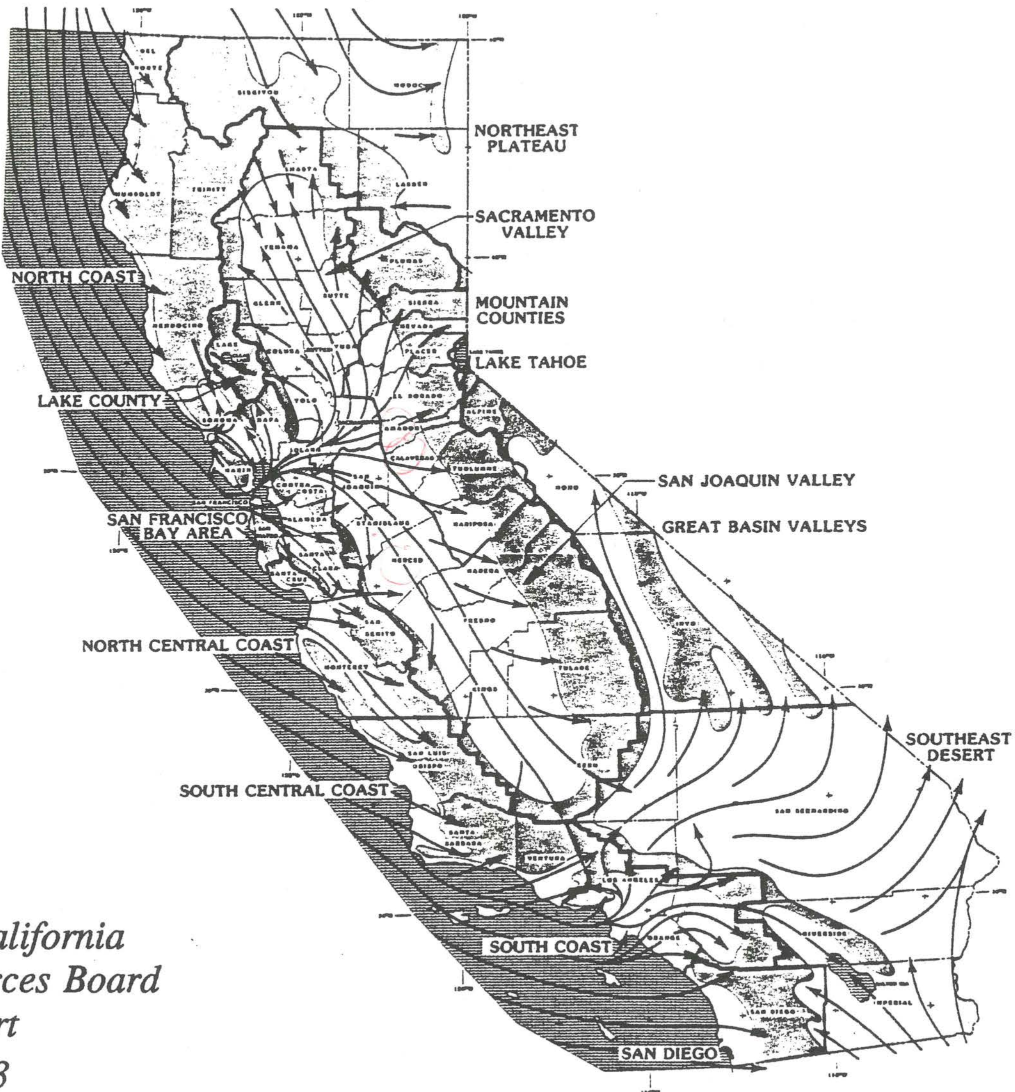
Assessment and Mitigation of the Impacts of Transported Pollutants on Ozone Concentrations in California



State of California
Air Resources Board
Staff Report
June 1993

State of California
AIR RESOURCES BOARD

ASSESSMENT AND MITIGATION OF THE IMPACTS OF TRANSPORTED POLLUTANTS ON OZONE CONCENTRATIONS IN CALIFORNIA

TRIENNIAL REVIEW

June 1993

Staff Report: Initial Statement of Reasons

Prepared by

Technical Support Division

ACKNOWLEDGMENTS

The 1993 transport assessment update was prepared by the staffs of the Modeling and Meteorology Branch and the Air Quality Data Branch under the direction of Don McNerny and Rich Bradley, respectively.

Leadership and coordination was provided by Debora Popejoy, Manager of the Air Quality Analysis Section. Paul Allen was instrumental in producing the final report.

Supervision for portions of the effort were provided by Andrew Ranzieri, Manager of the Modeling Support Section and Arndt Lorenzen, Manager of the Meteorology Section.

We thank Jeanne Simmons and Lindy Hargis for clerical assistance.

Special thanks go the the following ARB staff who played a major role in preparing this assessment:

<u>Technical Support Division</u>

Paul Allen	Susan Lorenzen
Barbara Amberson	Roy Moore
Charles Bennett	Liz Niccum
Steve Gouze	Saffet Tankrikulu
Rich Hackney	Bill Wilson
David Ipps	Jeff Wright

<u>Office of Air Quality, Transportation and Planning</u>

Kurt Karperos

<u>Office of Legal Affairs</u>

Robert Jenne

TABLE OF CONTENTS

TABLE OF CONTENTS
(continued)

ASSESSMENT AND MITIGATION OF THE IMPACTS OF TRANSPORTED POLLUTANTS ON OZONE CONCENTRATIONS IN CALIFORNIA

Triennial Review

SUMMARY AND OVERVIEW

The movement or transport of pollutants from an upwind area frequently causes or contributes to exceedances of the state ambient air quality standard for ozone (state ozone standard) in a downwind area. In some instances, this transport is nearly the sole cause of such exceedances.

Under section 39610(b) of the California Clean Air Act of 1988 (the Act), the Air Resources Board (ARB) must assess the relative contributions of upwind emissions to downwind state ozone standard exceedances. The Act also requires the ARB to update this assessment at least every three years. The first assessment was approved by the ARB in August 1990. This report is the first triennial update of the August 1990 assessment. This update includes an evaluation of the impact of transport on areas designated nonattainment for ozone, an evaluation of new information and research results related to transport couples identified previously or identified as needing further study, and evaluations for eight potentially new transport couples. The staff recommends identifying six of the eight newly assessed couples as transport couples.

A list of all current and proposed couples is shown in Table 1. The six couples proposed for identification in this update are shown in **bold lettering**. These proposed new couples are:

1. San Joaquin Valley Air Basin to South Central Coast Air Basin,
2. Mexico to San Diego Air Basin,
3. Mexico to Southeast Desert Air Basin,
4. Broader Sacramento Area to Mountain Counties Air Basin,
5. San Joaquin Valley Air Basin to Mountain Counties Air Basin, and
6. San Francisco Bay Area Air Basin to Mountain Counties Air Basin.

Except for the proposed identification of Mexico as an upwind area, the proposed new couples include upwind areas that were previously identified as transport contributors in the 1990 assessment.

The two couples that were evaluated but which are not proposed for identification at this time are:

1. Southeast Desert Air Basin to the South Coast Air Basin and
2. San Luis Obispo County to the San Joaquin Valley Air Basin.

The staff did not find any evidence of transport of ozone precursors or ozone that would impact violations in these downwind areas.

In the August 1990 transport assessment, the staff identified the upwind area to Great Basin Valleys Air Basin as the San Joaquin Valley Air

Basin. The staff now proposes that the Board amend the identification regulation to be consistent with the Board's action by identifying the San Joaquin Valley Air Basin as the source of the transport pollutants affecting the Great Basin Valleys Air Basin rather than leaving it as "undetermined."

TABLE 1

Transport Identification

AREAS IMPACTED BY TRANSPORT:		AREAS OF ORIGIN OF TRANSPORT:
1.	North Central Coast	San Francisco Bay Area
2.	South Central Coast	South Coast California Coastal Waters **San Joaquin Valley**
3.	South Coast	South Central Coast
4.	San Diego	South Coast **Mexico**
5.	Upper Sacramento Valley	Broader Sacramento Area
6.	Broader Sacramento Area	San Francisco Bay Area San Joaquin Valley
7.	San Joaquin Valley	San Francisco Bay Area Broader Sacramento Area
8.	Great Basin Valleys	San Joaquin Valley
9.	Southeast Desert	South Coast San Joaquin Valley **Mexico**
10.	San Francisco Bay Area	Broader Sacramento Area
11.	**Mountain Counties**	**Broader Sacramento Area** **San Joaquin Valley** **San Francisco Bay Area**

Note: Bold lettering identifies the proposed new upwind and downwind areas.

The Act also requires the ARB to establish mitigation requirements for upwind districts commensurate with the degree of contribution to downwind state ozone standard exceedances. However, quantification of the transport contribution is not currently feasible, therefore, the staff has grouped transport impacts into three broad qualitative categories: overwhelming, significant, and inconsequential. Overwhelming transport refers to the impacts of transported pollutants or precursors which cause the exceedance in the downwind area, the exceedance is caused by the upwind sources of pollutants. Significant transport refers to the impacts which contribute to the exceedance in the downwind area, the exceedance is caused by both upwind and local sources. And Inconsequential transport refers to the impacts which do not contribute to the exceedance in the downwind area, the exceedance is caused by local sources alone.

The mitigation requirements adopted in August 1990 have since been changed. There are now only two parts to the mitigation requirements for upwind districts: (1) commit to adopt best available retrofit control technology for permitted stationary sources of reactive organic gas (ROG) and oxides of nitrogen (NOx) emissions, and (2) where overwhelming transport exists, include sufficient measures in the air quality plans to ensure expeditious attainment of the ozone standard in the downwind districts.

The staff recommends that the Board amend the mitigation regulation (Title 17, California Code of Regulations, section 70600) to assign mitigation responsibilities to the upwind areas based on new findings of overwhelming transport. These mitigation requirements would be consistent with the present mitigation requirements. The staff proposes that the regulation be amended to require those upwind areas identified as causing overwhelming impact to adopt sufficient control measures to attain the ozone standard within the impacted area. The staff proposes to add mitigation responsibility for overwhelmed impacts for these proposed new couples:

1. Broader Sacramento Area to Mountain Counties Air Basin
2. San Joaquin Valley Air Basin to Mountain Counties Air Basin.

The staff also proposes that the Board update its findings on the severity of transport impacts and make corresponding changes to the transport mitigation regulations. The staff proposes the addition of a classification of "overwhelming" transport to the following previously identified couples:

1. San Francisco Bay Area Air Basin to the northwestern portion of the San Joaquin Valley Air Basin (near Crow's Landing) and
2. San Francisco Bay Area Air Basin to the western portion of the Broader Sacramento Area (near Vacaville).

Upwind areas that are identified as causing overwhelming impacts in portions of a downwind air basin, will only be responsible for attainment in that portion of the downwind air basin and under those conditions that are impacted by overwhelming transport and not for attainment in the entire downwind air basin. The portion of the downwind air basin is generally a small band near the boundary of the upwind area. The downwind air basin is small band near the boundary of the upwind area. The downwind air basin is not relieved of attainment responsibility for those days not impacted by overwhelming transport.

The staff also proposes the addition of a classification of "significant" transport from the South Coast Air Basin to Southeast Desert Air Basin.

In May 1992, the ARB changed the boundaries of the Broader Sacramento Area and the Upper Sacramento Valley so that Yuba City moved from the Broader Sacramento Area to the Upper Sacramento Valley. This assessment reflects the changed boundaries but proposes no change to the mitigation regulations.

Table 2 summarizes the staff's proposed finding for the six new couples, the reassessment of the previous identified couples, and the findings of the 1990 assessment. The new or revised findings are highlighted with **bold lettering.**

TABLE 2

Summary of Staff Recommendations on
Impact of Transported Air Pollutants from
Upwind Areas on Downwind Ozone Concentrations

Transport Couples		Transport Characterization*
1.	**Broader Sacramento Area to Mountain Counties**	**O**
2.	**San Joaquin Valley to Mountain Counties**	**O**
3.	**San Francisco Bay Area to Mountain Counties**	**S**
4.	**Mexico to Southeast Desert**	**O, S**
5.	**Mexico to San Diego**	**O, S, I**
6.	**San Joaquin Valley to South Central Coast**	**S, I**
7.	San Francisco Bay Area to Broader Sacramento Area	O, S, I
8.	San Francisco Bay Area to San Joaquin Valley	O, S, I
9.	South Coast to Southeast Desert	O, S, I
10.	Broader Sacramento Area to Upper Sacramento Valley	O, S, I
11.	San Francisco Bay Area to North Central Coast Coast	O, S
12.	San Joaquin Valley to Southeast Desert	O, I
13.	South Coast to San Diego	O, S, I
14.	South Coast to South Central Coast	S, I
15.	South Central Coast to South Coast	S, I
16.	San Joaquin Valley to Broader Sacramento Area	S, I
17.	San Joaquin Valley to Great Basin Valleys	O
18.	Broader Sacramento Area to San Joaquin Valley	S, I
19.	Broader Sacramento Area to San Francisco Bay Area	S, I
20.	Calif. Coastal Waters to South Central Coast	S

* O = overwhelming
S = significant
I = inconsequential

Note: Bold lettering identifies the proposed new couples' transport characterizations. Couples numbered 1 through 6 are the proposed new couples. The staff recommends changes to the mitigation regulation with new responsibilities to mitigate overwhelming impacts for couples 7 and 8. Couples 9 and 10 have new responsibilities within the planning process but without changes to the mitigation regulation. Couples 11 through 13 were reevaluated but with no new characterization of transport. There was no new assessment for couples numbered 14 through 20.

CHAPTER I

Background

A. Introduction

The California Clean Air Act of 1988 (the "Act"; Stats. 1988, Chapter 1568; as amended by AB 2783, Stats. 1992, Chapter 945) requires each air pollution control and air quality management district in which a state ambient air quality standard for ozone, carbon monoxide, sulfur dioxide, or nitrogen dioxide is exceeded to develop a plan and an emission control program to attain the standard(s). The Act recognizes that ozone and ozone precursors can be carried by winds over long distances and thereby contribute to air quality problems outside the district or air basin where they originated. To address this, the Act requires upwind districts to mitigate the impact on downwind areas of pollutants generated in the upwind districts. The Act directs the Air Resources Board (ARB or Board) to assess transport and to establish mitigation requirements for upwind districts. This chapter provides background information related to the assessment and mitigation and describes the public consultation process.

B. Transport Assessment

The Act directs the ARB to: (1) identify downwind areas affected by transported air pollutants and the upwind basins or regions which are the sources of the pollutants, and (2) assess the relative contributions of upwind emissions to downwind ozone concentrations to the extent permitted by available data (Health and Safety Code section 39610(a) and (b)). The ARB is required to update this analysis at least once every three years (Health and Safety Code 39610(d)). The Health and Safety Code does not preclude the staff from reporting to the Board on new findings and research when results become available. The staff has and will continue to report to the Board on significant findings between the triennial updates.

In December 1989, the ARB adopted a regulation identifying 14 transport couples, each consisting of an upwind area that is the source of transported ozone or ozone precursors and a downwind receptor area impacted by those pollutants (Title 17, California Code of Regulations, section 70500). In May 1992, the ARB approved changes to the transport identification regulation which redefined the boundaries of the Upper Sacramento Valley and the Broader Sacramento Area.

In August 1990, the ARB approved a qualitative assessment of the relative contributions of upwind emissions to downwind ozone concentrations. In that assessment, the relative contribution was qualitatively classified as either "overwhelming", "significant", or "inconsequential."

This report is the first triennial update of the August 1990 assessment. The scope of this transport assessment update includes an evaluation of areas recently designated nonattainment for ozone (that is, the Mountain Counties Air Basin) in order to identify the extent to which they are impacted by transport. It also includes an evaluation of new information and research results related to transport couples identified previously or identified as needing further study. Specific changes to the transport identification regulation are discussed in Chapter II. Proposed new transport couples are discussed in Chapter IV. Assessments of couples not proposed for identification are discussed in Chapter V. Chapter VI discusses the staff's recommendations to change the mitigation regulation for previously identified couples. Chapter VII discusses the assessment updates for the rest of the previously identified couples.

C. Transport Impact Mitigation

Health and Safety Code section 39610(b) directs the ARB to establish mitigation requirements for upwind districts commensurate with their contributions to the air quality problems in the downwind areas. This was first done in conjunction with the August 1990 transport assessment. There were three parts to the mitigation requirements applicable to upwind districts: (1) adopt a "no-net-increase" permitting program for all new or modified stationary sources, (2) commit to adopt best available retrofit control technology for permitted stationary sources of reactive organic gas (ROG) and oxides of nitrogen (NOx) emissions, and (3) where overwhelming transport exists, include sufficient measures in the air quality plans to ensure expeditious attainment of the ozone standard in the downwind districts.

In March 1993 the ARB approved the deletion of the "no-net-increase" requirement from the mitigation regulation (section 70600). The effect of this deletion is that permitting requirements for all districts are those specified in the Act as it was amended in 1992, regardless of whether the district is a source of transported pollutants. The remaining two mitigation requirements were not changed. The modifications made in March 1993, have not yet been submitted to the Office of Administrative Law and have not yet been legally effective. For reference, the text of the March 1993 amendments can be found in Appendix E.

The only part of the transport mitigation requirements affected by this update is the part related to expeditious attainment in the downwind districts affected by overwhelming transport. The specific changes to the mitigation regulation are discussed in Chapter II.

