochemical modeling efforts, this accuracy is sufficient.

DTIM4 is the latest in the series of 'Direct Travel Impact Models' used to estimate gridded on-road motor vehicle emissions. Besides the EMFAC emission rate file, DTIM4 uses digitized roadway segments (links) and traffic analysis zone centroids to allocate emissions for travel and trip ends. DTIM4 gridded emission files have fewer categories than EMFAC outputs. Several EMFAC emission categories are combined into each category output. There are also several categories of emissions that EMFAC produces that are not estimated by DTIM4.

DTIM4 is used to estimate both the spatial and temporal distribution of all on-road motor vehicle emissions. The DTIM4 results are used as surrogates to distribute the EMFAC emissions for each category. The main goal of this chapter is to further describe procedures we developed to use EMFAC and DTIM4 to produce day specific gridded on-road motor vehicle emission estimates. The procedures described here are done separately for each of the 53 counties in the CCOS emission modeling region.

C.2 EMFAC Emission Categories

The following 13 vehicle classes have emission estimates from EMFAC

- LDA Light Duty Autos
- LDT1 Light Duty Trucks < 3,750 pounds GVW
- LDT2 Light Duty Trucks > 3,750 - 5,750
- MDV Medium Duty Vehicles > 5,750 – 8,500
- LHD1 Light Heavy Duty Vehicles > 8,500 – 10,000
- LHD2 Light Heavy Duty Vehicles > 10,000 – 14,000
- MHD Medium Heavy Duty Vehicles > 14,000 – 33,000
- HHD Heavy Heavy Duty Vehicles > 33,000

- LHV Line Haul Vehicles
- SBUS School Bus
- UBUS Urban Bus
- MH Motorhomes
- MCY Motorcycles

Additionally, there are up to 3 technology groups within each vehicle type:

- Catalyst
- Non-catalyst
- Diesel

For each of the combinations of vehicle types and technologies there can be many emission categories:

- Start Exhaust
- Running Exhaust
- Idle Exhaust
- Hot Soak
- Running Evaporatives
- Resting Evaporatives
- Partial Day Resting Evaporatives
- Multi-Day Resting Evaporatives
- Diurnal Evaporatives
- Partial Day Diurnal Evaporatives
- Multi-Day Diurnal Evaporatives
- Break Wear PM
- Tire Wear PM

A DTIM4 preprocessor calculates fleet average emission factors for each EMFAC technology type for each emission category. The vehicle type distribution used to calculate fleet emission factors is an input, so it can be varied as needed.

C.3 DTIM4 Emission Categories

During DTIM4 operation, all emissions are collapsed into a total of 20 emission categories that depend only on the technology and whether the vehicle is catalyst, non-catalyst or diesel:

SCC Description

- Non TOG Exhaust Emissions
- Catalyst Start Exhaust
- Catalyst Running Exhaust
- Non-catalyst Start Exhaust
- Non-catalyst Running Exhaust
- Hot Soak
- Diurnal Evaporatives
- Diesel Exhaust
- Running Evaporatives
- Resting Evaporatives
- Multi-Day Resting
- Multi-Day Diurnal
- PM Tire Wear
- PM Brake Wear
- Catalyst Buses
- Non-catalyst bus
- Diesel Bus
- Catalyst Idle
- Non-catalyst Idle
- Diesel Idle

C.4 Hourly Temperature and Relative Humidity

Both DTIM4 and EMFAC require hourly inputs of temperature and relative humidity (RH). For CRPAQS we run DTIM with a gridded temperature/RH array for each hour. These gridded fields were used to develop an hourly average temperature and RH for each county air basin subarea for use with EMFAC. The current July/August and September 2000 ozone episodes emission files utilized CalMet temperature and relative humidity fields, which are based on measurements. The same fields are also used to estimate biogenic organic and soil NOx emissions.

C.5 Creating the Emission Rate File

EMFAC will create a .erp file for any desired combination of vehicle speeds, ambient temperatures, and relative humidities. However, DTIM places restrictions on the total array size. The sets of values we build the array with are:

Speed: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65

Temp: 30, 45, 60, 70, 75, 80, 85, 90, 100, 110

RH: 0, 30, 50, 70, 80, 90, 100

EMFAC is used to create an emission rate (.erp) file for each county and calendar year, as well as an emissions file used as the basis for all on-road motor vehicle emission mass estimates used in subsequent modeling studies.

C.6 Day Specific EMFAC Inventories

As mentioned, EMFAC is used to produce estimates of emissions for each day of each episode, by county. County average hourly temperatures are input to EMFAC to produce a 'BURDEN' inventory in a comma separated (.bcd) format. Both DTIM exhaust and evaporative emissions are scaled by category to the EMFAC emissions estimates for each county/air basin area. EMFAC bus and idle emission categories are not estimated by DTIM. These categories are added to the gridded emission files.

C.7 The DTIM4 System

DTIM4 is also used to produce estimates of emissions for each day of each episode, by county. DTIM4 consists of 3 executables. CONVIRS4, IRS4, and DTIM4. CONVIRS4 reads a .erp file from EMFAC and reformats it for input to IRS4. IRS4 uses VMT fractions to composite emission rates for the fleet being simulated. An important input to IRS4 is the vehicle type weighting for emission rate compositing. We use the vehicle type VMT for each county/air basin output from EMFAC. If we run LM and HDV separately the VMT for LM is the sum of LDA, LDT1, LDT2, MDV MCY and MH. The HDV VMT is the sum of LHDV1, LHDV2, MHD, and HHD.

Besides the composite emission rate file from EMFAC/CNVIRS4/IRS4, DTIM4 needs link and trip end activity files. All activity has been resolved to one-hour periods for each county by Jim Wilkinson of Alpine Geophysics under contract to the ARB. This was done for midweek days, Mondays, Fridays, and an average weekend day. The estimated activity for Mondays, Fridays, and weekend days are different than the midweek activity. The differences are due to the differences seen in traffic counts. When we processed Mondays, Fridays, and weekend days, we scaled the daily emissions according to the ITN county VMT to EMFAC VMT ratio.

C.8 Evaporative Emissions

DTIM4 and EMFAC use different methods to estimate evaporative emissions. However, as mentioned, we use the DTIM4 evaporative emissions as both spatial and temporal 'surrogates' to resolve EMFAC emission estimates. During processing, we drop the evaporative categories 11 and 12 and put all EMFAC resting emissions in category 10, and all diurnal emissions in category 7.

C.9 Exhaust Emissions

The exhaust emissions from EMFAC are also resolved spatially and temporally by DTIM4 emission estimates. Since transportation models do not estimate VMT for buses or excess idling categories, these are added to DTIM4 emissions. The exhaust CO, NOx, SOX, and PM emissions that DTIM4 allocates to category 1 are reassigned to catalyst starts, non-catalyst starts, catalyst stabilized, non-catalyst stabilized, and diesel exhaust categories according to the appropriate day specific EMFAC inventory.