D. Public Consultation Process

As part of this year's transport assessment update, the staff conducted a public consultation workshop on March 23, 1993, to discuss its transport assessment studies with districts and other interested parties. A copy of the workshop notice is shown in Appendix A, and the list of workshop participants is shown in Appendix B.

At the workshop, the staff presented an overview of transport assessment methods. Assessments and impacts of each new proposed transport couple and updated assessments (if any) of the previous couples were discussed. A handout provided to the workshop participants summarized

CHAPTER II

Proposed Regulatory Changes

The Air Resources Board (ARB) is required to update the transport analysis at least once every three years. As part of this update, the staff recommends that new transport couples be identified and that additional mitigation requirements be established for some upwind areas. This chapter describes the ARB staff's proposals to change the regulation (Title 17, CCR, section 70500) that identifies the transport couples and the regulation (Title 17, CCR, section 70600) that specifies the mitigation requirements for upwind areas. This chapter also discusses the impacts and alternatives to this proposed action.

A. Transport Identification Changes

Since the Board's original adoption in 1989 of a regulation identifying 14 transport couples, the ARB staff has evaluated new data. Based on the analysis of air quality data, meteorological data, and data from special studies, the staff recommends the identification of 6 additional transport couples. These new couples are shown in Table II.1, where the proposed new upwind and downwind areas are shown in **bold lettering**. In summary, the new couples are: (1) Broader Sacramento Area to Mountain Counties Air Basin, (2) San Joaquin Valley Air Basin to Mountain Counties Air Basin, (3) San Francisco Bay Area Air Basin to Mountain Counties Air Basin, (4) Mexico to Southeast Desert Air Basin, (5) Mexico to San Diego Air Basin, and (6) San Joaquin Valley Air Basin to South Central Coast Air Basin. Except for the proposed identification of Mexico as an upwind area, the proposed new couples include only upwind areas that were previously identified in the 1990 assessment as transport contributors. The proposed text of Title 17, CCR, section 70500 can be found in Appendix C.

At the December 1989 Board meeting, the staff identified the Great Basin Valleys Air Basin as a receptor of transported pollutants but did not at that time identify the upwind transport contributor. In the August 1990 transport assessment[1], the staff established that the upwind area was the San Joaquin Valley Air Basin. The mitigation regulation was adopted to reflect the mitigation requirements for the San Joaquin Valley, but the identification regulation was not amended at that time. The staff now proposes to amend the identification regulation to be consistent with mitigation regulation by identifying the San Joaquin Valley Air Basin as the source of the transport pollutants affecting the Great Basin Valleys Air Basin rather than leaving it as "undetermined."

B. Changes Resulting from the Transport Assessment

Besides proposing additional transport couples, the staff proposes that the Board update its findings on the severity of transport impacts and to make corresponding changes to the transport mitigation regulations. The report focuses on the 6 proposed new couples and 7 of the 14 previously

TABLE II.1

Transport Identification

AREAS IMPACTED BY TRANSPORT:		AREAS OF ORIGIN OF TRANSPORT:
1.	North Central Coast	San Francisco Bay Area
2.	South Central Coast	South Coast California Coastal Waters **San Joaquin Valley**
3.	South Coast	South Central Coast
4.	San Diego	South Coast **Mexico**
5.	Upper Sacramento Valley	Broader Sacramento Area
6.	Broader Sacramento Area	San Francisco Bay Area San Joaquin Valley
7.	San Joaquin Valley	San Francisco Bay Area Broader Sacramento Area
8.	Great Basin Valleys	San Joaquin Valley
9.	Southeast Desert	South Coast San Joaquin Valley **Mexico**
10.	San Francisco Bay Area	Broader Sacramento Area
11.	**Mountain Counties**	**Broader Sacramento Area** **San Joaquin Valley** **San Francisco Bay Area**

Note: Bold lettering identifies the proposed new upwind and downwind areas.

identified couples. Each of these is discussed below.

1. Transport Findings

The staff's assessments of transport contained in this report, which drew from all available evidence, were performed in cooperation with the affected air pollution control districts. The staff examined representative days when the state ozone standard was violated in downwind areas. Exceedances identified as extreme concentrations, however, generally were not examined as being affected by transport (see Chapter III on discussion of extreme concentrations) because attainment designations are not based on extreme concentrations. Also, because of the limitations of the data and the inherent difficulties in understanding and characterizing the mechanisms that result in ozone formation and transport, the staff's findings are qualitative, as they were in the 1990 assessment. Because the data and tools are not available to quantify the upwind contributions to ozone violations in the downwind areas, a qualitative assessment is consistent with the language of Health and Safety Code section 39610 (a) and (b) which provides for assessments to the extent permitted by available data. Therefore, the staff continues to characterize the impact of transported ozone or ozone precursors on downwind ambient ozone concentrations as "overwhelming", "significant", or "inconsequential".

In addition to proposing 6 new couples, the staff reevaluated transport impacts of 7 previously identified couples. These couples were reevaluated because there was either new data available from studies, new monitor sites were established, or boundary changes had been made (e.g. between the Broader Sacramento Area and Upper Sacramento Valley). From the reevaluation of these 7 existing couples, the staff recommends changes to the mitigation regulations for 2 couples. The San Francisco Bay Area Air Basin to San Joaquin Valley Air Basin couple was reevaluated using new data available from the San Joaquin Valley Air Quality Study. The staff has also reevaluated transport from the San Francisco Bay Area Air Basin to the Broader Sacramento Area. For both of these couples, a new finding of "overwhelming" transport to the downwind air basin near the upwind area boundary is proposed as addition to the previous findings.

The reevaluation of the remaining 5 couples did not result in recommendations for mitigation requirement changes, but the staff proposes changes to the characterization of the severity of transport impacts for 1 of these 5 couples. Impacts of transport on Imperial County were considered in the reevaluation of transport from the South Coast Air Basin to the Southeast Desert Air Basin because Imperial County was not included in the 1990 assessment. For this couple, the staff proposes to add a finding of "significant" transport.

The Broader Sacramento Area to the Upper Sacramento Valley couple was reevaluated because the boundary separating the two areas was redefined by the Board in May 1992. This boundary change is discussed in Chapter VII. Although the staff found "overwhelming" transport from the Broader Sacramento Area to The Upper Sacramento Valley at Yuba City, this does not change either the transport characterization nor the mitigation regulation since the Broader Sacramento Area was identified as causing "overwhelming" transport to the Upper Sacramento Valley in the previous transport assessment[2].

The transport impact from the San Francisco Bay Area Air Basin on air quality measured at the Pinnacles monitor in the North Central Coast Air Basin was also evaluated since data from this monitor were not considered in the 1990 assessment. The staff does not propose to add any new finding for the San Francisco Bay Area to the North Central Coast Air Basin couple.

After reviewing a recent transport assessment of the South Coast Air Basin to the San Diego Air Basin done by the staff of the San Diego Air County Pollution Control District and reevaluating the San Joaquin Valley transport to the Southeast Desert Air Basin, the staff reaffirmed its 1990 findings in both cases. Other previously identified couples were not reevaluated because new data did not suggest any changes to the previous assessment.

The staff also assessed two other prospective couples but does not recommend that they be identified at this time. These two couples are: (1) Southeast Desert Air Basin to the South Coast Air Basin and (2) San Luis Obispo County to the San Joaquin Valley Air Basin. The staff did not find any evidence of transport of ozone precursors or ozone that would impact violations in these downwind areas.

Table II.2 summarizes the staff's proposed findings for 6 new couples, the reassessment of the previously identified couples, and the unchanged findings of the 1990 assessment. The new or revised findings are highlighted with **bold lettering.**

2. Mitigation Changes

The staff recommends that the Board amend the mitigation regulation (Title 17, CCR, section 70600) to assign mitigation responsibilities to the upwind areas based on new findings of overwhelming transport. These proposed mitigation requirements are consistent with the present mitigation requirements. The staff proposes that the regulation be amended to require those upwind air basins identified as causing overwhelming impacts to adopt control measures sufficient to attain the ozone standard within the impacted areas. An upwind air basin that is identified as causing overwhelming impacts in portions of a downwind air basin, will be responsible only for attainment in portions of the downwind air basin and under those conditions that are impacted by overwhelming transport and not for attainment in the entire downwind air basin. Under these circumstances, the portion of the downwind air basin is generally a small band near the boundary of the upwind area. The downwind air basin is not relieved of control responsibilities for those days not affected by overwhelming transport nor for days on which local emissions contribute to ozone violations. The proposed text of the mitigation regulation can be found in Appendix D.

TABLE II.2

Summary of Staff Recommendations on
Impact of Transported Air Pollutants from
Upwind Areas on Downwind Ozone Concentrations

	Transport Couples	Transport Characterization*
1.	**Broader Sacramento Area to Mountain Counties**	**O**
2.	**San Joaquin Valley to Mountain Counties**	**O**
3.	**San Francisco Bay Area to Mountain Counties**	**S**
4.	**Mexico to Southeast Desert**	**O, S**
5.	**Mexico to San Diego**	**O, S, I**
6.	**San Joaquin Valley to South Central Coast**	**S, I**
7.	San Francisco Bay Area to Broader Sacramento Area	O, S, I
8.	San Francisco Bay Area to San Joaquin Valley	O, S, I
9.	South Coast to Southeast Desert	O, S, I
10.	Broader Sacramento Area to Upper Sacramento Valley	O, S, I
11.	San Francisco Bay Area to North Central Coast Coast	O, S,
12.	San Joaquin Valley to Southeast Desert	O, I
13.	South Coast to San Diego	O, S, I
14.	South Coast to South Central Coast	S, I
15.	South Central Coast to South Coast	S, I
16.	San Joaquin Valley to Broader Sacramento Area	S, I
17.	San Joaquin Valley to Great Basin Valleys	O
18.	Broader Sacramento Area to San Joaquin Valley	S, I
19.	Broader Sacramento Area to San Francisco Bay Area	S, I
20.	Calif. Coastal Waters to South Central Coast	S

* O = overwhelming
S = significant
I = inconsequential

Note: Bold lettering identifies the proposed new couples and their proposed transport characterizations. Couples numbered 1 through 6 are the proposed new couples. The staff recommends changes to the mitigation regulation with new responsibilities to mitigate overwhelming impacts for couples 7 and 8. Couples 9 and 10 have new responsibilities within the planning process but without changes to the mitigation regulation. Couples 11 through 13 were reevaluated but with no new characterization of transport. There was no new assessment for couples numbered 14 through 20.

C. Environmental/Economic Impacts

Amendment of the identification regulation pursuant to Health and Safety Code section 39610(a) may result in adverse impacts. Identification by the Board of an area as a contributor or receptor of transported air pollutants will result in the district and the Broad amending air quality plans in accordance with the California Clean Air Act. The recommended changes to the mitigation regulation will not change the mitigation requirements, but will extend those requirements to additional areas. The mitigation regulation may result in both beneficial and adverse impacts. The possible impacts are discussed below.

1. Environmental Impacts

The implementation of required mitigation measures in upwind areas will have positive environmental impacts in the downwind and in most of the upwind areas. The mitigation regulation will provide for more expeditious attainment of the ozone standard in downwind areas by reducing emissions of both ROG and NOx that contribute to the poor air quality there. The staff does not anticipate new impacts in upwind areas due to application of BARCT as required by the mitigation regulation, because the staff has not proposed any new upwind areas except for Mexico (Mexico is not subject to the proposed regulations). The proposed new couples include only the upwind areas that were previously identified as transport contributors in the 1990 assessment.

The requirement on upwind areas to provide for attainment in overwhelmed downwind areas may result in adoption of additional controls in the affected upwind areas. The environmental impacts of those controls will be addressed in the formal planning and rulemaking process in the upwind districts.

2. Economic Impacts

The Board's Executive Officer has determined that the proposed regulations will not create costs or savings (as defined in Government Code section 11346.5(a)(6)) to any state agency or in federal funding to the state, costs or mandate to any local agency or school district reimbursable by the state pursuant to Part 7 (commencing with section 17500) Division 4, Title 2 of the Government Code, or result in other nondiscretionary costs or savings to local agencies, except as noted below:

The amended regulations may create costs to, and impose a mandate upon, the San Francisco Bay Area Air Quality Management District, the San Joaquin Valley Air Quality Management District, and those air pollution control and air quality management districts located within the Broader Sacramento Area. These districts may need to adopt additional control measures in order to mitigate the impact of their emissions on downwind areas. Such control measures would be proposed as part of district air quality attainment plans for ozone under the California Clean Air Act, and would be adopted by the districts pursuant to their normal regulatory adoption procedures. (See Health and Safety Code sections 40725-40728.5.)

However, this mandate does not require state reimbursement pursuant to Government Code sections 17500 et seq., and section 6 of Article XIIIB of the California Constitution, because the districts have the authority to levy fees sufficient to pay for the mandated program. (See Health and Safety Code sections 42311 and 41512.5.)

The air pollution control and air quality management districts responsible for areas designated nonattainment for ozone, carbon monoxide, sulfur dioxide, and nitrogen dioxide are required to prepare and periodically update air quality plans pursuant to Health and Safety Code section 40910 et seq. The costs incurred by the districts in connection with the planning process are not reimbursable by the state pursuant to Part 7 (commencing with section 17500) Division 4, Title 2 of the Government Code because the applicable statutes do not mandate a new program or higher level of service of an existing program within the meaning of section 6 Article XIIIB of the California Constitution. In addition, districts have the authority to levy fees sufficient to cover their costs for planning, enforcement, and other district programs. See Health and Safety Code section 42311 and 41512.5.

The Board does not anticipate that the amendment of the identification or the mitigation regulations will result in additional controls statewide, but merely change the distribution of emission controls from the downwind areas to the upwind areas. Ozone exceedances are already occurring and the Act requires that districts adopt emission control measures to attain the ozone standard. If an upwind area has to do more because of the impact of transported pollutants or precursors to a downwind area, then the downwind area has to do less, perhaps much less because the downwind controls would be ineffective in some transport situations.

However, the regulations could result in district control measures on some individual businesses, that would not otherwise be required. It is therefore possible that some individual businesses will experience adverse economic impacts because of the Board's regulatory action. Control strategies and measures adopted by upwind districts pursuant to the mitigation requirement to provide attainment in the downwind areas could have direct economic impacts on businesses in the upwind districts. Districts are required to include a preliminary assessment of the cost-effectiveness of control measures in their attainment plans adopted pursuant to California Clean Air Act. All districts must also consider cost-effectiveness of proposed rules at the time of district rule making, and districts with greater than 500,000 population must analyze the socio-economic impact of proposed rules. (See Health and Safety Code section 40728.5.) An opportunity for public review and participation is provided for all district rulemakings. Any indirect economic effects from the proposed regulations will be disclosed and addressed during the districts' proceedings.

The Board must determine, as part of its action on the proposed regulations, that no alternative considered by the agency would be more effective in carrying out the purpose for which the regulations are proposed, and that no alternative would be as effective and less burdensome to affect private persons than the proposed action.

D. Alternatives

State law explicitly requires the ARB to assess the contribution of upwind emissions to downwind ozone concentrations based on the preponderance of evidence, and to establish transport mitigation requirements that are commensurate with those contributions (Health and Safety Code section 39610 (b)). This mandate precludes consideration of the "no action" alternative. The identification process leaves little room for alternatives. Each transport couple is accompanied by discussion of the basis for the identification. Implicit in these discussions is the consideration of possible alternatives. Various alternatives to the mitigation requirements were considered by the staff when the regulation was revised in March 1993. This proposal does not change the requirements; it only amends the regulation to assign additional responsibilities to previously identified upwind areas based on new findings of overwhelming transport.

E. References

1. Air Resources Board, June 1990: Assessment and Mitigation of the Impacts of Transported Pollutants on Ozone Concentrations within California.

2. Air Resources Board, August 1990: Supplement to the June 1990 Staff Report "Assessment and Mitigation of the Transported Pollutants on Ozone Concentrations Within California."

CHAPTER III

The Impact of Transported Pollutants on Downwind Ozone Concentrations

A. Purpose of Transport Assessment Studies

As mentioned in Chapter I, the California Clean Air Act (the Act) requires the ARB to assess the relative contribution of upwind emissions to downwind ozone concentrations which exceed the state ozone standard. The transport assessment studies discussed in this report are intended to define this "relative contribution" to the fullest extent possible.

B. Terminology

Throughout this report, the staff will refer to ozone levels as "ozone concentrations", a more precise term. Ozone is produced by the chemical reaction of nitrogen oxides and hydrocarbons in the presence of sunlight. For the purposes of this report, "nitrogen oxides" include nitric oxide and nitrogen dioxide as well as minor compounds also measured and commonly reported as nitrogen oxides such as nitric acid, nitrate radical, dinitrogen pentoxide, nitrous acid and peroxyacetyl nitrate.[1,2]

The terms "hydrocarbons", "reactive hydrocarbons", and "reactive organic gases" are used generally and interchangeably to mean all organic compounds which may participate in the ozone formation process.

This report assesses the impact of transported emissions for each transport couple identified according to Section 70500, Title 17, of the California Code of Regulations. The upwind and downwind areas that comprise these transport couples are usually defined as air basins, however, some adjustments are made for metropolitan area boundaries and topographical barriers.

Many references are made to the data collected during the 1990 San Joaquin Valley Air Quality Study/Atmospheric Utility Signatures, Predictions, and Experiments field programs. These programs will be referred to as SJVAQS/AUSPEX throughout this report.