EMFAC2002 is the current model used by the ARB to estimate on-road mobile source emissions factors for California (ARB, 2002). As part of the ARB's effort, it will develop gridded, hourly day-specific emissions estimates of TOG, NO_X, Sox, PM, and CO for the episodes to be modeled for the CRPAQS modeling study.

Because the ARB plans to modify EMFAC2002 to support changes to heavy heavy-duty diesel emissions factors, among others, it will be necessary to track these revisions and their potential impact on the on-road mobile source inventory. If the ARB indeed does revise EMFAC2002, ARB will decide how best to proceed with integrating these changes into the air quality modeling inventory.

D. Biogenic Emissions

Development of effective fine particulate ($PM_{2.5}$) control strategies in California requires accurate emission inventories of their precursor emissions, including biogenic volatile organic compounds (BVOCs) such as isoprene and monoterpenes. Due to the heterogeneity of vegetation landcover, species composition and leafmass distribution in California, quantifying BVOC emissions in this domain requires an emission inventory model with region-specific input databases and a high degree of spatial and temporal resolution. In response to this need, the California Air Resources Board (CARB) has developed a GIS-based model for estimating BVOC emissions, called BEIGIS, which uses California-specific input databases with a minimum spatial resolution of 1 square km and an hourly temporal resolution.

The BEIGIS isoprene emission algorithm (Guenther et al. 1991, 1993) is of the form $I = I_S \times C_L \times C_T$, where I is the isoprene emission rate (grams per gram dry leafmass per hour) at temperature T and photosynthetically active radiation flux PAR. I_S is a base emission rate (grams per gram dry leafmass per hour) at a standard temperature of 30 °C and PAR flux of 1000 μmol $m^{-2}s^{-1}$. C_L and C_T are environmental adjustment functions for PAR and temperature, respectively. The monoterpene emission algorithm adjusts a base monoterpene emission rate by a temperature function (Guenther et al. 1993). Methylbutenol (MBO) emissions are modeled with an algorithm developed by Harley et al. (1998) similar to that for isoprene. Dry leaf mass/ leaf area ratios, and base emission rates for isoprene, monoterpenes and MBO, are plant species-specific and assembled from the

scientific literature. Modeled BVOC emissions for a given spatial domain therefore represents the contribution by various plant species (through their leaf mass and emission rates) to the total BVOC emissions.

The main inputs to BEIGIS are landuse and vegetation landcover maps, gridded leaf area indices (LAI) derived from AVHRR satellite data (Nikolov 1999), leaf area/dry leaf mass factors, base emission rates, and gridded hourly ambient temperature and light intensity data (CALMET or MM5). For urban areas, landuse/vegetation landcover databases were developed from regional planning agency data and botanical surveys (Horie et al. 1990; Nowak 1991; Sidawi and Horie 1992; Benjamin et al. 1996, 1997; McPherson et al. 1998). Natural areas are represented using the GAP vegetation database (also satellite-derived and air photo interpreted) developed by the U.S.G.S. Gap Analysis Program (Davis et al. 1995). Agricultural areas are represented using crop landcover databases developed by the California Department of Water Resources (http://www.waterplan.water.ca.gov). Ground surveys have been funded by ARB to validate the vegetation landcover and LAI input databases used in BEIGIS (Winer et al. 1998; Karlik and McKay 1999; Winer and Karlik 2001, Karlik 2002). Validation through flux measurements in the field is ongoing.

Using BEIGIS, the ARB will develop hourly-resolved emissions of isoprene, monoterpenes and methyl butanol (MBO), gridded at a 1-km resolution. The ARB estimates biogenic OVOCs (other VOCs). Biogenic OVOCs comprise around twenty percent of some biogenic inventories and are known to affect air quality modeling predictions (e.g. Hanna et al., 2002). OVOCs are estimated as an added fraction, scaled to the total isoprene, monoterpene and MBO emissions.

E. References

EMFAC2002 http://www.arb.ca.gov/msei/on-road/latest_version.htm

DTIM4 User's Guide, California Department of Transportation, April 2000

Benjamin, M., Sudol, M., Bloch, L. and A. Winer. 1996. Low-emitting urban forests: a taxonomic methodology for assigning isoprene and monoterpene emission rates. Atmospheric Environment. 30 (9): 1437-1452.

Benjamin, M., Sudol, M., Vorsatz, D. and A. Winer. 1997. A spatially and temporally resolved biogenic hydrocarbon emissions inventory for the California south coast air basin. Atmospheric Environment. 31 (18): 3087-3100.

Davis, F. W., P. A. Stine, D. M. Stoms, M. I. Borchert and A. D. Hollander. 1995. Gap analysis of the actual vegetation of California –1. The southwestern region. Madrono 42: 40-78.

Guenther, A. B., P. R. Zimmerman, P. C. Harley, R. K. Monson and R. Fall. 1993. Isoprene and monoterpene emission rate variability – model evaluations and sensitivity analyses. Journal of Geophysical Research. 98(D7): 12609-12617.

Guenther, A. B. R. K. Monson and R. Fall. 1991. Isoprene and monoterpene emission rate variability: observations with eucalyptus and emission rate algorithm development. Journal of Geophysical Research. 96: 10799-10808.

Harley, P., V. Fridd-Stroud, J. Greenberg, A. Guenther and P. Vasconcellos. 1996. Emission of 2-methyl-3-buten-2-ol by pines: A potentially large natural source of reactive carbon to the atmosphere. Journal of Geophysical Research. 103: 25479-25486.

Horie, Y., Sidawi, S. and R. Ellefsen. 1990. Inventory of leaf biomass and emission factors for vegetation in California's south coast air basin. Final Technical Report III-C. South Coast Air Quality Management District. Diamond Bar, CA.

Karlik, J. and A. McKay. 1999. Development of methodology and databases for estimating leaf masses in California airsheds. Final Report. Contract No. 97-719. State of California Air Resources Board. Sacramento, CA.

Karlik, J. 2002. Validation of databases for modeling biogenic volatile organic compound emissions in central California. Draft Final Report. Contract No. 00-16CCOS. San Joaquin Valleywide Air Pollution Study Agency and California Environmental Protection Agency – Air Resources Board.

McPherson, E. G. 1998. Structure and sustainability of Sacramento's urban forest. Journal of Arboriculture. 24 (4): 174-190.

Nikolov, N. T. 1999. 1-km resolution database of vegetation leaf area index and canopy clumping factor for the western U.S.A. Final Report, U.S.D.A. Forest Service Agreement No. PSW-99-001-RJVA. N&T Services. Oak Ridge, TN.

Nowak, D. J. 1991. Urban forest development and structure: Analysis of Oakland, California. PhD dissertation. University of California, Berkeley, CA.

Sidawi, S. and Y. Horie. 1992. Leaf biomass density for urban, agricultural and natural vegetation in California's San Joaquin Valley. Final Report. San Joaquin Valley Air Pollution Study Agency.

Winer, A., Karlik, J. and J. Arey. 1998. Biogenic hydrocarbon inventories for California: generation of essential databases. Final Report. Contract No. 95-309. State of California Air Resources Board. Sacramento, CA.

Winer, A. and Karlik, J. 2001. Development and validation of databases for modeling biogenic hydrocarbon emissions in California's airsheds. Final Report. Contract No. 97-320. California Environmental Protection Agency – Air Resources Board. Sacramento, CA.

APPENDIX B

Books:

Finlayson-Pitts,B.J. and J.N. Pitts, 2000. Chemistry of the Upper and Lower Atmosphere: Theory, Experiments, and Applications, Academic Press, San Diego (ISBN 0-12-257060-x)

Jacobson, M.Z., 1999. Fundamentals of Atmospheric Modeling, Cambridge University Press, New York (ISBN 0-521-63717-1)

Seinfeld, J.H. and S. Pandis, 1998. Atmospheric Chemistry and Physics: Air Pollution to Climate, John Wiley, New York (ISBN 0-471-17815-2)

Reports and Guidance:

Guidance for the Performance Evaluation of Three Dimensional Air Quality Modeling Systems for Particulate Matter and Visibility, American Petroleum Institute, Document CP033-98-1b, November 1998, Seigneur *et al.*

Guidance for Demonstrating Attainment of Air Quality Goals for PM2.5 and Regional Haze, US Environmental Protection Agency, Draft 2.1, January, 2001. (Found at http://www.epa.gov/scram001/guidance/guide/draft_pm.pdf)

Particulate Matter Science for Policy Makers: A NARSTO Assessment. February 2003. (Found at http://www.cgenv.com/Narsto)

California Regional $PM_{10}/PM_{2.5}$ Air Quality Study: Objectives and Associated Data Analysis and Modeling Approaches, Magliano et al., February 1999

Lurmann F.W., Kumar N., Loomis C., Cass G.R., Lowenthal D., Reynolds S.D., 1996. PM_{10} Air Quality Models for Application in the San Joaquin Valley PM_{10} SIP. Report Prepared for the California Air Resources Board (hardcopy only).

Seigneur C., Pai P., Louis J-F., Hopke P., and Grosjean D., 1997. Review of Air Quality Models for Particulate Matter. Report Prepared for the American Petroleum Association.

Journal Articles:

Allen, J.O., D.P. Fergenson, *et al.*, 2000. Particle detection efficiencies of aerosol time of flight mass spectrometers under ambient sampling conditions. *Environmental Science & Technology* 34, 211-217.

Bowman F., J. Odum, P.N. Pandis, and J.H. Seinfeld, 1997. A new adsorption/absorption model for the formation of secondary atmospheric Aerosols. *Atmospheric Environment* 31, 3921-3931.

Blanchard, C.L., E.L. Carr, *et al.*,1999. Spatial representativeness and scales of transport during the 1995 Integrated Monitoring Study in California's San Joaquin Valley. *Atmospheric Environment* 33, 4775-4786.

Cass, G.R., L.A. Hughes, *et al.*, 2000. The chemical composition of atmospheric ultrafine particles. Philosophical Transactions of the Royal Scociety of London Series – Mathematical Physical and Engineering Sciences, 358, 2581-2592.

Chock, D.P. and S.L. Winkler, 1994. A comparison of advection algorithms coupled with chemistry. *Atmospheric Environment* 28, 2659-2675.

Chock, D.P., S.L. Winkler, *et al.,* 1994. Comparison of stiff chemistry solvers for air quality modeling. *Environmental Science & Technology* 28,1882-1892.

Chung, A., D.P.Y. Chang, *et al*., 2001. Comparison of real-time instruments used to monitor airborne particulate matter*. Journal of the Air & Waste Management Association* 51, 109-120.

Chung, A., J.D. Herner, *et al*., 2001. Detection of alkaline ultrafine atmospheric particles at Bakersfield, California. *Environmental Science & Technology* 35, 2184-2190.

Collett, J.L., K.J. Hoag, *et al*., 1999. Internal acid buffering in San Joaquin Valley fog drops and its influence on aerosol processing. *Atmospheric Environment* 33, 4833-4847.

Dhaniyala S., 1996. Numerical Schemes to Models Condensation and Evaporation of Aerosols, *Atmospheric Environment* 30, xxxx-xxxx.

Feilberg A, R.M. Kamens, M.R. Strommen, and T. Nielson, 1999. Modeling the Formation, Decay, and Partitioning of Semivolatile Nitro-polycyclic Aromatic Hydrocarbons (nitroanphthalenes) in the Atmosphere, *Atmospheric Environment* 33: 1231-1243.

Fraser, M.P., M.J. Kleeman, *et al*., 2000. Modeling the atmospheric concentrations of individual gas-phase and particle-phase organic compounds. *Environmental Science & Technology* 34, 1302-1312.

Gard, E.E., M.J. Kleeman, *et al.,* 1998. Direct observation of heterogeneous chemistry in the atmosphere. *Science* 279, 1184-1187.

Hoag, K.J., J.L. Collett, *et al*., 1999. The influence of drop size-dependent fog chemistry on aerosol processing by San Joaquin Valley fogs. *Atmospheric Environment* 33, 817-4832.

Hughes, L.S., J.O. Allen, *et al*., 1999. Size and composition distribution of atmospheric particles in southern California. *Environmental Science & Technology* 33, 3506-3515.

Hughes, L.S., J.O. Allen, *et al*., 2000. Evolution of atmospheric particles along trajectories crossing the Los Angeles basin. *Environmental Science & Technology* 34, 3058-3068.

Kleeman, M.J., G.R. Cass, *et al*., 1997. Modeling the airborne particle complex as a source-oriented external mixture. *Journal of the Geophysical Research-Atmospheres* 102, 21355-21372.

Kleeman, M. J. and G. R. Cass, 1998. Source contributions to the size and composition distribution of urban particulate air pollution. *Atmospheric Environment* 32, 2803-2816.

Kleeman, M.J. and G.R. Cass, 1999. Effect of emissions control strategies on the size and composition distribution of urban particulate air pollution. *Environmental Science & Technology* 33, 177-189.

Kleeman, M.J., J.J. Schauer, *et al*., 1999. Size and composition distribution of fine particulate matter emitted from wood burning, meat charbroiling, and cigarettes. *Environmental Science & Technology* 33, 3516-3523.

Kleeman, M.J., L.S. Hughes, *et al*., 1999. Source contributions to the size and composition distribution of atmospheric particles: Southern California in September 1996. *Environmental Science & Technology* 33, 4331-4341.

Kleeman, M.J. and G.R. Cass, 1999. Identifying the effect of individual emissions sources on particulate air quality within a photochemical aerosol processes trajectory model. *Atmospheric Environment* 33, 4597-4613.