C. Ozone Chemistry

The amount of pollutants transported to downwind areas is governed by meteorology, surface deposition, and the amount of pollutants emitted in the upwind area. Atmospheric chemistry and pollutant emissions in the downwind area determine how the transported pollutants affect downwind ozone concentrations.

Ozone is formed through a series of reactions requiring sunlight along with emissions of hydrocarbons and nitrogen oxides. The following three chemical equations show the fundamental ozone cycle.[3] The only important reaction leading to the formation of ozone (O_3) begins with the photodisassociation of nitrogen dioxide (NO_2) to nitric oxide (NO) and atomic oxygen (O):

$$NO_2 + \text{sunlight} \dashrightarrow NO + O \tag{1}$$

The atomic oxygen then quickly combines with molecular oxygen (O_2) to form ozone:

$$O + O_2 \dashrightarrow O_3 \tag{2}$$

These two reactions combine into the following reversible reaction:

$$NO_2 + O_2 + \text{sunlight} \leftarrow\!\!\dashrightarrow NO + O_3 \tag{3}$$

The concentrations of compounds in the reaction establish a dynamic equilibrium depending on the precursors and sunlight available. About 90 to 95 percent of the nitrogen oxides (NOx) are actually emitted as NO. Hydrocarbon emissions lead to the conversion of NO to NO_2 without consuming ozone, driving reaction (3) to the right. As concentrations of reactive hydrocarbons increase, the ozone formed from a given amount of NOx emissions also increases but only up to a certain point. As hydrocarbon emissions increase further, ozone concentrations do not increase appreciably unless more nitrogen oxides are introduced. An atmosphere such as this is called hydrocarbon rich, and ozone production is limited by the emissions of nitrogen oxides.

Typically, reactions consuming nitrogen oxides are faster than reactions consuming hydrocarbons in the atmosphere. As a result, as a parcel of polluted air leaves an urban area, nitrogen oxides are removed from the atmosphere faster than hydrocarbons. Downwind, the air mass becomes NOx deficient, and ozone production is limited by the amount of available NOx.[4]

Another effect of NOx emissions can be seen from equation (3). The increase in NO molecules causes the NO to combine with the O_3 forcing the reaction to the left. This behavior, known as scavenging, results in reduced ozone concentrations and higher NO_2 concentrations near the NO emission source. As the pollutants are carried downwind, the increased NO_2 leads to higher ozone concentrations. Thus, reducing NOx emissions in the upwind area will help decrease ozone concentrations downwind. Because of decreased ozone scavenging, this NOx emission reduction may lead to increased ozone concentrations near the source of the NOx emissions. However, hydrocarbon emission controls near the source of NOx reductions can be used to offset the ozone increase.

Transported ozone, hydrocarbons, and nitrogen oxides--all affect ozone concentrations in a downwind area. Hydrocarbon-to-NOx ratios are important indicators for precursor control in urban areas; high ratios favor NOx control while low ratios favor hydrocarbon control. But the hydrocarbon-to-NOx ratio may have little impact on ozone concentrations in relation to transport. Sillman[5] has shown that at low NOx concentrations, (up to 5 ppb), the rate of production of ozone increases proportionately with NOx and shows only a slight positive dependence on the hydrocarbon concentration. This finding is very different from ozone chemistry in the urban atmosphere where ozone formation depends on both NOx and hydrocarbons.

D. Methods of Analysis

The transport of ozone and its precursors from an upwind to a downwind area occurs when winds of a sufficient speed, direction, and duration are present. Transport can take place near the earth's surface or in layers up to several thousand feet above the surface. Pollutants transported aloft reach the surface when the low-level inversion disappears as a result of surface and convective heating. A coastal marine layer typically intrudes as far inland as 100 miles or more into most of California resulting in temperature inversions within the lowest several thousand feet of the atmosphere. Ozone generated near the surface on sunny days disperses throughout this mixed, marine layer. As the sun sets and the air near the ground cools, a ground-based inversion develops. The pollutants aloft remain in a layer which is now separated from the surface layer, and these pollutants can be transported in different directions than surface winds may indicate.

At night, the ozone concentrations near the ground decrease because without sunlight the photochemical process stops and no further ozone can be formed. Ozone is then removed from the atmosphere through deposition on vegetation or other surfaces or through reaction with nitric oxide. However, the ozone aloft remains. As the air is heated the next morning, heat-induced turbulence causes the nighttime inversion to gradually erode, and the mixed layer increases in height. As the mixed layer increases in height, ozone aloft (which may have been transported at night from another area) is carried to the surface.

The next three sections of this chapter describe the techniques used to assess the transport of air pollutants based upon the available data. Specifically, this chapter explains the three methods of assessment: photochemical grid modeling, meteorological data analysis, and air quality data analysis.

The results from two or more of the analytical approaches can be used to infer whether transport occurs or not. The more analyses which provide confirming results, the stronger the staff's conclusion that transport occurred. The comparison of emissions between upwind and downwind areas is important only in a relative sense. For instance, if a wind trajectory analysis indicates that transport winds move air from an upwind area to a downwind area, the potential impact on the downwind area's ozone concentration is dependent on the relative emissions between the two areas. If the upwind area has much higher emissions than the downwind area the potential impact is higher than if the downwind area has much higher emissions than the upwind area.

Sometimes different analytical approaches will yield conflicting results. In these cases, the recommendations are based on the staff's judgement of the most reliable approaches and information best confirmed by other approaches. For many transport couples there will be limited capability to quantify the impact of transported pollutants on downwind ozone concentrations. The recommendations in some cases will be more qualitative than in others.

1. Photochemical Grid Modeling

Photochemical grid models (PGMs) use mathematics to simulate the physical and chemical mechanisms that produce ozone in the atmosphere. The modeling domain is a 3-dimensional array of grid cells covering the area of interest. Typical grid cells are 5 by 5 kilometers (about 3 by 3 miles) in the horizontal and 50 to 500 meters (about 165 to 1640 feet) thick in the vertical dimension. A modeling domain may require 10,000 cells to cover an area of interest. Meteorological data such as wind speed, wind direction, turbulence, and temperature must be input into the model for each cell and for each hour of simulation. The PGM then calculates the hourly concentrations of precursors of ozone within each cell taking into account emissions, the movement of pollutants among cells, the chemistry that occurs among chemical species within each cell, and the meteorological variables such as temperature that influence chemical reaction rates.

The meteorological data required to run a PGM must be collected in sufficient detail to describe the spatial and temporal variability that may exist within the modeling domain. Since it is not feasible to collect meteorological data for each cell, data values for most cells must be interpolated from the available surface and aloft monitoring data. In most areas of California that are close to mountains or to the ocean, values for meteorological variables change rapidly over relatively short distances. Also, wind speed and direction, and temperature change with height. Existing surface and aloft meteorological monitoring networks are not adequate to describe these changes, and special monitoring programs are required to supplement these networks where a PGM will be used.

A PGM will calculate pollutant concentrations within each cell for each hour. The results of these calculations are influenced by initial and boundary conditions. The initial conditions are the pollutant (ozone and precursor) concentrations in each cell of the modeling domain at the beginning of the simulation. The boundary conditions are pollutant concentrations in air entering the domain. Even clean air has some pollutants (the "background" concentration of ozone over the Pacific Ocean is about 4 pphm), and where areas upwind of the modeling domain have high emissions, boundary concentrations may also be high. As with meteorological data, boundary conditions must be provided as input for a PGM for each hour of simulation. Special monitoring programs are almost always required to supplement routine monitoring networks where a PGM will be used.

There are a number of factors that may contribute to inaccurate results from a PGM. In many areas of California, it is difficult and expensive to collect data, particularly where geography causes extreme variability of meteorological and air quality measurements. Inaccurate quantification of these variables can lead to inaccurate estimates of how the pollution is moving or mixing. PGM simulations are frequently started a day before the time period of interest to allow the PGM to diminish the impact of the initial conditions. These simulation results may differ from measured air quality because pollutant concentrations are assumed uniformly distributed within each cell while observed pollutant concentrations are measured at a single point.

When the upwind and downwind areas of a transport couple are both contained within the same modeling domain, transport between the upwind and downwind areas can be directly estimated. The model is run with a baseline and reduced emissions inventory in the upwind region. Differences in the simulation in the downwind region are attributable to the upwind emissions. The San Joaquin Valley modeling study and the Sacramento Valley study were designed to address specific sets of transport couples as well as to address ozone control strategies.

When the upwind area of a transport couple is not within the modeling domain, the impact of transported pollutants must be determined indirectly by perturbing boundary pollutant concentrations. Pollutant concentrations at the upwind modeling domain boundaries represent transport. If the the model is run with altered boundary concentrations, the differences in downwind ozone concentrations may be attributable to the changes in transported pollutants.

When the downwind portion of a transport couple is not within the modeling domain, the impact of the upwind emissions within the modeling domain on pollutant concentrations in the downwind area cannot be determined. However, it may be possible to identify the transport of pollutants across a plane at the boundary of the two areas forming the transport couple is estimated using the PGM. Amounts of ozone, nitrogen oxides, and hydrocarbons leaving the modeling domain can be estimated. The differences between the pollutant amounts calculated from base case simulations and from zero emissions simulations can be considered to be the total amount of pollutants transported to the downwind area. These pollutant amounts can then be compared with emission inventory estimates in the downwind area to give an idea about the relative importance of the transport. This is not a very powerful use of the UAM and should be used carefully.

2. Meteorological Data Analysis

a. Analysis of Surface Winds

The staff used hourly surface wind speed and direction data to establish whether the surface air flow could transport pollutants from upwind to downwind areas. The staff concluded there was potentially transport from upwind to downwind areas if: (1) wind directions were consistently from the upwind to the downwind areas, and (2) the wind speeds were persistent and fast enough to move emissions from the upwind area to the downwind area in a period of time consistent with the time of maximum ozone concentrations in the downwind area.

b. Analysis of Winds Aloft

The staff reviewed winds aloft data to establish whether the air flow aloft could transport pollutants from the upwind to downwind areas. For each transport couple, the staff reviewed the wind speed and direction data collected at sites nearest the upwind and downwind areas. Upper air data were routinely collected twice per day at only three stations within California (Oakland, Vandenberg AFB, and San Diego). Therefore, winds aloft for a given transport couple were typically available from one station only. Some supplemental winds aloft data for limited periods were also available from military, air quality, or research projects. The staff made a determination of potential transport from an upwind area if the direction, speed, and persistence of winds aloft indicated air movement from the upwind to the downwind area.

c. Calculation of Estimated Transport Time

Transport time was defined as the length of time required to move an air parcel from an upwind to a downwind area. The time was computed by dividing the distance between the two areas by the mean wind speed. The staff made a determination of potential transport from an upwind to a downwind area if the transport time for upwind emissions would lead to their arrival in the downwind area near the time of maximum ozone concentrations in the downwind area.

d. Review of Daily Streamline Analysis

The ARB staff drew daily surface streamline charts for 4 a.m., 10 a.m., and 4 p.m. Streamlines are lines drawn parallel to plotted wind directions which depict air flows of differing scales throughout most of California. The staff reviewed daily streamline analysis charts to identify whether the general air flow directions were conducive to movement of air from the upwind to the downwind area. The staff made a determination of potential transport between upwind and downwind areas if the air flow direction was from the upwind to the downwind area.

e. Review of Surface Air Flow Types

The staff classified the streamline patterns in the San Francisco Bay Area, Sacramento Valley, San Joaquin Valley, South Coast Air Basin into surface air flow patterns by wind direction. The staff made a determination of potential transport from an upwind to a downwind area if the general wind direction by the air flow type was from the upwind to the downwind area.

f. Trajectory Analysis

Trajectory analysis is a pictorial technique which estimates the path an air parcel took over a specified period of time. The technique used hourly or two hourly surface streamline charts to estimate the average speed and direction of the air parcel for a one-hour or two-hour increment. Segments were drawn for each one-hour increment for a predetermined period (typically 12-24 hours) to simulate the path of an air parcel. Forward trajectories traced the path of an air parcel forward in time from a site to determine where the air parcel ended up after a specified period of time. Backward trajectories traced the path of an air parcel backward in time from a downwind site to determine the upwind origin. The staff made a determination of potential transport from an upwind to a downwind area if the forward trajectories showed that the air parcel moved from the upwind area to the downwind area. Conversely, the backward trajectories needed to show that an air parcel at the exceedance site in the downwind area originated in the upwind area.

g. Surface Pressure Gradient Analysis

The staff analyzed surface pressure gradient data to estimate the strength and direction of the wind over an area when wind data were missing. A pressure gradient is the difference in surface atmospheric pressure at two sites divided by the horizontal distance between the two sites. Pressure gradients exert a force on air that results in air movement (wind) from an area with high pressure to an area with low pressure. The staff made a determination of potential transport from an upwind to a downwind area if the surface pressure was higher in the upwind than in the downwind area.

h. Presence of the Marine Air Layer

The staff used the temperature data from the 4 a.m. and 4 p.m. soundings at Oakland to detect the presence of and to estimate the depth of the marine layer. The marine layer is confined to a coastal setting and is the cool, moist air at or near the surface that extends to the top of the inversion layer. An increase in the depth of the marine air layer from morning to afternoon is a strong indication of onshore air flow. The depth of the marine air layer is used to indicate the intensity of the onshore flow. The staff made a determination of potential transport from a coastal environment if an inversion existed at or near the surface, the top of the inversion in the upwind area was higher than the elevation of the site at which the exceedance occurred, and the direction of the winds was from the upwind to the downwind area.

i. Review of the Daily Maximum Temperature

The staff reviewed the daily maximum temperatures to estimate how far inland the marine air may have penetrated during the day. A downwind site with a significantly different maximum temperature than the maximum temperature at the upwind site was a strong indication of a different air mass at each site. However, if the downwind and upwind sites had similar maximum temperatures, it is suggested that both sites may have shared the same air mass. The staff made a determination of potential transport if the maximum temperature in a coastal upwind area was similar to the maximum temperature in a portion of the downwind inland area.

In addition, a change in the maximum temperature from one day to the next at a site typically exposed to the marine air layer may indicate a related change in the flow of the marine air layer inland. For example, if the temperature was 65 degrees Fahrenheit at an inland site and then on the following day the temperature was 90 degrees Fahrenheit, the staff concluded that the inland area was no longer exposed to the marine air layer and that the potential for transport decreased.

3. Air Quality Data Analysis

a. Analysis of the Geographic Extent of Exceedances

The staff analyzed the size and shape of the area(s) exceeding the state ozone standard to obtain some information about the source of the ozone and precursors contributing to the exceedances. Exceedances in an air basin that occurred only in an area downwind of major emission sources in that basin indicated that emissions in that basin most likely caused the high ozone concentrations. The staff made a determination of potential transport if exceedances occurred in contiguous portions of the upwind and downwind air basins.

b. Analysis of Exceedances as Extreme Concentrations

The staff analyzed all exceedances in the downwind area to determine if the concentrations were extreme as defined in the California Code of Regulations, Title 17, section 70300. An extreme concentration is a concentration that is statistically expected to recur less frequently than once every year. An exceedance that is identified as an extreme concentration is not considered a violation and as such generally was not considered in the air quality data analysis of transport.

c. Estimating the Source of Emissions Based on Time of Daily Maximum Ozone Concentration

Maximum ozone concentrations in a downwind area resulting from photochemical reactions involving "local" emissions typically occur around solar noon but can range between 11 a.m. and 2 p.m. Maximum concentrations occurring before 11 a.m. may be the result of the fumigation of ozone trapped aloft from the previous day. The staff made a determination of potential transport if maximum concentrations in the downwind area occurred late in the afternoon or early evening, or if the winds aloft data indicated that an upwind area was a potential source of the fumigated ozone, or if the surface winds indicated a potential for the transport of ozone precursors from the upwind area to the downwind area by early afternoon.

d. Similarity of Daily Maximum Ozone Concentrations

The staff compared the daily maximum ozone concentrations in the upwind and downwind areas because similar daily maximum concentrations may indicate that the same air mass had affected both areas. The staff made a determination of potential transport if similar maximum ozone concentrations occurred in the upwind and downwind areas and the air flow was conducive to transport from the upwind area to the downwind area.

e. Review of the Hour of the Daily Maximum Ozone Concentration

The staff reviewed the progression of the daily maximum ozone concentration along a potential transport path to identify the potential transport of ozone from an upwind area to a downwind area. The progression of the time of maximum ozone concentration indicated the movement of a polluted air mass from an upwind area to a downwind area. The staff made a determination of potential transport if the time of the daily maximum ozone concentration at air monitoring stations was progressively later along a transport path from an upwind area to a downwind area.

f. Time Series Analysis

The staff conducted time series analyses to identify the likelihood that ambient ozone concentrations originated from local or from transported emissions. Time series analyses involves plotting the hourly concentrations of ozone for a three-day period centered on the exceedance day. Hourly ozone concentration plots are drawn for air monitoring stations in both the upwind and downwind areas. Daily profiles of ozone concentrations for the air monitoring stations in the upwind and downwind basin are compared to determine similarities. The staff made a determination of potential transport if the shapes of the diurnal plots of ozone concentration are similar in the upwind and downwind air basins, especially there are similar bimodal maximums and consistent maximums for several successive hours.

g. Comparison of Ozone Precursor Emissions in the Upwind and Downwind Areas

The staff used data from the 1989 ARB emission inventory to compare the magnitude of ozone precursor emissions in the upwind and downwind areas. The staff made a determination of significant contribution if the meteorological data indicated the potential for transport between the upwind and downwind areas and the magnitude of emissions were relatively similar in both areas. The staff made a determination of overwhelming contribution if the meteorological data indicated the potential for transport between the upwind and downwind areas and the emissions in the upwind area were high while emissions in the downwind area were low.