Kleeman, M.J., J.J. Schauer, *et al.*, 2000. Size and composition distribution of fine particulate matter emitted from motor vehicles. *Environmental Science & Technology* 34,1132-1142.

Kleeman, M.J., A. Eldering, *et al.*, 2001. Effect of emissions control programs on visibility in southern California. *Environmental Science & Technology* 35, 4668-4674.

Kleeman, M.J. and G.R. Cass, 2001. A 3D Eulerian source-oriented model for an externally mixed aerosol. *Environmental Science & Technology* 35, 4834-4848.

Lillis, D., C. N. Cruz, *et al*., 1999. Production and removal of aerosol in a polluted fog layer: model evaluation and fog effect on PM. *Atmospheric Environment* 33, 4797-4816.

Lurmann F.W., A.S. Wexler, S.N. Pandis, S. Musarra, N. Kumar, and J.H. Seinfeld, 1997. Modeling the Urban and Regional Aerosols - II. Application to the California's South Coast Air Basin. *Atmospheric Environment* 31, 2695-2715.

Magliano, K.L., V.M. Hughes, *et al*., 1999. Spatial and temporal variations in PM10 and PM2.5 source contributions and comparison to emissions during the 1995 integrated monitoring study. *Atmospheric Environment* 33, 4757-4773.

Meng Z., D. Dabdub , J.H. Seinfeld, 1997. Chemical Coupling Between Atmospheric Ozone and Particulate Matter. *Sceince* 277, 166-119.

Meng Z., D. Dabdub, J.H. Seinfeld, 1998. Size and Chemically-Resolved Model of Atmospheric Aerosol Dynamics, *Journal of the Geophysical Research-Atmospheres* 103, 3419-3435.

Noble C.A., and K.A. Prather, 1996. Real-Time Measurements of Correlated Size and Composition Profiles of Individual Atmospheric Aerosol Particles. *Environmental Science & Technology* 30, 2667-2680.

Odum, J.R., T. Hoffmann, F. Bowman , D. Collins , R.C. Flagan, and J.H. Seinfeld, 1996. Gas/Particle Partitioning and Secondary Organic Aerosol Yields. *Environmental Science & Technology* 30, 2580-2585.

Odum, J.R., T.P.W. Jungkamp, R.J. Griffin, R.C. Flagan, and J.H. Seinfeld, 1997. The Atmospheric Aerosol Forming Potential of Whole Gasoline Vapor, *Sceince* 276, 96-98.

Odum, J.R., T.P.W. Jungkamp, R.J. Griffin, H.J.L. Forstner, R.C. Flagan, and J.H. Seinfeld, 1997. Aromatics, Reformulated Gasoline, and the Atmospheric Organic Aerosol Formation. *Environmental Science & Technology* 31,1890-1897.

Pilinis C., 1990. Derivation and Numerical Solution of the Species Mass Distribution Equation for Multicomponent Particulate Systems. *Atmos. Environ* 24,1923-1928.

Pun, B.K. and C. Seigneur, 1999. Understanding particulate matter formation in the California San Joaquin Valley: conceptual model and data needs. *Atmospheric Environment* 33, 4865-4875.

Pun, B.K., J.F. Louis, *et al*., 2000. Ozone formation in California's San Joaquin Valley: A critical assessment of modeling and data needs. *Journal of the Air & Waste Management Association* 50, 961-971.

Pun, B.K. and C. Seigneur, 2001. Sensitivity of particulate matter nitrate formation to precursor emissions in the California San Joaquin Valley. *Environmental Science & Technology* 35 2979-2987.

Roth, P.M., 1999. A qualitative approach to evaluating the anticipated reliability of a photochemical air quality simulation model for a selected application. *Journal of Air and Waste Management Association* 49, xxxx-xxxx.

Richards, L.W., S.H. Alcorn, *et al*., 1999. Optical properties of the San Joaquin Valley aerosol collected during the 1995 integrated monitoring study. *Atmospheric Environment* 33, 4787-4795.

Russell, A. and R. Dennis, 2000. NARSTO critical review of photochemical models and modeling. *Atmospheric Environment* 34, 2283-2324.

Schauer, J.J., M.J. Kleeman, *et al*., 1999. Measurement of emissions from air pollution sources. 1. C-1 through C-29 organic compounds from meat charbroiling. *Environmental Science & Technology* 33, 1566-1577.

Schauer, J.J., M.J. Kleeman, *et al*., 1999. Measurement of emissions from air pollution sources. 2. C-1 through C-30 organic compounds from medium duty diesel trucks. *Environmental Science & Technology* 33,1578-1587.

Schauer, J.J., M.J. Kleeman, *et al.*, 2001. Measurement of emissions from air pollution sources. 3. C-1-C-29 organic compounds from fireplace combustion of wood. *Environmental Science & Technology* 35, 1716-1728.

Schauer, J.J., M.J. Kleeman, *et al.*, 2002. Measurement of emissions from air pollution sources. 4. C-1-C-27 organic compounds from cooking with seed oils. *Environmental Science & Technology* 36, 567-575.

Schauer, J.J., M.J. Kleeman, *et al.*, 2002. Measurement of emissions from air pollution sources. 5. C-1-C-32 organic compounds from gasoline-powered motor vehicles. *Environmental Science & Technology* 36, 1169-1180.

Seigneur, C., B. Pun, *et al.,* 2000. Guidance for the performance evaluation of three-dimensional air quality modeling systems for particulate matter and visibility. *Journal of the Air & Waste Management Association* 50, 588-599.

Seigneur, C., C. Tonne, *et al*., 2000. The sensitivity of PM2.5 source-receptor relationships to atmospheric chemistry and transport in a three-dimensional air quality model. *Journal of the Air & Waste Management Association* 50, 428-435.

Seigneur, C., 2001. Current status of air quality models for particulate matter. *Journal of the Air & Waste Management Association* 51, 1508-1521.

Solomon, P.A. and K.L. Magliano, 1999. The 1995-Integrated Monitoring Study (IMS95) of the California Regional PM10/PM2.5 air quality study (CRPAQS): Study overview. *Atmospheric Environment* 33, 4747-4756.

Strader, R., F. Lurmann, *et al*., 1999. Evaluation of secondary organic aerosol formation in winter. *Atmospheric Environment* 33, 4849-4863.

Sun, P., D.P. Chock, *et al.,* 1994. An Implicit-Explicit Hybrid Solver for a System of Stiff Kinetic Equations. *Journal of Computational Physics* 115, 515-523.

Sun Q, A.S. Wexler, 1998. Modeling Urban and Regional Aerosols – Condensation and Evaporation Near Acid Neutrality. *Atmospheric Environment* 32,3527-3531.

Sun Q, A.S. Wexler, 1998. Modeling Urban and Regional Aerosols – Application to the 24-25 June SCAQS Episode. *Atmospheric Environment* 32, 3533-3545.