E. References

1. Fehsenfeld, F.C. et al.: Intercomparison of NO_2 measurement techniques. J. Geophys. Res. 95:3579-3597, 1990.

2. Gregory, G.L. et al.: An Intercomparison of Airborne Nitrogen Dioxide Instruments. J. Geophys. Res. 95:10103-10127, 1990.

3. J. Seinfeld: Urban Air Pollution: State of the Science. Science, Volume 243: 745-752, February 10, 1989.

4. J. Seinfeld: Ozone Air Quality Models, A Critical Review. JAPCA, Volume 38, No. 5, May 1988.

5. S. Sillman, J. Logan, S. Wofsy: The Sensitivity of Ozone to Nitrogen Oxides and Hydrocarbons in Regional Ozone Episodes. Harvard University, 29 Oxford Street., Cambridge, Massachusetts, 02138. Revised Manuscript, July 7, 1989.

CHAPTER IV

Assessment of New Transport Couples with Identification

A. Broader Sacramento Area to Mountain Counties

1. Summary and Recommendation

The staff of the Air Resources Board (ARB) studied the transport from the Broader Sacramento Area (BSA) to the Mountain Counties Air Basin (MCAB) because of two events that occurred in 1992. First, in May 1992, the ARB redefined the boundaries of the BSA. One result of this action was that all of Nevada County was no longer part of the BSA but was part of the MCAB. Also, in December 1992, the ARB designated the Mountain Counties Air Basin nonattainment for the state ozone standard based on the exceedances recorded in Nevada City and on new exceedances recorded at other monitors in the air basin. As a newly designated nonattainment area, with few stationary sources and low vehicle volumes, the staff believed that a transport assessment was necessary.

The staff's analysis shows that overwhelming transport occurred from the BSA to the northern portion of the MCAB. The staff recommends that the Board classifies the transport from the BSA to the MCAB as "overwhelming" and that the air quality plans of the districts in the BSA include sufficient measures to attain the state ozone standard within the northern portion of the MCAB.

2. Conclusions

The staff found that the contribution of the BSA's emissions to all exceedances of the state ozone standard in the northern portion of the MCAB to be overwhelming. The staff's conclusion is based on analyses of the air quality and meteorological data for the 39 days that the northern portion of the MCAB exceeded the state standard in 1989 through 1991.

3. Geographic Setting

The MCAB covers most of the high Sierra between Lake Almanor in the north and Sequoia National Park in the south. Specifically, the basin includes all of Plumas, Sierra, Nevada, Amador, Calaveras, Tuolumne, and Mariposa Counties. The basin also includes most of Placer and El Dorado Counties. The portion of those two counties which are not part of MCAB, roughly the areas west of Highway 49, are included in the BSA. A map of the area is shown in Figure IV.1

Deep river valleys have been gouged in the western slopes of the Sierra by the winter runoff. Differential heating and cooling of mountain slopes cause upslope flow in daytime and downslope flow at night[1]. The upslope flow carries pollutants up the Sierra, and the downslope flow carries pollutants down the mountains.

FIGURE IV.1

TRANSPORT COUPLE
BROADER SACRAMENTO AREA TO NORTHERN MOUNTAIN COUNTIES

* Broader Sacramento Area includes Sacramento Metropolitan Air Quality Management District, Yolo-Solano Air Pollution Control District, the southern third of Sutter County Air Pollution Control District, and the western portions of El Dorado and Placer County Air Pollution Control Districts.

For the purpose of assessing transport from the BSA to the MCAB, the focus of the MCAB as a receptor was limited to Placer, Nevada, and Sierra Counties. This area of the MCAB is northeast of the Sacramento metropolitan area. Frequent summertime atmospheric pressure patterns and the governing topography of the coast range in the Bay Area channel marine air into the Central Valley. The northern reaches of this air flow are further channeled north and northeastward towards the Sacramento Valley and the northern Sierra Nevada. These conditions highlight the transport relationship between the BSA and the MCAB.

4. Analysis

During the study period of 1989 to 1991 there were 92 exceedances of the state ambient air quality standard for ozone in the MCAB. Of those, 39 were in the northern portion of the air basin measured at Nevada City and Colfax (see Table IV.1). Some of the data from Colfax has been deleted due to incorrect equipment functions between May 7, 1990 and November 30, 1991. That data, therefore, is not included in Table IV.1. All 39 days were characterized for windflow type and possible transport.

Days were reviewed for possible inconsequential transport from the BSA into the MCAB by examining the air flow patterns the day of and the day before the exceedance and the height of the inversion. Light/calm wind speeds and/or stagnant air mass on the day of and day before the exceedance would be indications of potential inconsequential transport conditions. There were no days which met these criteria for inconsequential transport.

The same parameters were used to look for the most likely days that represent possible significant (shared) transport between the BSA and the MCAB. In addition to the meteorological data, the emission inventory of the upwind area was compared to the emission inventory of the downwind area to screen for potentially shared days. None of the 39 days met the criteria for shared days.

The 39 days were then reviewed for potential overwhelming transport affected days. <u>All</u> days exhibited similar meteorological conditions; persistent southwesterly winds with marine air pushing emissions northeastward, and successively later hours of exceedances from Sacramento, Folsom, Rocklin, Auburn, Colfax, to Nevada City. The staff chose three episodes to review in depth to demonstrate transport from the BSA to the northern MCAB--two in 1989 and one in 1990. Surface transport trajectories were done which further indicate that those episodes were caused by overwhelming transport.

a. June 12-14, 1989

The June 1989 exceedance episode is characterized by a strong marine air intrusion into the Sacramento Valley which impacted air quality in the Mountain Counties Air Basin. During this episode, the east-Pacific semi-permanent high pressure system was situated off the California coast. Much of the northern Sierra Nevada and the Sacramento Valley were dominated by an area of low pressure. This combination established a strong

TABLE IV.1

COLFAX AND NEVADA CITY OZONE EXCEEDANCE DATES

Date	Max O3 Conc. pphm	Site(s)	Date	Max O3 Conc. pphm	Site(s)
13 Jun 89	10	COF	15 Aug 89	11	COF, NC
14 Jun 89	10	COF	16 Aug 89	11	NC
22 Jun 89	10	COF	19 Aug 89	10	COF
26 Jun 89	10	COF	28 Aug 89	10	COF
8 Jul 89	11	COF	5 Sep 89	10	COF, NC
10 Jul 89	10	COF	23 Sep 89	10	COF
11 Jul 89	11	COF, NC	27 Jul 90	12	NC
12 Jul 89	10	COF, NC	28 Jul 90	12	NC
13 Jul 89	10	COF, NC	30 Jul 90	11	NC
14 Jul 89	12	COF, NC	2 Aug 90	11	NC
15 Jul 89	10	NC	3 Aug 90	12	NC
22 Jul 89	10	COF	4 Aug 90	10	NC
24 Jul 89	10	COF	23 Jul 91	10	NC
25 Jul 89	12	COF, NC	26 Jul 91	11	NC
26 Jul 89	10	COF	30 Jul 91	10	NC
27 Jul 89	10	COF	24 Aug 91	10	NC
28 Jul 89	10	COF, NC	19 Sep 91	11	NC
2 Aug 89	10	COF	25 Sep 91	12	NC
4 Aug 89	10	COF, NC	26 Sep 91	10	NC
5 Aug 89	10	COF, NC			

COF = Colfax
NC = Nevada City

pressure gradient. This gradient was the driving force for the windflow pattern which established an airflow trajectory from the San Francisco Bay Area northeastward through the Broader Sacramento Area to the northern Mountain Counties Air Basin. While this brief description may appear to include the San Francisco Bay Area Air Basin (SFBAAB) as part of the upwind source region for exceedances in the northern portion of the MCAB, it is highly unlikely that this is the case given the volumes of relatively unpolluted marine air which passes through the Bay Area as well as the 150+ mile trajectory by which the polluted air would have to travel. The case for transport from the BSA is altogether different however. Neither the volumes of air nor the great distance is a consideration for BSA transport to the MCAB. As well, the trajectory from the BSA is much narrower than the trajectory from the SFBAAB. Additionally, the BSA emissions are 9 times those in the northern MCAB.

The June 1989 episode was also characterized by a temperature inversion height greater than the elevation of the two sites in northern MCAB. This is significant in assessing transport as sites situated above the inversion are less directly affected by surface windflow patterns.

Table IV.2 depicts the ambient air quality standard exceedances for ozone along the trajectory from the BSA to the MCAB. It is important to note that the latest exceedances in the northern MCAB are the farthest away from the emission sources in the BSA. That is characteristic of transport between these two areas.

TABLE IV.2

Maximum Ozone Concentrations (pphm)
and
Exceedance Durations (given in time of day)
for June 12-14, 1989

Site	6-12-89 max/dur	6-13-89 max/dur	6-14-89 max/dur
Sac. T. St.	6 --	6 --	4 --
Cit. Hgts.	11 14-1500	9 --	10 1400
Folsom	12 14-1600	11 14-1700	12 13-1400
Rocklin	11 15-1700	10 1500	10 1500
Auburn	not avail.	not avail.	not avail.
Colfax	8 --	10 1700	10 15, 17-1800
Nevada City	not avail.	not avail.	not avail.

b. July 24-26, 1989

The July 1989 exceedance episode occurred under a regime of several days of strong seabreezes. Again, such as the June 1989 exceedance, July 1989 was typical of meteorological patterns which create transport conditions. Upslope flow in the vicinity of Camino, Blue Canyon, and Truckee was both evident and consistent. The pressure patterns both on the California Coast and over the Central Valley and Sierra Nevada set ideal conditions for transport as the pressure gradient across the state was continuous from west to east, high to low. Table IV.3 indicates the successive exceedance pattern which was caused by transport along a trajectory from the BSA to the northern portion of the MCAB. On the southwest end of the trajectory is the source of the majority of the emissions, but also sites which did not record exceedances of the state ambient air quality standard for ozone. As distance from the emission sources increased, the photochemical processes had time to cause ozone precursors to form ozone. The table indicates that the latest exceedances are also those most removed downwind from the emission sources.

TABLE IV.3

Maximum Ozone Concentrations (pphm)
and
Exceedance Durations (given in time of day)
for July 24-26, 1989

Site	7-24-89 max	7-24-89 dur	7-25-89 max	7-25-89 dur	7-26-89 max	7-26-89 dur
Sac. T St.	8	--	6	--	6	--
Cit. Hgts.	9	--	9	--	8	--
Folsom	12	13-1700	10	13-1500	9	--
Rocklin	10	1700	10	14-1500	9	--
Auburn	10	1400	12	14-1700	10	1700
Colfax	10	16-1700	12	15-1800	10	17-1800
Nev. City	8	--	10	1700	8	--

d. August 1-4, 1990

The August 1990 episode is well supported by meteorological data. The summertime semi-permanent high pressure system was situated off the California coast. This synoptic condition caused an inverted thermal trough to establish over the Central Valley. This, in turn, caused wind speeds to be very high as the cool coastal air mass and the hotter valley air mass attempted to reach equilibrium. The winds from the coast were channeled north and north-eastward by the governing valley terrain. This airflow pattern was persistent for several days. As the distance from the straits through which the air flow was channeled increased, the marine air intrusion took on speeds of lesser and lesser magnitude.

Table IV.4 indicates air quality along a southwest-northeast line through the BSA to northern MCAB. Along this line, air quality is cleanest to the southwest where wind speeds are still significant and the volume of marine air is greatest. As the clean air moves through the BSA, BSA emissions are moved along a trajectory towards the north and northeast. At the end of this trajectory are Nevada City and Colfax. Not only are these two sites downwind of an area which has emissions about 8 times greater, they also are at an elevation which is usually near the top of a stable temperature inversion layer. This location is a conducive environment for pooling of pollutants because the eastern Pacific high pressure dominating the area causes subsiding air which, in turn, causes two things to happen - warming of air as it descends and inhibiting vertical mixing above certain altitudes depending upon the strength of the high pressure. At the same time, vertical mixing, or ventilation, is taking place in the lower levels of the stable layer due to surface heating. At the top of the stable layer

---

TABLE IV.4

Maximum Ozone Concentrations (pphm)
and
Exceedance Durations (given in time of day)
for August 1-4, 1990

Site	8-1-90 max/dur		8-2-90 max/dur		8-3-90 max/dur		8-4-90 max/dur	
Sac. T.	6	--	6	--	5	--	10	1300
Cit. Heights	11	13-1500	9	--	8	--	12	13-1700
Folsom	9	--	6	--	6	--	9	--
Rocklin	11	13-1400	10	15-1600	9	--	9	--
Auburn	11	13-1500	13	12-1900	13	14-1900	10	13-1800
Colfax	not avail.		not avail.		not avail.		not avail.	
Nevada City	9	--	10	14 00	10	1700	10	1000

there is less vertical mixing. This, coupled with the subsidence, causes pollutants to pool near the top of the inversion. The severity of this pooling will be determined by a number of factors including the strength of the high pressure and the duration of its existence, horizontal wind speed and direction at all levels through the inversion, sunlight conditions, and contribution of emissions.

5. Emission Inventory

The most recent emission inventory data available are the 1989 statewide, air basin, and county totals compiled by the ARB staff[2]. While such emission totals provide only general information, they were useful for determining the relative difference in emissions between various areas. This information provided a general indication of the potential for the emissions in each area to contribute to ozone concentrations.

Table IV.5 illustrates the disparity between emission inventories in the BSA and those in the MCAB. Appropriate counties in the Mountain Countain Air Basin are indicated to identify the area which has the most direct impact as a receptor. Since the 1989 emission inventory was compiled prior to the changes in the Broader Sacramento Area boundaries, the values in the table represent the staff's best estimate of emissions for the two areas. The emissions in the BSA are about 8 times greater than the emissions in the downwind portion of the Mountain Counties.

TABLE IV.5

1989 Emissions - tons/day

BASIN	ROG	NOx	ROG+NOx
MC (Nevada & Sierra Counties & portions of Placer and El Dorado Counties)	20	25	45
BSA	180	170	350
Ratio: BSA/MC	9	7	8

The staff did not make a quantitative determination of the relative contribution of emissions in the MCAB versus the contribution of the emissions in the BSA to the ozone exceedances in the MCAB. Based on the inventory comparisons, the staff made a qualitative conclusion that the transported ozone and ozone precursor emissions from the BSA could have an overwhelming impact on the MCAB's ozone concentrations.

6. Summary of Previous Transport Studies

Lorenzen[3] documented the transport of smoke from 1,000 acres of burned tules, a rush-like marsh plant, conducted by seven different duck clubs near Suisun Bay. Visibilities were reduced to less than 7 miles as far into the Sierra Nevada as Colfax and Pollock Pines.

Unger[4] and Duckworth and Crowe[5] showed that the urban plume from the Sacramento Metropolitan area is transported downwind and up the major river canyons east of Sacramento. In 1980, Lehrman[6] carried out an extensive field study which found that the slopes of the Sierra Nevada can be affected for a distance of at least 50-75 miles to the north of Sacramento. He also measured tracers at low concentrations at Lake Tahoe which were released in the Central Valley. Morgan[7] found the sea breezes flush out the Central Valley and wash the Sierra Nevada slopes, sometimes as high as 3,000-foot level, with pollutants. Palmer[8] measured high ozone levels near the crest of the Sierra about 15 miles south of Lake Tahoe during periods of persistent westerly winds.

7. References

1. Defant, F., 1951: Local Winds. Compendium to Meteorology, T. F. Malone, Ed., Am. Meteor. Soc., 655-672.

2. Air Resources Board, 1991: Emission Inventory 1989. ARB Staff Report prepared by the Emission Inventory Branch of the Technical Support Division, August 1991, 38 pp + 1 Appendix.

3. Lorenzen, A., 1981: Delta Tule Burn Impacts Visibility. California Air Quality Data. 13(3), 2-3.

4. Unger, C. D., 1978: Transport of Photochemical Smog in the Central Valley and the Sierra Nevada Mountains of California. Unpublished Rep., ARB , Planning Division, 35 pp.

5. Duckworth, S. and D. Crowe, 1979: Ozone Patterns on the Western Sierra Nevada Slopes: Downwind of Sacramento During the Summer of 1978. Rep., Aerometric Analysis Branch, ARB, 28 pp.

6. Lehrman, D. E., Smith, T. B., Reible, D. D., and F. H. Shair, 1981b: A study of the Origin and Fate of Air Pollutants in California's Sacramento Valleys, Vols. I & II. Final Rep. MRI 81 FR-1842, Prepared for ARB, Meteor. Res., Inc., 25 pp and 210 pp, respectively.

7. Morgan, D. L., 1974: Jet Winds in the San Joaquin Valley. Final Rep., Dept. of Geo., CSU-Fresno, PSW Grant No. 13, Pac. SW Forest & Range Exp. Stn., 39 pp.

8. Palmer, T. Y., Smith, L. R., and J. Neirinckx, 1975: Ozone in the Valleys of the High Sierra Nevada. Preprints, Conf. on Atmos. Modeling, Las Vegas, Am. Meteor. Soc., 1-3.