Venkatram, A., J. Pleim,1999. The electrical analogy does not apply to modeling dry deposition of particles. *Atmospheric Environment* 33, 3075-3076.

Wesely, M.L., B.B. Hicks, 2000. A review of the current status of knowledge on dry deposition. *Atmospheric Environment* 34, 2261-2282.

Wexler A.S., F.W. Lurmann, and J.H. Seinfeld, 1994. Modeling Urban and Regional Aerosols - I. Model Development. *Atmospheric Environment* 28, 531-546.

Zhang, Y., C. Seigneur, *et al*., 1999. Simulation of aerosol dynamics: A comparative review of algorithms used in air quality models. *Aerosol Science and Technology* 31, 487-514.

Zhang, Y., C. Seigneur, *et al*., 2000. A comparative review of inorganic aerosol thermodynamic equilibrium modules: similarities, differences, and their likely causes. *Atmospheric Environment* 34, 117-137.

APPENDIX C

CONTRACT LANGUAGE

CONTRACT NO. *03-x PM*

SAN JOAQUIN VALLEYWIDE AIR POLLUTION STUDY AGENCY

AND

CONTRACTOR

This Agreement, which shall be effective upon the *DATE*, by and between the SAN JOAQUIN VALLEYWIDE AIR POLLUTION STUDY AGENCY (hereafter "STUDY AGENCY"), a joint powers agency, and *CONTRACTOR* (hereafter "CONTRACTOR").

W I T N E S S E T H:

WHEREAS, STUDY AGENCY has the need to *TASK*;

WHEREAS, STUDY AGENCY released its Request for Proposal entitled "*RFP TITLE*" dated *DATE* ("the RFP"), which is incorporated herein, to those persons determined by STUDY AGENCY to be capable of *TASK*

WHEREAS, CONTRACTOR responded to said RFP by sending STUDY AGENCY its Proposal, dated *DATE*, ("the Proposal"), which is incorporated herein;

WHEREAS, STUDY AGENCY has requested CONTRACTOR to perform such services pursuant to the terms and conditions of its RFP; and

WHEREAS, CONTRACTOR represents that it is willing and able to perform the foregoing services requested by STUDY AGENCY pursuant to the terms and conditions thereof.

NOW, THEREFORE, the parties hereby agree as follows:

1. EMPLOYMENT OF CONTRACTOR

1.1 STUDY AGENCY shall employ CONTRACTOR as an independent contractor to provide, to the reasonable satisfaction of the STUDY AGENCY, those expert consulting services requested to be performed pursuant to Exhibit A of this Agreement, "Scope of Work," which is attached hereto and incorporated herein, the RFP, and the Proposal. In the event of any conflict between or among the terms and conditions of this Agreement, the exhibits incorporated herein, and the documents referred to and incorporated herein be resolved by giving precedence in the following order of priority:

1.1.1 To the text of this Agreement, Exhibit A, "Scope of Work," to this Agreement, Exhibit B, "Schedule of Deliverables"; and

1.1.2 To the RFP.

1.2 In addition to those obligations stated in paragraph 1.1 of this Agreement, CONTRACTOR shall provide STUDY AGENCY with one (1) reproducible master copy of each written work product completed pursuant to this Agreement, one (1) bound copy of each written work product, one (1) electronic copy in Adobe Acrobat, and one (1) electronic copy in Microsoft Word.

1.3 All work product that CONTRACTOR shall deliver to STUDY AGENCY hereunder shall be performed according to the work schedule and deadlines for performance identified in Exhibit B, "Schedule of Deliverables," to this Agreement, which is attached hereto and incorporated herein.

1.4 CONTRACTOR shall provide its services through the following key persons: *KEY PERSONS.*

1.5 It is the express intent of the parties to preserve the respective teams of the aforementioned key persons through the entire term of this Agreement. In case of death, illness, or other incapacity of any of the foregoing key persons, CONTRACTOR shall use its best efforts to promptly provide a replacement key person of at least equal professional ability and experience as the key person replaced,

without additional cost to STUDY AGENCY. CONTRACTOR may add to or replace persons on its support staff without STUDY AGENCY's approval, provided, however, that replacement support staff personnel shall be of at least equal ability as the person(s) replaced. Notwithstanding anything else stated to the contrary in this Agreement, it is understood that CONTRACTOR may not replace any of the aforementioned key persons without the prior, express written approval of the STUDY AGENCY.

1.6 Subject to any express limitations established by STUDY AGENCY as to the degree of care and amount of time and expense to be incurred and any other limitations expressly contained in this Agreement, CONTRACTOR shall perform the services under this Agreement with that level of due care and skill ordinarily exercised by other qualified professional consultants in the field of CONTRACTOR's expertise under similar circumstances at the time the services are being performed.

1.7 CONTRACTOR may retain such subcontractors and/or subconsultants as CONTRACTOR deems necessary to assist CONTRACTOR in completing the work under this Agreement. Such subcontractors and subconsultants, if any, shall be expressly approved in writing by STUDY AGENCY before they are retained to perform work under this Agreement. CONTRACTOR's use of any such subcontractors or subconsultants shall not, in any way whatsoever, relieve CONTRACTOR of its obligations under subparagraph 1.1 of this Agreement. It is understood that CONTRACTOR shall be STUDY AGENCY's sole point of contact in the performance of the services covered by this Agreement.

1.8 CONTRACTOR's obligation under this Agreement shall be deemed discharged only after all tasks identified in paragraph 1.1 have been completed and approved by the STUDY AGENCY "Technical Committee."

2. NO THIRD-PARTY BENEFICIARIES

2.1 It is understood that CONTRACTOR's services under this Agreement are being rendered only for the benefit of STUDY AGENCY, and no other

person, firm, corporation, or entity shall be deemed an intended third-party beneficiary of this Agreement.

3. TERM

3.1 This Agreement shall become effective upon execution by the parties and shall continue until terminated as provided herein. In no event shall the term of this Agreement extend past *DATE*, without the express, written consent of the parties hereto.

4. TERMINATION

4.1 STUDY AGENCY shall have the right to terminate this Agreement at its discretion, and without cause, at any time upon the giving to CONTRACTOR thirty (30) days' advance, written notice of an intention to terminate. If STUDY AGENCY terminates this Agreement in such event, CONTRACTOR shall be compensated for services satisfactorily provided to STUDY AGENCY up to the date of termination, as reasonably determined by STUDY AGENCY, together with such additional services performed after termination which are expressly authorized in writing by STUDY AGENCY to wind up such work.

4.2 The parties hereto may mutually agree to terminate this Agreement at any time, and in such case, upon any terms as are mutually agreeable, provided that such agreement is made pursuant to a written amendment to this Agreement.

4.3 CONTRACTOR shall have the right to terminate this Agreement immediately if:

4.3.1 STUDY AGENCY defaults in the payment of any sum due to be paid to CONTRACTOR; and

4.3.2 Such default for failure to pay or failure to perform any other obligation hereunder continues thirty (30) days after written notice thereof has been provided by CONTRACTOR to STUDY AGENCY.