B. San Joaquin Valley to Mountain Counties

1. Summary and Recommendation

The staff analysis indicated that all exceedances in the southern 4-county portion of the Mountain Counties Air Basin (MCAB) were due to overwhelming transport from the northern 5-county portion of the San Joaquin Valley Air Basin (SJVAB). Emissions in the northern SJVAB were 10 times the emissions in the southern portion of the MCAB.

The staff recommends that the Board classifies the transport from the SJVAB to the southern portion of the MCAB as "overwhelming" transport from the SJVAB. The staff also recommends that the air quality attainment plan of the San Joaquin Valley Unified Air Pollution Control District include sufficient measures to attain the state ozone standard within the southern portion of the Mountain Counties Air Basin.

2. Conclusions

The staff concludes that an assessment for overwhelming transport into the MCAB from the SJVAB for all days except for one day, is supported by airflow patterns, exceedance characteristics, and by the relative ozone precursor emissions within the MCAB. The staff believes that the one day exception be eliminated from consideration due to the forest fire which dominated the region in the MCAB during this particular exceedance episode. The transport assessment of this particular episode is considered inconclusive due to the interference of the forest fire. Shared or inconsequential transport can also be ruled out due to the lack of emission sources in the downwind area, other than the forest fire.

3. Geographic Setting

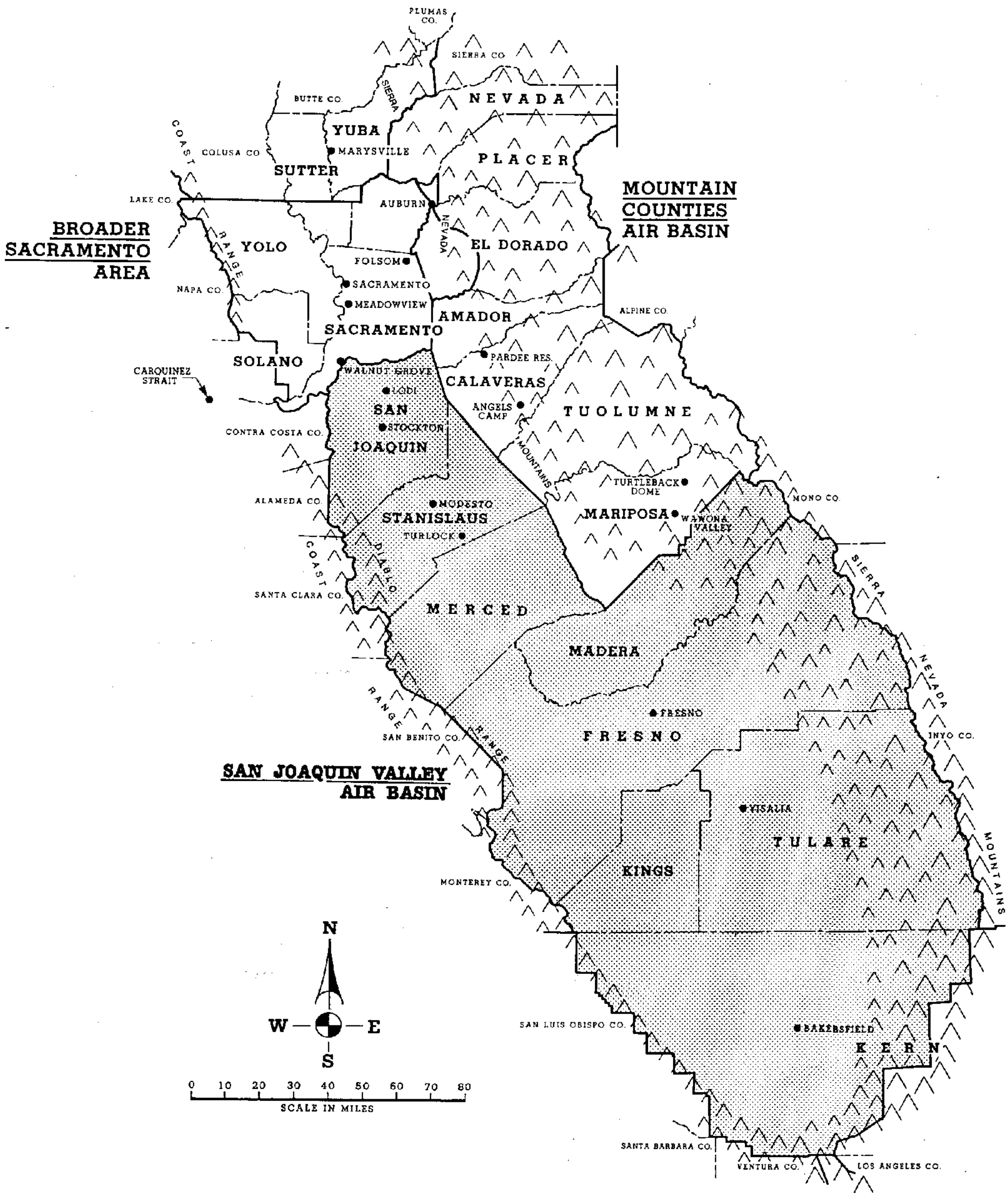
The MCAB covers most of the high Sierra between Lake Almanor in the north and Sequoia National Park in the south. Specifically, the basin includes all of Plumas, Sierra, Nevada, Amador, Calaveras, Tuolumne, and Mariposa Counties. The basin also includes most of Placer and El Dorado Counties. The portions of those two counties which are not part of MCAB, roughly the areas west of Highway 49, are included in the Broader Sacramento Area. A map of the area is shown in Figure IV.2.

Deep river valleys have been gouged in the western slopes of the Sierra by the winter runoff. Differential heating and cooling of mountain slopes cause upslope flow in daytime and downslope flow at night[1]. The upslope flow carries pollutants up the Sierra, and the downslope flow carries pollutants down the mountains. The Sierra foothills, aside from those included in the Broader Sacramento Area, are also included in this air basin where upslope flow makes it easy for transport to take place.

For the purpose of assessing transport from the SJVAB to the MCAB, the focus of the MCAB as a receptor was limited to Amador, Calaveras, Tuolumne, and Mariposa Counties. This area of the MCAB is situated due east

FIGURE IV.2

TRANSPORT COUPLE
SAN JOAQUIN VALLEY TO SOUTHERN MOUNTAIN COUNTIES



of the San Francisco Bay and the Sacramento/San Joaquin River delta region. The governing topography of the coast range in the Bay Area channels the marine airflow into the Central Valley. The northern reaches of this air flow are further channeled northward towards the Sacramento Valley; the southern reaches southward towards the San Joaquin Valley. The central area of this air flow, uninhibited by terrain as it crosses approximately 50 miles of the Central Valley, continues eastward to the foothills of the Sierra Nevada.

The focus on the SJVAB as a source area was limited to Fresno, Madera, Merced, San Joaquin, and Stanislaus Counties. These counties are adjacent to the southern portion of the MCAB and are the most likely source of ozone and ozone precursors to the MCAB.

4. Analysis

Pardee Reservoir, Angels Camp, Wawona Valley and Turtleback Dome were chosen as sites for this assessment. There were 62 days when the state ozone standard was exceeded during the years of study, 1989 to 1991. The dates and air basin maximum concentrations are listed in Table IV.6.

The elevations of Angels Camp and Pardee Reservoir are 1832 feet and 1228 feet, respectively. These sites were maintained for the 1990 SJVAQS/AUSPEX. Therefore, data were not available for any other time frame than July and August 1990 for those two sites.

The elevation of Turtleback Dome is 5297 feet, and the elevation of Wawona Valley is 4199 feet. This is significant because a surface windflow trajectory, which is the most reliable transport assessment method in the absence of modeling, begins to lose credibility as terrain becomes more severe and the elevation increases. Higher elevations are more likely impacted by a trajectory aloft rather than a trajectory which has been calculated at the surface. The greatest shortfalls in making assessments involving sites at higher elevations lie in trying to construct trajectories or make determinations on sites which are situated significantly above the mixing layer--which is the case with both Turtleback Dome and Wawona Valley.

a. September 24, 1991

The air flow charts for all exceedance days were reviewed for possible inconsequential or significant transport conditions. Only one day out of all 62 days, September 24, 1991, did not look like it was the result of overwhelming transport. An in-depth study was made of that day. For approximately 3 weeks in September, a forest fire had been allowed to burn freely in the Yosemite region. A couple days before the exceedance occurred, the fire burned out of control.

Fresno aircraft temperature sounding data were reviewed to determine the height of the thermal inversion top and thus the layer of stability. The inversion top was consistently at least 2000 feet below the elevation of Wawona Valley and Turtleback Dome. A transport assessment was made based on a preponderance of data. Surface trajectories were not suitable to

TABLE IV.6

MCAB OZONE EXCEEDANCE DATES

Date	Max O3 Conc. pphm	Site(s)	Date	Max O3 Conc. pphm	Site(s)
23 Jun 89	10	WWV	9 Sep 90	10	WWV
9 Aug 89	10	WWV	10 Sep 90	11	WWV
16 Aug 89	11	WWV	11 Sep 90	10	WWV
9 May 90	10	WWV	14 Sep 90	10	WWV
19 Jun 90	10	WWV	15 Sep 90	10	WWV
21 Jun 90	12	WWV	26 Sep 90	10	WWV
30 Jun 90	10	WWV	2 Jul 91	10	TBD
9 Jul 90	13	PAR	26 Jul 91	11	TBD
10 Jul 90	11	PAR	27 Jul 91	10	TBD
11 Jul 90	10	WWV	28 Jul 91	10	TBD
12 Jul 90	10	PAR	31 Jul 91	10	TBD
14 Jul 90	10	PAR	13 Aug 91	10	TBD
20 Jul 90	10	PAR, ANG	14 Aug 91	11	TBD
26 Jul 90	10	PAR	24 Aug 91	10	TBD
27 Jul 90	12	WWV, PAR, ANG	3 Sep 91	10	TBD
28 Jul 90	12	WWV	12 Sep 91	10	TBD
29 Jul 90	10	WWV	13 Sep 91	10	TBD
30 Jul 90	11	WWV	17 Sep 91	10	TBD
31 Jul 90	10	WWV, PAR	18 Sep 91	12	TBD
1 Aug 90	10	PAR	19 Sep 91	11	TBD
2 Aug 90	11	WWV, PAR	20 Sep 91	10	TBD, WWV
3 Aug 90	12	WWV	21 Sep 91	10	TBD
4 Aug 90	10	WWV, PAR	22 Sep 91	11	TBD, WWV
5 Aug 90	11	PAR, ANG	23 Sep 91	12	TBD
6 Aug 90	12	PAR, ANG	24 Sep 91	12	TBD
7 Aug 90	13	PAR, ANG	25 Sep 91	12	TBD
8 Aug 90	13	PAR	2 Oct 91	11	TBD
9 Aug 90	12	PAR	3 Oct 91	11	TBD
11 Aug 90	11	WWV	4 Oct 91	10	TBD
23 Aug 90	12	PAR	17 Oct 91	10	TBD
29 Aug 90	10	WWV	19 Oct 91	10	TBD

PAR = Pardee Reservoir*
ANG = Angles Camp*
TBD = Turtleback Dome
WWV = Wawona Valley**

*Note: Ozone data for these sites are from the San Joaquin Valley Study. Data is considered research grade only by ARB.

**Note: Ozone data for these sites collected by National Park Service.

construct for the exceedances at Turtleback Dome or Wawona Valley due to the severe terrain and because the sites were so far above the mixing layer. Modeling was not available for this couple.

The air quality was especially significant during the September 1991 episode. Exceedances occurred in the middle of the night. Normally, this would be an indicator of transport, as the sunlight needed to promote the photochemical reactions that form ozone was non-existent. However, the preponderance of remaining data did not reveal any consistencies by which to firmly support a transport finding. In addition, the forest fire confounded the staff's analysis, and the staff could not reach a conclusion regarding transport impact on this exceedance day.

b. June 30, 1990

The staff determined that the ozone standard was exceeded at Wawona Valley on June 30, 1990, due to overwhelming transport. Both surface and, where available, aloft data were used in the assessment.

The meteorological data included in the assessment consisted of surface wind flow charts the day before and the day of the exceedance. Also, aircraft temperature soundings were analyzed to assess the wind direction at levels which would coincide with the elevation of both Wawona Valley and Turtleback dome. The 4000, 4500, and 5000 foot wind directions were all from the northwest. This direction was consistent down to the surface wind directions which were also north-northwesterly due to the strong seabreeze which dominated the airflow pattern both on June 29 and June 30.

This assessment was also made using a preponderance of data because the MCAB is extremely data sparse. This presents a problem in staff's efforts to assess transport from any upwind area into the MCAB.

5. Emission Inventory

The most recent emission inventory data available is the 1989 statewide, air basin, and county totals compiled by the ARB staff[2]. While emission totals provide only general information, they were useful for determining the relative difference in emissions between various areas. This information provided a general indication of the potential for the emissions in each area to contribute to ozone concentrations.

Table IV.7 illustrates the disparity between emission inventories in the SJVAB and those in the MCAB. Appropriate counties are indicated as these are the areas which have the most direct impact as a source and receptor. As indicated in the table, emissions in the SJVAB are 10 times greater than the emissions in the downwind portion of the MCAB.

The staff did not make a quantitative determination of the relative contribution of emissions in the MCAB versus the contribution of the emissions in the SJVAB to the ozone exceedances in the MCAB. Based on the

TABLE IV.7

1989 Emissions - tons/day

AIR BASIN	ROG	NOx	ROG+NOx
MC (Amador, Mariposa, Calaveras, and Tuolumne Counties)	27.9	24.8	52.7
SJV (Fresno, Madera, San Joaquin, Merced, and Stanislaus Counties)	267	255	522
Ratio: SJV/MC	9.6	10.3	9.9

inventory comparisons, the staff made a qualitative conclusion that the transported ozone and ozone precursor emissions from the SJVAB could have an overwhelming impact on the MCAB ozone concentrations.

6. Summary of Previous Transport Studies

There is much evidence of transport from the SJVAB up the Sierra slopes[3,4,5,6,7,8,9]. There have also been reports of ozone damage to trees in the southern Sierra Nevada at elevations as high as 7,000 feet[10,11]. Schwall[12] reports the following:

> In the summer season (June through August 1979), the Rockwell monitoring systems were placed at the eastern edge of the valley at locations east of Modesto, Merced, and Madera. This allowed observation of the air masses turning from southbound main transport to eastbound upslope flows. The air pollution was well-correlated between these sites, both on an hourly and daily basis. The ozone levels were high, with frequent exceedances of the national ambient air quality standard.

7. References

1. Defant, F., 1951: Local Winds. Compendium to Meteorology, T. F. Malone, Ed., Am. Meteor. Soc., 655-672.

2. Air Resources Board, 1991: Emission Inventory 1989. ARB Staff Report prepared by the Emission Inventory Branch of the Technical Support Division, August 1991, 38 pp + 1 Appendix.

3. Miller, P. R., McCuichan, M. H., and H. P. Milligan, 1972: Oxidant Air Pollution in the Central Valley, Sierra Nevada Foothills, and Mineral King Valley of California. Atmos. Environ., 6, 623-633.

4. Meteorological Research, Inc., 1976: Air Quality Evaluation of Final Environmental Statement Mineral King Recreation Development. MRI 76 R-1466, Contract USDA-FS-R5-RES(Adm)-75-02, (MRI Project Manager - Hans Giroux), 75 pp. + 6 Appendices.

5. Carroll, J. J., and R. L. Baskett, 1979: Dependence of Air Quality in a Remote Location on Local and Mesoscale Transports: A Case Study. J. Appl. Meteor., 18, 474-486.

6. Lehrman, D., Smith, T. B., and S. C. Gouze, 1980: Upper San Joaquin River Valley Impact Study. Final Rep. MRI 80 FR-1745, USFS Contract No. 53-9158-9-6251, Meteorology Research, Inc., 121 pp.

7. Lehrman, D., Gouze, S. C.., and T. B. Smith, 1980a: Data Volume, Upper San Joaquin River Valley Impact Study. Final Rep. MRI 80 DV-1745, USFS Contract No. 53-9158-9-6251, Meteorology Research, Inc., 210 pp.

8. Blumenthal, D. L., 1985: Southern San Joaquin Valley Ozone Study, Data Volume. Final Rep. STI 94100-501-D4, WOGA Contract No. 84-8.0.05(2)-07-01, Sonoma Tech., Inc.

9. Moore, G. E., Daly, C., and M-K Lui, 1987: Modeling of Mountain-Valley Wind Fields in the Southern San Joaquin Valley, California. J. App. Meteor., 26, 1230-1242.

10. William, W. T., Brady, M. and S. C. Willison, 1977: Air Pollution Damage to the Forest of the Sierra Nevada Mountains of California. I. Air Pollution Control Association, 27, 230-234.

11. Prontos, J., Volger, D. R., and R. S. Smith, 1978: An Evaluation of Ozone Injury to Pines in the Southern Sierra Nevada. Rep. No. 78-1, Forest Insect and Disease management, USDA Forest Service, Region Five, San Francisco, 17 pp.

12. Schwall, R. J., 1981: A Study of the Origin and Fate of Air Pollutants in California's Great Central Valley, Aerometric Monitoring. Final Rep. EMSC-4059.26FR, ARB Contract A7-172-30, Rockwell International, 71 pp. + Appendix.