4.4 Breach of Agreement: STUDY AGENCY may immediately suspend or terminate this Agreement, in whole or in part, where in the determination of STUDY AGENCY there is:

4.4.1 An illegal or improper use of funds;

4.4.2 A failure to comply with any term of this Agreement;

4.4.3 A substantially incorrect or incomplete report submitted to STUDY AGENCY;

4.4.4 Improperly performed services; or

4.4.5 Any other breach of the Agreement.

In no event shall any payment by STUDY AGENCY constitute a waiver by STUDY AGENCY of any breach of this Agreement or any default which may then exists on the part of CONTRACTOR. Neither shall such payment impair or prejudice any remedy available to STUDY AGENCY with respect to the breach or default. STUDY AGENCY shall have the right to demand of CONTRACTOR the repayment to STUDY AGENCY of any funds disbursed to CONTRACTOR under this Agreement which in the judgment of STUDY AGENCY were not expended in accordance with the terms of this Agreement. CONTRACTOR shall promptly refund any such funds upon demand.

In addition to immediate suspension or termination, STUDY AGENCY may impose any other remedies available at law, in equity, or otherwise specified in this Agreement.

In the event of any breach of this Agreement, STUDY AGENCY, upon the recommendation of the Policy Committee, may, without prejudice to any of its other legal remedies, terminate this Agreement upon five (5) days' written notice to CONTRACTOR. In such event, STUDY AGENCY shall pay CONTRACTOR only the reasonable value of

the services theretofore rendered by CONTRACTOR as may be agreed upon by the parties or determined by a court of law, but not in excess of the total Agreement price.

5. DATA

5.1 No reports, professional papers, information, inventions, improvements, discoveries or data obtained, prepared, assembled, or developed by CONTRACTOR pursuant to this Agreement shall be released or made available (except as otherwise provided herein) without prior written approval of the Chief of the Modeling and Meteorology Branch, Planning & Technical Support Division, Air Resources Board. The consent of the Chief of the Modeling and Meteorology Branch, Planning & Technical Support Division, Air Resources Board, shall not be unreasonably withheld.

5.2 All models used must be in the public domain. All model codes, inputs, and outputs, and data obtained, prepared, assembled or developed shall be provided to the Program Manager in a magnetic media aceptable to the Program Manager

6. REPORTS

6.1 CONTRACTOR shall place the following language in a conspicuous place on all monthly progress reports and on the final report:

"The statements and conclusions in this report are those of the Contractor and not necessarily those of the California Air Resources Board, the San Joaquin Valleywide Air Pollution Study Agency, or its Policy Committee, their employees or their members. The mention of commercial products, their source, or their use in connection with material reported herein is not to be construed as actual or implied endorsement of such products."

7. COMPENSATION/INVOICING

7.1 STUDY AGENCY agrees to pay CONTRACTOR and CONTRACTOR agrees to receive compensation at the rate specified in paragraph 7.6 of this Agreement.

7.2 The amount to be paid to CONTRACTOR under this Agreement includes all sales and use taxes incurred pursuant to this Agreement, if any, including any such taxes due on equipment purchased by CONTRACTOR. CONTRACTOR shall not receive additional compensation for reimbursement of such taxes and shall not decrease work to compensate therefor.

7.3 Advance payments shall not be permitted. Payments will be permitted only at which time-equivalent services have been satisfactorily rendered. Progress payments shall be subject to review by the ARB Program Manager and the STUDY AGENCY Technical Committee. Progress payments shall be made monthly upon receipt of an invoice, a monthly progress report, and a claim for payment form, which is attached as Exhibit C and incorporated herein by reference. Invoices will be sent to Chief, Modeling and Meteorology Branch, Planning & Technical Support Division, Air Resources Board, P.O. Box 2815, Sacramento, CA 95812. With respect to the payment period completed, the invoice shall set forth in detail, in accordance with the Agreement budget, charges for time expended on the project, including the classification of personnel involved in such time expenditure, and the monthly, weekly, or hourly rates for such personnel, as appropriate. The invoice shall also contain an itemization of all materials used for the project, including the purpose of their use and their cost. Payment shall be made within thirty (30) days of receipt of the invoice.

7.4 Concurrently with the invoice, CONTRACTOR shall certify (i.e., through copies of issued invoices, checks, or receipts) that complete payment has been made to any and all subcontractors and subconsultants as provided.

7.5 It is understood that all expenses incidental to CONTRACTOR's performance of services under this Agreement shall be borne exclusively by CONTRACTOR.

7.6 In no event shall compensation paid by STUDY AGENCY to CONTRACTOR for the performance of all services under this Agreement exceed *COST*.

7.7 STUDY AGENCY shall be solely responsible for payment and not any of the parties to the Joint Powers Agreement forming the STUDY AGENCY.

7.8 STUDY AGENCY shall withhold payment equal to ten percent (10%) of each monthly invoice until completion of work requested by the STUDY AGENCY Technical Committee on the tasks specified in Exhibit A and approval by the ARB Program Manager and the STUDY AGENCY Technical Committee. It is CONTRACTOR's responsibility to submit an invoice in triplicate for the ten percent (10%) withheld.

7.9 The terms of this Agreement and the services to be provided thereunder are contingent on the approval of funds by the appropriating government agency. Should sufficient funds not be allocated, the services provided may be modified or this Agreement terminated at any time by giving CONTRACTOR thirty (30) days' prior written notice.

8. EXTRA SERVICES

8.1 CONTRACTOR shall not undertake any extra services not enumerated herein unless expressly authorized by STUDY AGENCY through an amendment to this Agreement, which shall be executed in the same manner as this Agreement, or by express, written authorization if such extra services are being performed by CONTRACTOR to wind up its services under this Agreement pursuant to subparagraph 4.1 of this Agreement.

8.2 When such extra services are being performed, CONTRACTOR shall keep complete records showing that STUDY AGENCY requested such extra services, the hours and description of activities worked by each person who worked on the project, the reason for such extra services, and all the costs and charges applicable to the extra services authorized.

9. INDEPENDENT CONTRACTOR

9.1 In performance of the work, duties, and obligations assumed by CONTRACTOR under this Agreement, it is mutually understood and agreed that CONTRACTOR, including any and all of CONTRACTOR's officers, agents, and employees, will at all times be acting and performing as an independent contractor, and shall act in an independent capacity and not as an officer, agent, servant, employee, joint venturer, partner, or associate of the STUDY AGENCY or the Policy Committee.

9.2 Furthermore, STUDY AGENCY shall have no right to control, supervise, or direct the manner or method by which CONTRACTOR shall perform its work and function. However, STUDY AGENCY shall retain the right to administer this Agreement so as to verify that CONTRACTOR is performing its obligations in accordance with the terms and conditions thereof. CONTRACTOR and STUDY AGENCY shall comply with all applicable provisions of law and the rules and regulations, if any, of governmental authorities having jurisdiction over matters the subject thereof.