C. San Francisco Bay Area to Mountain Counties

1. Summary and Recommendation

The staff's analysis indicates that transport from the San Francisco Bay Area Air Basin (SFBAAB) increases ozone concentrations in the Mountain Counties Air Basin (MCAB). There are no indications that the MCAB is capable of exceeding the state ambient air quality standard for ozone without transport impact from an upwind area.

The staff recommends that the Board classifies the transport of pollutants from the SFBAAB as "significant" to the southern portion of the MCAB. The staff also concludes that transport of emissions from the SFBAAB and the San Joaquin Valley Air Basin (SJVAB), collectively, overwhelms the southern portion of the MCAB. Since the San Joaquin Valley Air Quality Model is not yet available, it is impossible to separate the impact of the emissions from the SFBAAB from the emissions from the SJVAB. The staff analyses shows that SJVAB emissions alone can overwhelm the southern portion of the MCAB, therefore, the staff recommends that the Board assign the mitigation responsibilities to the SJVAB.

2. Conclusions

The staff concluded in Section B. of this chapter that the emissions from the SJVAB alone caused exceedances of the state ozone standard in the MCAB. The staff recommends that SJVAB be held responsible for demonstrating attainment in the MCAB. However, the emissions from the SFBAAB also contributed to these exceedances, and therefore, the SFBAAB shares in the responsibility for attaining the state ozone standard in the MCAB. The staff concludes that the MCAB did not have sufficient emissions to exceed the state ozone standard without transport from the two upwind air basins.

The contribution to exceedances in the MCAB from the emission sources in the SFBAAB will be evaluated late in 1993 when the model from the SJVAQS/AUSPEX is available.

3. Geographic Setting

The MCAB covers most of the high Sierra between Lake Almanor in the north and Sequoia National Park in the south. Specifically, the basin includes all of Plumas, Sierra, Nevada, Amador, Calaveras, Tuolumne, and Mariposa Counties. The basin also includes most of Placer and El Dorado Counties. The portion of those two counties which are not part of the MCAB, roughly the areas west of Highway 49, are included in the Broader Sacramento Area (BSA). A map of the area is shown in Figure IV.3.

Deep river valleys have been gouged in the western slopes of the Sierra by the winter runoff. Differential heating and cooling of mountain slopes causing upslope flow in daytime and downslope flow at night was demonstrated by Defant[1]. The Sierra foothills, aside from those included in the BSA, are also in this air basin.

FIGURE IV.3

TRANSPORT COUPLE
SAN FRANCISCO BAY AREA TO SOUTHERN MOUNTAIN COUNTIES

For the purpose of assessing transport from the SFBAAB to the MCAB, the focus of the MCAB as a receptor was limited to Amador and Calaveras Counties. This area of MCAB is situated due east of the San Francisco Bay and the Sacramento/San Joaquin River delta region. The governing topography of the coast range in the Bay Area channels the marine airflow into the Central Valley. The northern reaches of this air flow are further channeled northward towards the Sacramento Valley; the southern reaches are channeled southward towards the San Joaquin Valley. The central area of this air flow, uninhibited by terrain as it crosses approximately 50 miles of the Central Valley, through San Joaquin and Stanislaus Counties in the SJVAB, continues eastward to the foothills of the Sierra Nevada in Amador and Calaveras Counties.

4. Analysis

Monitors at Angels Camp and Pardee Reservoir in Calaveras County were chosen for assessing transport from the SFBAAB to the MCAB due to their moderate elevation in the easy terrain of the Sierra Nevada foothills as well as their close proximity to the SFBAAB. The elevations of Angels Camp and Pardee Reservoir are 1832 feet and 1228 feet, respectively. Of all sites in the MCAB, these two are the lowest. This is important because a surface windflow trajectory, which is the most reliable transport assessment method in the absence of modeling, begins to lose credibility as terrain becomes more severe and the elevation increases. Higher elevations are more likely impacted by a trajectory aloft rather than a trajectory which has been calculated at the surface.

Angels Camp and Pardee Reservoir were sites maintained for the 1990 SJVAQS/AUSPEX. Therefore, data were not available for any other time frame than July and August 1990. There were 17 ozone exceedance days at Pardee Reservoir but only 5 ozone exceedance days at Angels Camp (Table IV.8). Analysis of all the exceedance days showed overwhelming transport from the San Joaquin Valley Air Basin (see Section B. of this chapter). The staff studied August 6 and 7 in depth to demonstrate transport from the SFBAAB. This episode was chosen because there is additional data available from the SJVAQS/AUSPEX.

Both surface and, where available, aloft data were used in the assessment. Surface wind trajectories were accomplished which included data in the SFBAAB, SJVAB, and the MCAB. The aloft data were only available for August 6. Surface data were available for both August 6 and 7. The meteorological data included in the assessment consisted of upper air temperature profiles and wind profiles at sites used in the SJVAQS/AUSPEX. Also, surface wind and pressure data were analyzed. Air quality data from the Air Resources Board and the SJVAQS/AUSPEX were used. Emission inventories were used as input to the air quality assessment.

TABLE IV.8

OZONE EXCEEDANCE DATES AT PARDEE RESERVOIR AND ANGELS CAMP

Date	Max O3 Conc. pphm	Site(s)
9 Jul 90	13	PAR
10 Jul 90	11	PAR
12 Jul 90	10	PAR
14 Jul 90	10	PAR
20 Jul 90	10	PAR, ANG
26 Jul 90	10	PAR
27 Jul 90	12	PAR, ANG
31 Jul 90	10	PAR
1 Aug 90	10	PAR
2 Aug 90	11	PAR
4 Aug 90	10	PAR
5 Aug 90	11	PAR, ANG
6 Aug 90	12	PAR, ANG
7 Aug 90	13	PAR, ANG
8 Aug 90	13	PAR
9 Aug 90	12	PAR
23 Aug 90	12	PAR

PAR = Pardee Reservoir
ANG = Angels Camp

Notes: Ozone data for these sites are from the San Joaquin Valley Air Quality Study. Data is considered research grade only by ARB.

TABLE IV.9

Maximum Ozone Concentrations (pphm), Exceedance Durations, and Hour of Max Ozone Concentration (exceedance durations and hour of max ozone expressed in time of day)

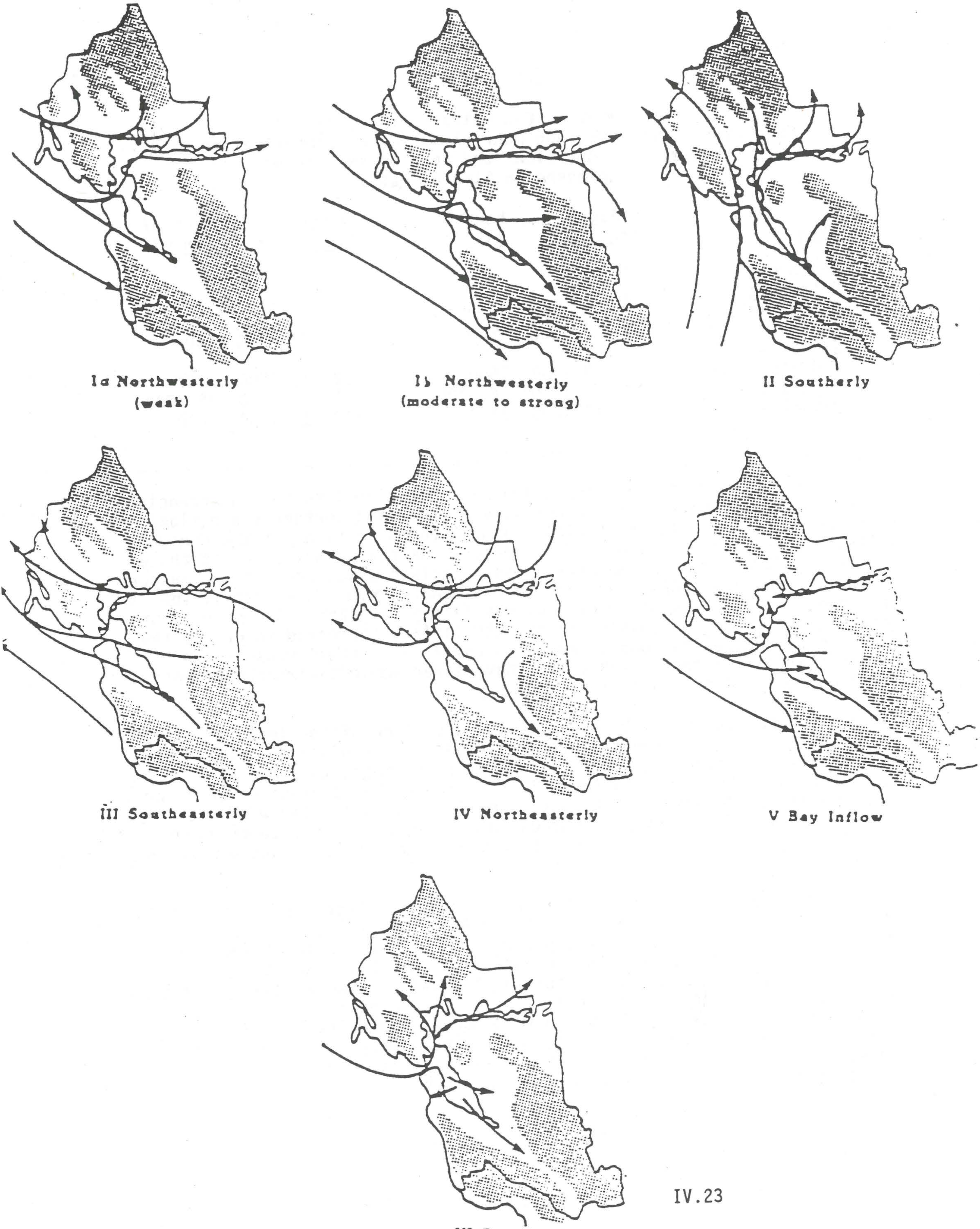
Site	6 Aug 90 max	6 Aug 90 dur	hour of max 03	7 Aug 90 max	7 Aug 90 dur	hour of max 03
Concord	9	--		7	--	
Pittsburg	9	--		7	--	
Bethel Island	12	13-1500	1400	8	--	
Lodi/Stockton	12	12-1600	1500	12	13-1400	1400
Stockton Mariposa St.	13	12-1600	1500	12	12-1500	1400
Angels Camp	12	16-1700	16-1700	11	13-1800	15-1700
Pardee Res.	12	11-1600	1200	13	10-1700	1600

The occurrence of a strong marine air intrusion into the San Francisco Bay Area causes significant southerly, westerly, and northerly air flow patterns into the northern, central, and southern sections of the Central Valley, respectively. Figure IV.4, depicts the characterization of these patterns. Under this regime, the pressure driven winds provide a transport mechanism from the SFBAAB eastward to the MCAB. Prior to August 6, the air mass over the entire assessment area was fairly stagnant. As the pressure forces began to be predominant again, the airflow increased to create the higher ozone concentrations of August 6 and 7. For these reasons, the SFBAAB stations listed in Table IV.9 have lower ambient air measurements of ozone on August 7 than August 6.

Consideration should be given to the elevation of the impacted sites. The staff believes transport aloft, while not measured and calculated as extensively as surface transport, is more of an impact to sites at elevations near the top of a thermal inversion - the location of both Angels Camp and Pardee Reservoir on August 6 and 7, 1990. As well, wind aloft at various sites measured for the SJVAQS/AUSPEX depicted consistency in the windflow with a westerly component throughout the area of transport at the elevation of the MCAB sites.

Table IV.9, above, illustrates the progressive increase in ozone values from the SFBAAB across the SJVAB to the MCAB. This pattern is consistent with transport of ozone and ozone precursors considering the meteorological assessment discussed above. The character of the exceedance is indicative of transport given the night and morning low values (background). The time of the exceedance onset is slightly earlier than expected compared to sites in the upwind air basin which began exceedances at the same time. The staff believes transport aloft is the reason for this early exceedance given that the windflow aloft is faster and less inhibited than surface flow which affects the sites in the upwind air basins. The

FIGURE IV.4 SAN FRANCISCO BAY AREA AIR FLOW PATTERNS



Ia Northwesterly (weak)

Ib Northwesterly (moderate to strong)

II Southerly

III Southeasterly

IV Northeasterly

V Bay Inflow

VI Bay Outflow

impact of transport aloft continued until a time at which surface transport reached the area and exacerbated the exceedance occurrence.

In addition to the meteorological and air quality analyses, tracer data obtained from the 1990 SJVAQS was analyzed[2]. The results showed that tracer gas released from Pittsburg on August 3, 1990, between 6 and 10 a.m. was detected at both Pardee Reservoir and Angels Camp by 10 pm. This is conclusive evidence that pollutants emitted near Pittsburg are transported to the MCAB. The staff interprets the results of the tracer study and the staff analysis as indicating significant transport from the SFBAAB to the MCAB. However, it should be noted that this analysis is strictly qualitative. In order to make a quantitative transport assessment, sophisticated 3-dimensional air quality models, such as the PGM or SARMAP models, should be used. A substantial data set is required, which includes meteorological, air quality, and date-specific emission inventory data.

5. Emission Inventory

The most recent emission inventory data available is the 1989 statewide, air basin, and county totals compiled by the ARB staff[3]. While such emission totals provide only general information, they were useful for determining the relative difference in emissions between various areas. This information provided a general indication of the potential for the emissions in each area to contribute to ozone concentrations.

Table IV.10 illustrates the wide disparity between emission inventories in the SFBAAB and the MCAB. Appropriate counties are indicated as these are the areas which have the most direct relationship as source and receptor. The emissions in the upwind counties in the SFBAAB are 20 times greater than the emissions in the downwind portion of the Mountain Counties.

The staff did not make a quantitative determination of the relative contribution of emissions in the Mountain Counties versus the contribution of the emissions in the SFBAAB and the SJVAB to the ozone exceedances in the Mountain Counties. The staff could not determine the quantitative contribution of emissions from SFBAAB, and therefore, the staff made a qualitative conclusion that the transported ozone and ozone precursors from the SFBAAB have a significant impact on the ozone concentrations in the MCAB. Based on the inventory comparisons, the staff made a qualitative conclusion that the transported ozone and ozone precursor emissions from the SFBAAB and the SJVAB, collectively, could have an overwhelming impact on the Mountain Counties' ozone concentrations. The staff's analysis of the SJVAQS database may be able to determine whether the emissions from SFBAAB, without the contribution of emissions from the SJVAB, could cause exceedances of the ozone standard in the MCAB.

TABLE IV.10

1989 Emissions - tons/day

AIR BASIN	ROG	NOx	ROG+NOx
SFBAAB (Solano, Contra Costa, and Alameda Counties)	308	291	599
SJVAB (San Joaquin and Stanislaus Counties)	115	102	217
MCAB (Amador and Calaveras Counties)	15	14	29
Ratio: SFBAAB/SJV	2.7	2.9	2.8
Ratio: SFBAAB/MCAB	20.5	20.8	20.7
Ratio: SJVAB/MCAB	7.7	7.3	7.5
Ratio: (SJV+SFBA)/MCAB	28.2	28.1	28.1

5. References

1. Defant, F., 1951: Local Winds. Compendium to Meteorology, T. F. Malone, Ed., Am. Meteor, Soc., 655-672.

2. San Joaquin Valley Air Quality Study. Draft report to the ARB, ARB contract no. 8833, Tracer Technologies, San Marcos, CA, July 1991.

3. Air Resources Board, 1991: Emission Inventory 1989. ARB Staff Report prepared by the Emission Inventory Branch of the Technical Support Division, August 1991, 38 pp + 1 Appendix.

D. Mexico to Southeast Desert

1. Summary and Recommendations

The staff analysis shows that transport from Mexico caused exceedances of the state ozone standard in the Imperial County portion of the Southeast Desert Air Basin (SEDAB) on some days ("overwhelming" transport). The analysis also shows that on other days transport from Mexico contributed to exceedances in the SEDAB ("significant" transport). In addition, none of the analyses show exceedances of the state ozone standard in the Imperial County portion of SEDAB that are caused entirely by local emissions without regard to transport.

The staff recommends that the Board identifies the transport couple "Mexico to Southeast Desert Air Basin" and that Mexico's transport to the Imperial County portion of SEDAB be classified as "overwhelming" on some days, and "significant" on other days. Since Mexico is outside the jurisdiction of the state, the staff does not recommend that the Board assign mitigation responsibilities to Mexico.

2. Conclusions

The staff believes that the contribution of Mexico's emissions to exceedances of the state ozone standard in the Southeast Desert Air Basin is "overwhelming" and "significant". This conclusion is based on screening ozone exceedance days in Imperial County and selecting case study days representing overwhelming transport and significant transport. These days were selected after reviewing all 16 exceedance days for the years 1989 through 1991, and are representative of recurring types of exceedance days. For each selected day the staff constructed trajectories which support the case for overwhelming and significant transport, respectively.

3. Geographical Setting

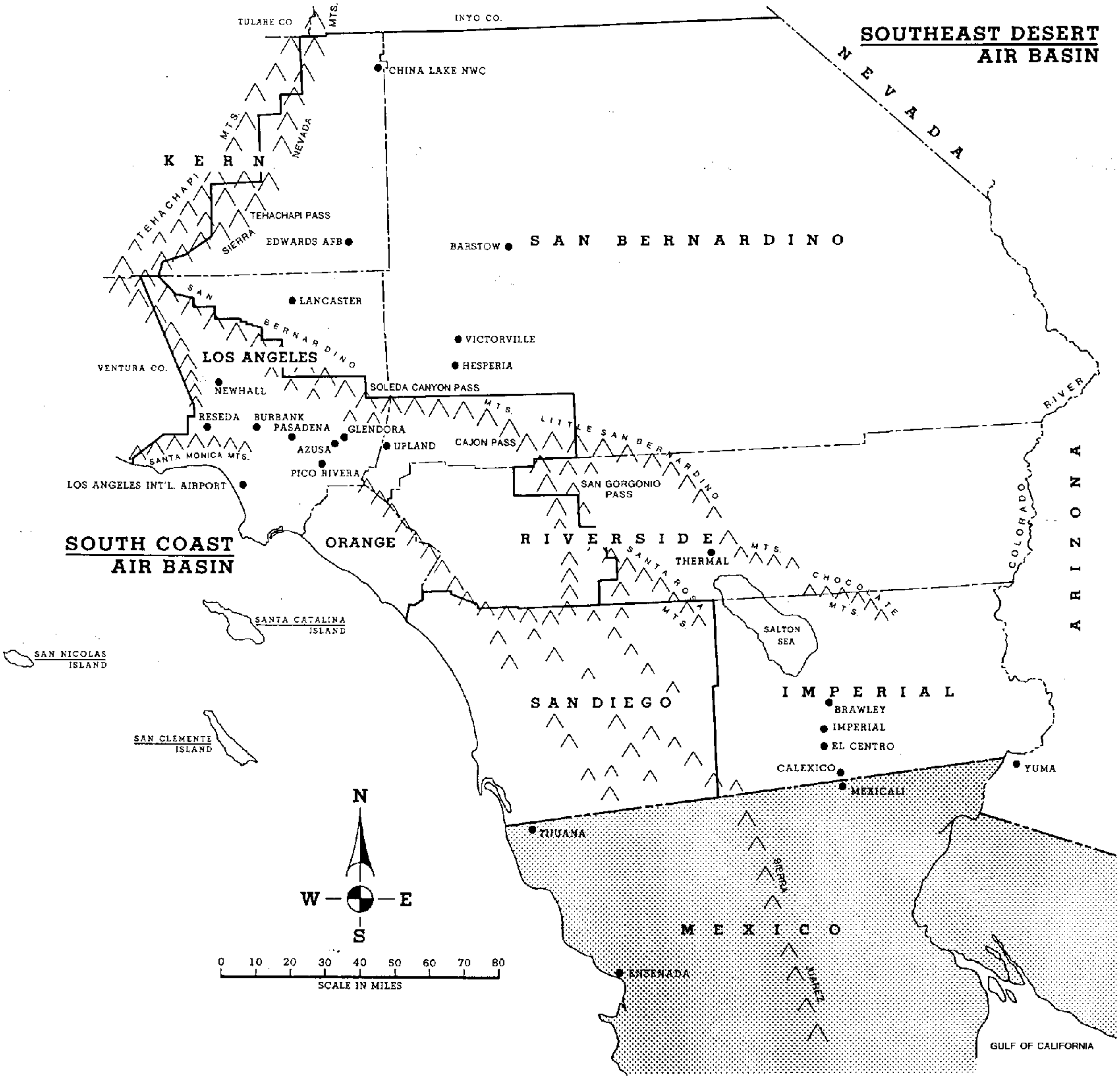
As shown in Figure IV.5, the SEDAB includes all of Imperial County, the portion of Riverside County east of the San Bernardino Mountains, the portion of San Bernardino County east of the San Gabriel and San Bernardino Mountains, the portion of Los Angeles County northeast of the San Gabriel Mountains, and the portion of Kern County east of the San Gabriel and Tehachapi Mountains. The basin is bounded on the north by the San Bernardino-Inyo County line, on the northeast by the Nevada state line, on the east by the Arizona state line including the Colorado River, and on the south by Mexico. The basin is bounded on the east and south by desert.

Many small mountain ranges dot the SEDAB--more to the east than in the west--with elevations greater than 5,000 feet. However, the topography of the basin is generally flat and slopes from 2,500 feet in the west to below sea level in the east. Overall, the SEDAB encompasses all of the Mojave Desert of southeastern California.

The geographical setting in Mexico--south of Imperial County--is the same as that in Imperial County. A large flat valley extends southward from

FIGURE IV.5

TRANSPORT COUPLE
MEXICO TO SOUTHEAST DESERT



the border to the Colorado River and the Gulf of Mexico, with mountain ranges on both sides.

4. Analysis

The Calexico air monitoring site in Imperial County was in operation for only October, November, and December 1991 during the 1989 to 1991 period, but ozone exceedances were recorded in two of the three months. El Centro air monitoring site had 13 exceedances of the state ozone standard during 1989 to 1991.

a. Overwhelming Transport

The staff selected November 8, 1991, to analyze because it had the highest ozone value at the Calexico site, 18 pphm, while El Centro did not exceed the ozone standard. Calexico and Mexicali, Mexico are adjacent. Mexicali has 1.1 million residents while Calexico has 20,000, less than 2 percent of the population in Mexicali. On calm days, pollutant emissions from Mexicali stay in the immediate vicinity, impacting the air quality of Calexico. These conditions led to the 18 pphm measured at Calexico on November 8, and are representative of many other days with calm or light winds.

The staff used wind trajectory analyses to identify the area of origin of pollutants transported into Imperial County. The surface low pressure was located northwest of the town of Imperial and a surface high pressure was located northeast of the area on November 8, 1991. Winds were very light over the Imperial Valley on November 8--they were reported calm the entire day at Mexicali and southerly at 7 knots or less at Imperial. The backward surface trajectory from Calexico showed slow movement of air from about 20 miles east-southeast of Mexicali to Calexico during the 14 hours leading to the 18 pphm ozone exceedance at 1:00 p.m. This very light air movement is typical for southern Imperial County. The staff believes this trajectory shows overwhelming transport.

The thermodynamics associated with this exceedance are interesting. The closest temperature measurement aloft on the morning of November 8, was the aircraft sounding at Thermal. Temperature was measured every 500 feet up from the surface. Starting at the surface, temperatures were: 60, 78, 80, 80, 78, 76, 74, 73, 70, 68, and 67 degrees F, at 5,000 feet. The morning low temperature at Imperial was 58 degrees at the same time the 60 degrees was observed at Thermal. Thermal temperatures aloft were assumed to be representative of the Calexico area as well. The time of the first ozone exceedance (11 pphm) was at 9:00 a.m. The temperature at this time was 76 degrees thus confining mixing to lower than 500 feet. By 1:00 p.m. the ozone concentration peaked at 18 pphm. The temperature was 86 degrees and surface air was mixing up to 1000 feet, the top of the inversion layer. After that time mixing deepened quickly, the temperature increased only 3 more degrees, and the ozone concentration began to decrease.

b. Significant Transport

Surface trajectories were also used for the "significant" transport assessment. Six days in 1990 had state ozone standard exceedances at El Centro--March 1, April 27, June 4, 8, 21, and 26. All days were analyzed for transport. Hourly surface data were plotted for each day. Each day was analyzed for surface pressure and winds, and backward trajectories were computed backwards from El Centro for each maximum ozone exceedance hour to determine the location of the air parcels in the 12 to 24 hours preceeding the maximum ozone exceedance. The trajectory for June 26, 1990 originated near the exit of San Gorgonio pass and is discussed in the South Coast to SEDAB section of this report. The June 21 trajectory came from near the Salton Sea. The June 8 trajectory started near the Chocolate Mountains. Because of the shape and climatology of the Imperial Valley and the proximity of El Centro and Mexicali, emissions from both cities can impact the monitor at El Centro. On the other days, March 1 and April 27, 990, trajectory parcels originated in Mexico and traveled over stationary sources located in both Mexico and southern Imperial County. All five of these days are identified as "significant" transport days.

6. Emission Inventory

The most recent emission inventory data available is the 1989 statewide, air basin, and county totals compiled by the ARB staff[1]. Emissions in the SEDAB are largely due to processing of raw materials such as gas, cement, and granite, as well as industrial sources dealing with chemicals and agriculture. Imperial County's 1989 emission inventory shows 28 tons per day of reactive organic gases and 31 tons per day of oxides of nitrogen. Although emission data are not available for Mexicali, the population of Mexicali is 9 times that of all of Imperial County. The emissions associated with such a large population are substantial. Emissions in Imperial County are relatively low compared to emissions from most of the areas bordering the SEDAB (Mexico and the South Coast Air Basin).

7. Previous Studies

The staff also reviewed an ozone transport study by STI[2] that concluded that ozone is primarily a local problem in the SEDAB. Those conclusions did not recognize the pollution potential from Mexicali, Mexico, which is situated on the U.S.-Mexico border.

8. References

1. Air Resources Board, 1991: Emissions Inventory 1989. ARB Staff Report prepared by the Emission Inventory Branch of the Technical Support Division, August 1991, 38 pp + 1 Appendix.

E. Mexico to San Diego

1. Summary and Recommendations

In 1989, the Air Resources Board (ARB) identified Mexico to San Diego Air Basin (SDAB) as being a "potential" transport couple requiring further research. A joint analysis by the staffs of the ARB and the San Diego County Air Pollution Control District (SDCAPCD) shows that on some days, ozone concentrations over the state standard in the SDAB can be caused entirely due to emissions from Mexico. In addition, under other meteorological conditions, emissions generated in the SDAB are sufficient to produce ozone concentrations in exceedance of the state ozone standard (state standard) without any transport from Mexico or elsewhere. This local exceedance is described in more detail in Chapter VII, Section E "South Coast to San Diego", in this report.

The staff recommends that the Board identifies "Mexico to San Diego Air Basin" as a transport couple and that Mexico's transport to the SDAB be classified as "overwhelming" on some days, "significant" on some days, and "inconsequential" on others. Since Mexico is outside the jurisdiction of the state, the staff does not recommend that the Board assign mitigation responsibilities to Mexico.

2. Conclusions

The staff believes that the contribution of emissions from Mexico to exceedances of the state standard in the SDAB is overwhelming, significant, and inconsequential. This conclusion is based in part on the staff's review and analysis of the work performed by the staff of the San Diego County Air Pollution Control District.

For 13 years or more, the SDCAPCD had categorized **all** violations of the state standard at **each** monitoring site in the District as being either due to transport from outside the County or due to emissions in the County. As of January 1991, however, the SDCAPCD meteorological staff began to classify ozone exceedances according to the same categories used by the ARB--inconsequential, significant, and overwhelming. These classifications, which are based on extensive data analyses **performed by the district staff**, are summarized below.

The SDCAPCD analysis method includes plotting hourly surface maps of the Western United States of pressures, temperatures, wind speeds, and wind directions. From these plots, pressure patterns and wind streamlines are drawn. In addition, upper air data are analyzed to produce three-dimensional flow fields up to an altitude of 18,000 feet. From the upper air data, a determination of the mixing height over the area is made. These analyses are then used to create backward trajectories for each ozone monitoring site starting from the time of the maximum ozone concentration. If the backward trajectory ends south of the border, i.e. in Mexico, without passing over major emission sources within the SDAB, then the day is categorized as overwhelming transport. If the backward trajectory ends in the SDAB without passing over major emission sources outside the SDAB, the day is categorized as local (i.e. inconsequential transport.) If the backward trajectory ends south of the border **and** passes over major emission sources within the SDAB or ends in the SDAB **and** passes over major emission sources outside the SDAB, then the day is categorized as significant.

3. Geographical Setting

Figure IV.6 shows the locations of geographical features discussed in this section. The SDAB consists of San Diego County. The SDAB is bounded on the north by the South Coast Air Basin (SCAB), on the east by the Southeast Desert Air Basin, on the west by the Pacific Ocean, and on the south by the Mexican State of Baja California. The County is divided by the Laguna Mountain Range which runs approximately parallel to the coast about 45 miles inland and separates the coastal area from the desert portion of the County. The Laguna Mountains reach peaks of over 6,000 feet with Cuyamaca Peak rising to 6,515 feet, the highest point in the County. The coastal region is made up of coastal terraces which rise up from the ocean into wide mesas changing into the Laguna Foothills farther east. Going still farther east, the topography gradually rises up to rugged mountains. On their east side, the mountains drop off rapidly to the Anza-Borrego Desert which is characterized by several broken mountain ranges with the desert valleys in between. To the north of the County are the Santa Ana Mountains which run parallel to the coast of Orange County turning east to join with the Laguna Mountains near the San Diego-Orange County border.

At present, there are nine ozone monitoring sites located in San Diego County. These include downtown San Diego, Kearny Mesa, El Cajon, Chula Vista, Oceanside, Escondido, Del Mar, Otay Mesa, and Alpine. The state ozone standard was exceeded at all of these sites on many occasions during 1989-1991.

The most likely site to be impacted by transport from Mexico is Otay Mesa, located about 50 yards north of the Mexican border. Light to moderate southerly/southeasterly winds can cause emissions from Mexico (especially from Tijuana) to be transported to the Otay Mesa site, thereby leading to an ozone exceedance.

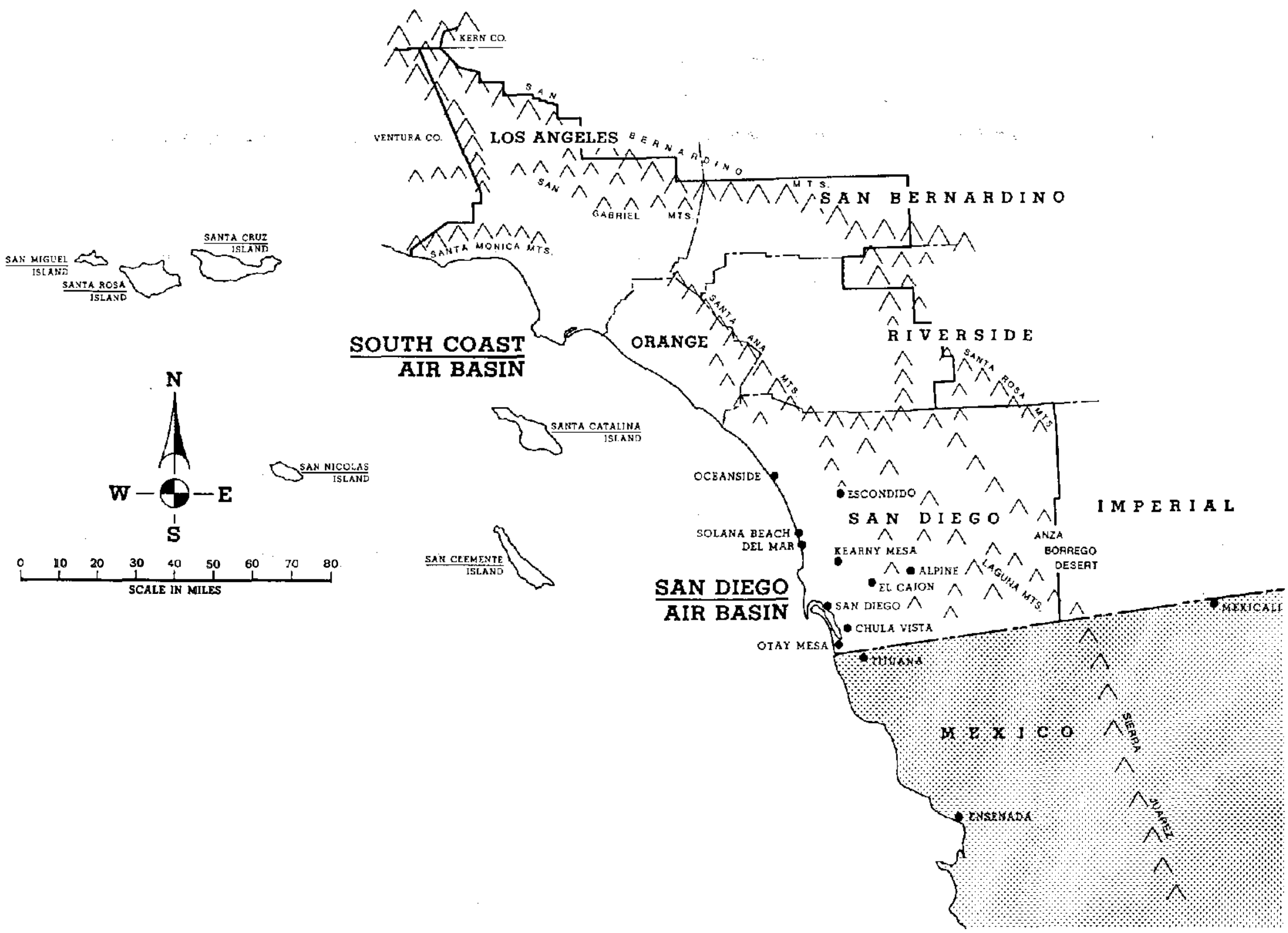
Alpine is the site at which the state standard is frequently exceeded because of local emissions. Alpine is located in the Laguna Foothills approximately 30 miles east of the City of San Diego at an elevation of 2,040 feet. Pollutants from the metropolitan San Diego Area are carried by the daytime sea-breeze up the mountain canyons to Alpine.