9.3 Because of its status as an independent contractor, CONTRACTOR shall have absolutely no right to employment rights and benefits available to STUDY AGENCY employees. CONTRACTOR shall be solely liable and responsible for providing all legally required employee benefits. In addition, CONTRACTOR shall be solely responsible and save STUDY AGENCY harmless from all matters relating to payment of CONTRACTOR's employees, including compliance with

Social Security, withholding, and all other regulations governing such matters. It is acknowledged that during the term of this Agreement, CONTRACTOR may be providing services to others unrelated to STUDY AGENCY or to this Agreement.

10. MODIFICATION

10.1 Any matters of this Agreement may be modified from time to time by the written consent of all the parties without, in any way, affecting the remainder.

11. NON-ASSIGNMENT

11.1 Neither party shall assign, transfer, or subcontract this Agreement nor their rights or duties under this Agreement without the prior, express written consent of the other party.

12. INDEMNIFICATION

12.1 CONTRACTOR agrees to indemnify, save, hold harmless, and at STUDY AGENCY's request, defend STUDY AGENCY, its boards, committees, representatives, officers, agents, and employees from and against any and all costs and expenses (including reasonable attorneys fees and litigation costs), damages, liabilities, claims, and losses (whether in contract, tort, or strict liability, including, but not limited to, personal injury, death, and property damage) occurring or resulting to STUDY AGENCY which arises from any negligent or wrongful acts or omissions of CONTRACTOR, its officers, agents, subcontractors, subconsultants, or employees in their performance of this Agreement, and from any and all costs and expenses (including reasonable attorneys fees and litigation costs), damages, liabilities, claims, and losses (whether in contract, tort, or strict liability, including, but not limited to, personal injury, death, and property damage) occurring or resulting to any person, firm, corporation, or entity who may be injured or damaged when such injury or damage arises from any negligent or wrongful acts, or omissions of CONTRACTOR, its officers, agents, subcontractors, subconsultants, or employees in their performance of this Agreement.

13. INSURANCE

13.1 Without limiting STUDY AGENCY's right to obtain indemnification from CONTRACTOR or any third parties, CONTRACTOR, at its sole expense, shall maintain in full force and effect the following insurance policies throughout the term of this Agreement:

13.1.1 Comprehensive general liability insurance with minimum limits of coverage in the amount of _____ Million Dollars ($) per occurrence;

13.1.2 Commercial automobile liability insurance for owned and non-owned vehicles which covers bodily injury and property damage with a combined single limit with minimum limits of coverage in the amount of _____ Million Dollars ($) per occurrence;

13.1.3 Workers Compensation Insurance, in accordance with California law.

13.2 Such insurance policies shall name STUDY AGENCY, its officers, agents, and employees, individually and collectively, as additional insured but only insofar as the operations under this Agreement are concerned. Such coverage for additional insured shall apply as primary insurance, and any other insurance, or self-insurance, maintained by STUDY AGENCY, its officers, agents, and employees shall be excess only and not contributing with insurance provided under CONTRACTOR's policies herein. This insurance shall not be cancelled or changed without a minimum of thirty (30) days' advance, written notice given to STUDY AGENCY.

13.3 Prior to the commencement of performing its obligations under this Agreement, CONTRACTOR shall provide certificates of insurance on the foregoing policies, as required herein, to STUDY AGENCY stating that such insurance coverages have been obtained and are in full force; that STUDY AGENCY, its officers, agents, and employees will not be responsible for any premiums on the policies; that

such insurance names STUDY AGENCY, its officers, agents, and employees, individually and collectively, as additional insured, but only insofar as the operations under this Agreement are concerned; that such coverage for additional insured shall apply as primary insurance, and any other insurance or self-insurance maintained by STUDY AGENCY, its officers, agents, and employees, shall be excess only and not contributing with insurance provided under CONTRACTOR's policies herein. This insurance shall not be cancelled or changed without a minimum of thirty (30) days' advance, written notice given to the STUDY AGENCY.

13.4 In the event CONTRACTOR fails to keep in effect at all times insurance coverage as herein provided, STUDY AGENCY may, in addition to other remedies it may have, suspend or terminate this Agreement upon the occurrence of such event.

13.5 If the CONTRACTOR is a government entity, then it may self-insure such of those risks identified in paragraphs 13.1.1 through 13.1.3 of this Agreement, provided, however, that:

13.5.1 STUDY AGENCY, its officers, agents, and employees, individually and collectively, shall be named as additional insured (except for Workers Compensation Insurance) on CONTRACTOR's self-insurance plan, but only insofar as the operations under this Agreement are concerned;

13.5.2 Such self-insurance plan shall be reasonably satisfactory to STUDY AGENCY; and

13.5.3 All those provisions identified in subparagraph 13.2 of this Agreement concerning the relationship of CONTRACTOR's primary and STUDY AGENCY's excess insurance to each other, the requirement of CONTRACTOR delivering a certificate of insurance or other suitable evidence to STUDY AGENCY, and the cancellation/change of insurance requirements shall apply to such self-insurance plan.

14. AUDITS AND INSPECTIONS

14.1 CONTRACTOR shall at any time during business hours, and as often as STUDY AGENCY may deem necessary, make available to STUDY AGENCY for examination all of its records and data with respect to the matters covered by this Agreement. CONTRACTOR shall, upon request by STUDY AGENCY, permit STUDY AGENCY to audit and inspect all of such records and data necessary to ensure CONTRACTOR's compliance with the terms of this Agreement.

14.2 CONTRACTOR shall maintain books, records, documents, and other evidence pertaining to the reimbursable time and materials and hold them available for audit and inspection by STUDY AGENCY for a minimum of three (3) years from the date this Agreement is completed or otherwise terminated.

15. BUDGET

15.1 CONTRACTOR shall be authorized to rebudget funds up to a maximum of twenty percent (20%) between major categories in the contract budget as contained in Exhibit A. All rebudgeting in excess of twenty percent (20%) requires the prior written approval of the Chief of the Modeling and Meteorology Branch, Planning and Technical Support Division, Air Resources Board, or his representative. Under no circumstances shall the total contract amount exceed *COST*.

16. NOTICES

16.1 The persons and their addresses having authority to give and receive notices under this Agreement include the following:

STUDY AGENCY: John DaMassa, Chief
Modeling and Meteorology Branch
Planning &Technical Support Division
Air Resources Board
P.O. Box 2815
Sacramento, CA 95812

CONTRACTOR: *CONTACT PERSON*

ADDRESS

16.2 Any and all notices between STUDY AGENCY and CONTRACTOR provided for or permitted under this Agreement or by law shall be in writing and shall be deemed duly served when personally delivered to one of the parties, or in lieu of such personal services, when deposited in the United States mail, postage prepaid, addressed to such party.

17. DISPUTES

17.1 In the event a dispute between CONTRACTOR and the ARB Program Manager, CONTRACTOR should first discuss the problem informally with the ARB Program Manager. If the dispute is not resolved, the following two-step procedure shall be followed by both parties:

17.1.1 CONTRACTOR and the ARB Program Manager shall each write to the STUDY AGENCY Technical Committee stating the issues in the dispute and the basis for their positions. The STUDY AGENCY Technical Committee shall make a determination within fourteen (14) working days after receipt of the written communications from CONTRACTOR and ARB Program Manager. The STUDY AGENCY Technical Committee shall notify CONTRACTOR and the ARB Program Manager in writing of the decision and the reasons therefor.

17.1.2 If CONTRACTOR or the ARB Program Manager disagrees with the STUDY AGENCY Technical Committee's decision, written notice shall be provided to the other party of an intention to seek non-binding third-party mediation of the dispute. Both parties must agree to submit to mediation. The dispute shall be considered by a panel of three (3) experts in the field of dispute. Each party shall have the right to select one panelist. The selected panel will then select a third member. The panel shall set a hearing date, time, and place convenient to the parties within thirty (30) days of panel selection. Within five (5) working days of the hearing date, each party shall submit a written statement to the panel and the other party setting forth the issues and

arguments to be presented. The hearing shall be informal with an opportunity for both parties to present their arguments. The panel shall provide the parties with a written decision within thirty (30) days of the hearing. The decision shall be binding on the parties, unless referred to the Governing Board within thirty (30) days. The costs of the panel shall be borne equally by the parties.

17.1.3 If either party has so requested, the matter shall be heard by the STUDY AGENCY Board, and the Board's determination shall be final.

18. POLITICAL ACTIVITY PROHIBITED

18.1 None of the funds, materials, property, or services provided under this Agreement shall be used for any political activity, or to further the election or defeat of any candidate for public office contrary to federal or state laws, statutes, regulations, rules or guidelines.

19. LOBBYING PROHIBITED

19.1 None of the funds provided under this Agreement shall be used for publicity, lobbying, or propaganda purposes designed to support or defeat legislation before the Congress of the United States of America or the Legislature of the State of California.

20. CONFLICT OF INTEREST

20.1 No officer, employee, or agent of STUDY AGENCY who exercises any function or responsibility for planning and carrying out the services provided under this Agreement shall have any direct or indirect personal financial interest in this Agreement. CONTRACTOR shall comply with all federal and state conflict of interest laws, statutes, and regulations which shall be applicable to all parties and beneficiaries under this Agreement and any officer, agent, or employee of STUDY AGENCY.

21. COMPLIANCE WITH LAWS

21.1 CONTRACTOR shall comply with all federal and state laws, statutes, regulations, rules, and guidelines which apply to its performance under this Agreement.

22. SEVERABILITY

22.1 In the event that any one or more provisions contained in this Agreement shall for any reason be held to be unenforceable in any respect by a court of competent jurisdiction, such holding shall not affect any other provisions of this Agreement, and the Agreement shall then be construed as if such unenforceable provisions are not a part hereof.

23. TIME IS OF THE ESSENCE

23.1 It is understood that for CONTRACTOR's performance under this Agreement, time is of the essence. The parties reasonably anticipate that CONTRACTOR will, to the reasonable satisfaction of STUDY AGENCY, complete all services to be provided hereunder by *DATE*, provided that CONTRACTOR neither causes nor is caused unreasonable delay in such performance.

24. GOVERNING LAW

24.1 Venue for any action arising out of or relating to this Agreement shall only be in Fresno County, California.

24.2 The rights and obligations of the parties and all interpretation and performance of this Agreement shall be governed in all respects by the laws of the State of California.

25. BINDING UPON SUCCESSORS

25.1 This Agreement, including all covenants and conditions maintained herein, shall be binding upon and inure to the benefit of the parties, including their respective successors-in-interest, assigns, and legal representatives.

26. INSPECTION AND RELEASE OF DATA

26.1 Upon termination or expiration of this Agreement, all data which is received, collected, produced, or developed by CONTRACTOR under this Agreement shall become the exclusive property of STUDY AGENCY, provided, however, CONTRACTOR shall be allowed to retain a copy of any non-confidential data received, collected, produced, or developed by CONTRACTOR under this Agreement, subject to STUDY AGENCY's exclusive ownership rights stated herein. Accordingly, CONTRACTOR shall surrender to STUDY AGENCY all such data which is in its (including its subcontractors, subconsultants, or agents) possession, without any reservation of right or title not otherwise enumerated herein.

26.2 STUDY AGENCY shall have the right, at reasonable times during the term of this Agreement, to inspect and reproduce any data received, collected, produced, or developed by CONTRACTOR under this Agreement. No reports, professional papers, information, inventions, improvements, discoveries, or data obtained, prepared, assembled, or developed by CONTRACTOR, pursuant to this Agreement, shall be released or made available (except to STUDY AGENCY) without prior, express written approval of STUDY AGENCY while this Agreement is in force.

27. NONDISCRIMINATION

27.1 The provisions of Exhibit D, the "Nondiscrimination Clause," is attached hereto and incorporated herein.

28. ENTIRE AGREEMENT

28.1 This Agreement, including all attached exhibits and documents which are referred to and incorporated herein, constitutes the entire agreement between CONTRACTOR and STUDY AGENCY with respect to the subject

matter hereof and supersedes all previous negotiations, proposals, commitments, writings, advertisements, publications, and understandings of any nature whatsoever unless expressly included in this Agreement.

29. WAIVER

29.1 No waiver of any breach of this Agreement shall be held to be a waiver of any other or subsequent breach. All remedies afforded in this Agreement shall be taken and construed as cumulative, that is, in addition to every other remedy provided therein or by law. The failure of STUDY AGENCY to enforce at any time any of the provisions of this Agreement or to require at any time performance by CONTRACTOR of any of the provisions therefor, shall in no way be construed to be a waiver of such provisions nor in any way affect the validity of this Agreement or any part thereof or the right of STUDY AGENCY to thereafter enforce each and every such provision.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the day and year first hereinabove written through their respective duly appointed and authorized representatives.

STUDY AGENCY
SAN JOAQUIN VALLEYWIDE AIR POLLUTION STUDY AGENCY

By _____

By_____

Chair

CONTRACTOR

Print Name and Title

_____

Tax I.D. No.

Recommended for approval:
SAN JOAQUIN VALLEYWIDE AIR POLLUTION STUDY AGENCY POLICY COMMITTEE

By _____

By_____

Title _____

Approved as to legal form:
SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL STUDY AGENCY

Philip M. Jay

Study Agency Counsel

Recommended for approval:
SAN JOAQUIN VALLEYWIDE AIR POLLUTION STUDY AGENCY TECHNICAL COMMITTEE

Approved as to accounting form:
SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL STUDY AGENCY

By _____	By _____
	Roger W. McCoy
Title _____	Finance Officer