4. Analysis

The ARB staff has reviewed the SDCAPCD analyses for ozone standard exceedances in 1991 at all of the San Diego County monitoring sites. The analysis showed 4 days of overwhelming transport from Mexico, 10 days of significant transport from Mexico, and 59 other days of ozone exceedances in which there was no transport from Mexico or any other air basin. These classifications were all based on the SDCAPCD analyses and surface wind trajectories.

FIGURE IV.6

TRANSPORT COUPLE
MEXICO TO SAN DIEGO



a. Overwhelming Transport

Transport from Mexico was classified as overwhelming on four days in 1991. They were April 29, April 30, August 28, and November 6. The peak ozone concentrations at Otay Mesa were 10 pphm, 10 pphm, 11 pphm, and 11 pphm, respectively. Each of these days had only one hour which exceeded the state ozone standard.

b. Significant Transport

Transport from Mexico was classified as significant on 10 days in 1991. One of those days had ozone exceedances at two different monitoring sites while the remaining nine days observed exceedances at only one site. Eight of the these eleven episodes were at Otay Mesa, two were at El Cajon, and one at Alpine. The peak ozone concentration at each of these sites during a significant transport day were 14 pphm, 11 pphm, and 12 pphm, respectively.

c. Inconsequential Transport

As stated above, on 59 days in 1991 during which the state ozone standard was exceeded, transport from sources outside of the SDAB was not implicated. Ozone concentrations as high as 16 pphm were observed on some of these days. For more information on these local days, please see Chapter VII, Section E "South Coast to San Diego" in this report.

F. San Joaquin Valley to San Luis Obispo County

1. Summary and Recommendations

The staff's analysis indicates that surface transport of pollutants from the San Joaquin Valley Air Basin (SJVAB) to San Luis Obispo County (SLOC) occurs generally in the afternoon when winds from the SJVAB are strong enough to flow over the coastal range mountains. These transport winds are opposed by the surface sea breezes from the west which normally prevent the outflow winds from reaching the coast. When the sea breeze is weakened, the outflow from the valley is able to penetrate much further to the west. This caused transport from the SJVAB, which combined with emissions from local sources, to significantly impact ozone exceedances in the SLOC on August 6, 1990. The staff's analysis of upper-level air quality and meteorology indicates that ozone may have also been transported from the SJVAB to SLOC via winds aloft.

There are also ozone exceedances in SLOC that are not affected by transport from outside the district. An analysis performed by the San Luis Obispo County Air Pollution Control District for July 21, 1989, is described in the Clean Air Plan for San Luis Obispo (Allen 1991). On this day, ozone exceedances were experienced at several SLOC monitoring stations without evidence of significant transport from regions outside the SLOC.

The staff recommends that the Board identify "San Joaquin Valley Air Basin to San Luis Obispo County" as a transport couple and that the SJVAB's transport to the SLOC be classified as "significant" on some days and "inconsequential" on others. The amount of transport of ozone aloft remains undetermined, and the staff recommends further research and measurements to better quantify the origin and behavior of the ozone reservoir.

2. Conclusions

The contribution of SJVAB emissions and ozone to the ozone exceedances in SLOC is significant for August 6, 1990. The period August 3-6, 1990, was analyzed to determine the cause of the ozone exceedance in SLOC.

The surface and upper-level winds from the west opposed the SJVAB outflow winds from the east for each day of the 4-day period. However, on August 5, the sea breeze weakened significantly. With little opposition from the west on August 5, and a strengthened outflow wind from the SJVAB, more SJVAB air was transported to SLOC. On August 6, stagnant conditions existed until mid-afternoon in SLOC. A mid-day ozone exceedance was observed at one station inland from the coastal plateau. The previously transported SJVAB air from the day before plus emissions from the populated coastal region were both involved in the formation of ozone on this day. By later in the afternoon, the sea breeze returned and ozone concentrations were diminished in SLOC.

Vertical temperatures measured in both the SJVAB and SLOC indicate elevated temperature inversions existed in the late morning to help trap pollutants near the surface for both August 5 and 6. Upper-level ozone measured by aircraft revealed the persistence of a reservoir of ozone aloft over both the western San Joaquin Valley sites and the SLOC sites. High concentrations of ozone aloft were transported from the upper-levels of the SJVAB into the upper-levels of the SLOC during August 5 when the upper-level sea breezes diminished and were replaced with easterly winds near Paso Robles. The upper-level ozone profile near Paso Robles in the early afternoon showed high ozone concentrations two hundred meters above the ground, which compared well with surface concentrations measured at Santa Margarita on August 6.

The surface and upper-level meteorological and air quality data provide strong evidence that ozone exceedances which occurred at Santa Margarita on August 6 at midday were partly the result of transported air from the SJVAB.

Evidence that state ozone standard exceedances can be caused by local emissions is reported in the Clean Air Plan for San Luis Obispo (Allen 1991). The analysis was for July 21, 1989. On this day, ozone exceedances were experienced at several county monitoring stations and SLOC emissions rather than transport of ozone or precursor pollutants caused the ozone exceedance.

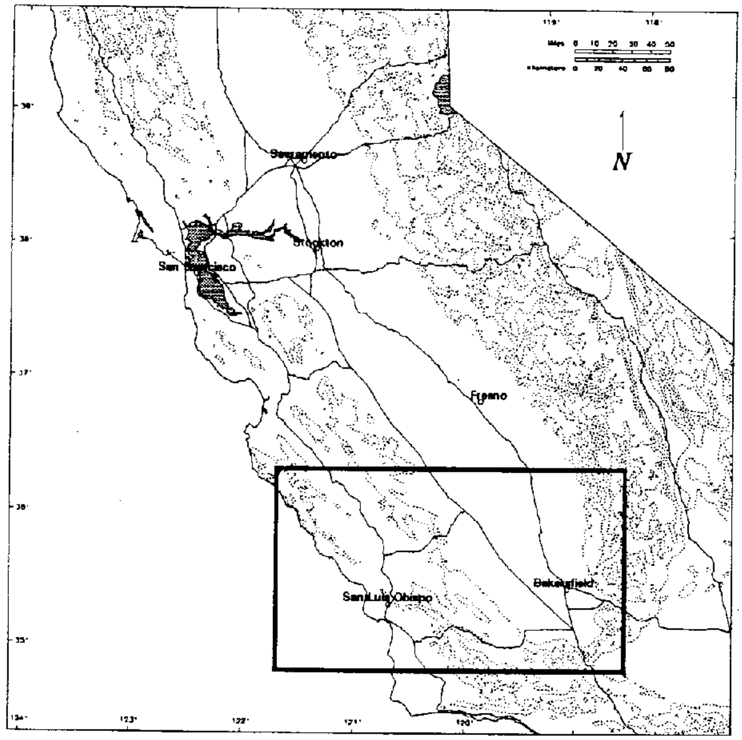
3. Geographic Setting

Figure IV.7 shows the locations of important geographical features discussed in this analysis. The SJVAB includes Kings, Fresno, Madera, Merced, San Joaquin, Stanislaus, and Tulare Counties. Also included is a part of Kern County which borders SLOC. The San Joaquin Valley is bounded by the high Sierra Nevada on the east side and the lower coastal range on the west. The major inflow of air into the SJVAB occurs near the Carquinez Strait in the Sacramento River Delta located in the northern part of the valley. There are few significant sources of pollution along the western side of the valley.

SLOC is bordered by Monterey County to the north, Santa Barbara County to the south, the Pacific Ocean to the west, and the SJVAB to the east. SLOC consists of three geographic regions: (1) The coastal plateau along the Pacific Ocean having 75% of the population and producing the highest emissions in the county. (2) The upper Salinas River valley in the northern section of the county having 23% of the population and historically measuring the highest ozone concentrations in the county. (3) The east county plain has only 2% of the county's population and the largest land area which consists mostly of the Carrizo Plain, a large drainage basin.

The Carrizo Plain borders the Temblor Mountain range to the east which lies in a northwest-southeast direction along the western side of the SJVAB. The only major break in the range occurs at the Cholame Pass in the northern end of the mountain range.

The meteorology of the SJVAB and SLOC is strongly influenced by the existence of a persistent high pressure area residing over the Pacific



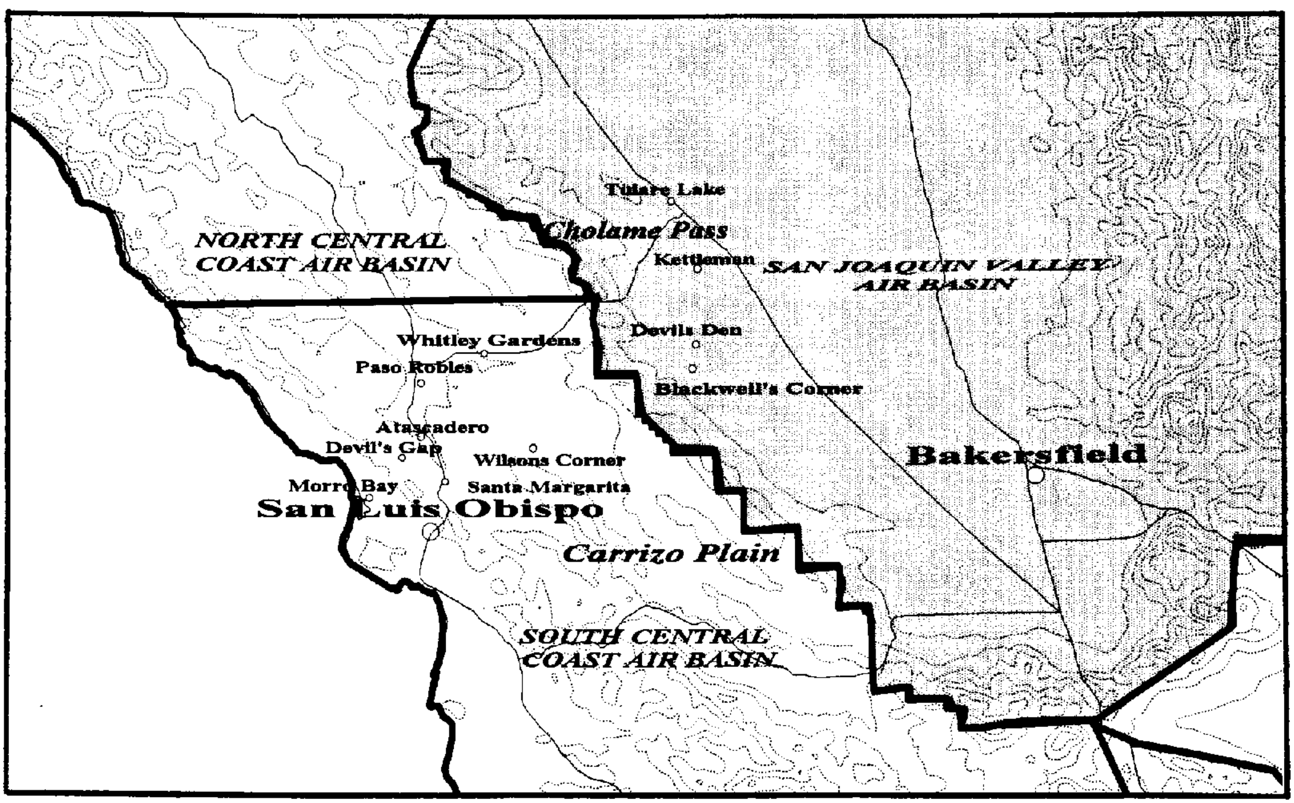


Figure IV.7

Southwestern SJV and SLOCA Location Map

Ocean. Seasonal variations in the strength and location of the high pressure system along with circulation driven by land and sea temperature differences affect the local winds. In the SJVAB, northwest winds blow down the axis of the valley during the day and most of this wind exits over the southeast Sierra Nevada, Tehachapis, and Coastal Ranges. This outflow along the coastal range bordering SLOC is opposed by coastal sea breezes. Normally this pattern persists as long as the location of the high pressure system is offshore or far enough away inland to not interrupt the daily sea breeze. The surface air quality for SLOC is directly affected by the relationship and strength of the opposing wind flows.

Occasionally, the onshore winds in SLOC revert to a weak offshore flow. This is usually caused by the presence of a strong high pressure system inland. The high pressure system over land causes the upper-level air to sink and heat as it moves downward in the atmosphere. This subsidence heating aloft causes an elevated layer of air to be warmer than the air underneath and subsequently prevents vertical mixing of air. Normal surface wind circulation patterns are shut down and stagnant conditions persist throughout SLOC and the SJVAB.

4. Analysis

The staff focused on data collected during the 1990 summer SJVAQS/AUSPEX and San Luis Obispo County Regional Ozone Study (SLOCROS) field programs to utilize the additional surface and upper-level wind, temperature, and air quality measurements. All days during the study period of July 7 - August 31, 1990, were examined for ozone exceedances in SLOC and the southwestern side of the SJVAB. The staff chose to analyze August 3-6, 1990, because exceedances of the state ozone standard occurred during this period in the SJVAB and SLOC.

The surface winds for August 3-6 were predominately from the north in the southwestern end of the SJVAB and SLOC. By late afternoon, the winds blew strongly enough to flow out of the valley over the Temblor Mountain Range and through the Cholame Pass. These outflow winds opposed the sea breeze from the west and this convergence of winds occurred just east of the Carrizo Plain on August 3, 4, and 6. On August 5, the sea breeze was very weak and the outflow winds from the SJVAB penetrated much closer to the coast. On August 6, winds were stagnant in SLOC until mid-afternoon.

The outflow winds on August 5 carried polluted air into SLOC, where it remained through mid-day on August 6. Surface ozone exceedances occurred on the southwestern side of the SJVAB on August 5 at 5 p.m, with Tulare Lake measuring an 11 pphm and later at 7 p.m. with Devil's Den measuring a 10 pphm. In SLOC on August 6, the surface air quality site at Atascadero measured 9 pphm from 11 a.m. until 1 p.m. At nearby Santa Margarita, a 10 pphm was measured at 11 a.m., an 11 pphm was measured at 12 noon, a 9 pphm at 1 p.m. and 10 pphm at 2 p.m.

Ozone was also carried aloft into SLOC. The upper-level wind patterns for August 3-6, 1990, are similar to the surface wind patterns for the SJVAB and SLOC. Upper-level winds near Tulare Lake were predominately from the north for the 4-day period. The winds aloft over Paso Robles showed a southwesterly sea breeze for August 4 and 6. However on August 5, the sea breeze was replaced with a weak easterly wind aloft, similar to the surface wind pattern.

Aircraft measured vertical ozone in spiral patterns down to near the surface over SLOC and also the southwestern side of the SJVAB for August 3-6. Measurements showed a large reservoir of ozone aloft persisted during the 4-day period. On August 6, the vertical profile for ozone near Paso Robles in the early afternoon showed a maximum of 13.3 pphm at 400 m msl. The aircraft ozone measurements made at the closest proximity to the surface (11.5 pphm) agreed well with the surface ozone exceedance of 10 pphm at 2 p.m. at nearby Santa Margarita.

The surface and upper-level meteorological data analyzed from August 3-6, 1990, indicates two opposing flows which maximized in the late afternoon. In the morning, a weak westerly sea breeze was able to flow into the SJVAB through the Cholame Pass. By the afternoon the northerly flow in the SJVAB had intensified and as it diverged out of the valley, it passed over the Temblor ridge and through the Cholame Pass. This is air that originated from the ocean west of the Bay Area, and also contained emissions from the SJVAB. It was opposed by sea breezes from the west. The result of these opposing flows is no net transport unless one of the two flows dominates.

On August 5, the sea breeze strength was significantly diminished, the outflow from the SJVAB advanced much further to the west than normal, and the winds aloft also carried pollutants into SLOC from the SJVAB. The lack of any significant westerly flow during the remainder of the day and into August 6 kept the air stagnant in SLOC. Local SLOC emissions were added to the stagnant air mass and ozone from aloft fumigated downward. The state ozone standard was exceeded at a SLOC air quality site in the middle of the day on August 6. Because both the transport from the SJVAB on August 5 and local SLOC emissions on August 6 contributed to the exceedances in the SLOC, the staff believes that August 6 is an example of a significant transport day from the SJVAB to the SLOC.

5. References

1. San Luis Obispo County Air Pollution Control District, 1991: Clean Air Plan: San Luis Obispo County.

2. Allen, P. 1991: Clean Air Plan: San Luis Obispo County. Appendix F: Characterization of Recent Ozone Excursions in San Luis Obispo County.

CHAPTER V

ASSESSMENT OF NEW COUPLES WITHOUT IDENTIFICATION

A. Southeast Desert to South Coast

1. Summary and Recommendations

Transport from the Southeast Desert Air Basin (SEDAB) to the South Coast Air Basin (SCAB) was identified by the ARB during the December 1989 Hearing, as an item needing further research.

The staff's analysis shows that transport from the Southeast Desert Air Basin (SEDAB) has an inconsequential effect on ozone concentrations above the state standard in the South Coast Air Basin (SCAB). This conclusion is based on examination of transport during a three day period that the staff believed was one of the most likely periods during 1989-1991 that transport from the SEDAB would impact SCAB ozone concentrations.

The staff recommends that the Board not identify the Southeast Desert Air Basin to the South Coast Air Basin as a transport couple.

2. Conclusions

The staff believes that the contribution of the Southeast Desert Air Basin emissions to exceedances of the state ozone standard in the South Coast Air Basin is insignificant. This conclusion resulted from a case study of a three-day period which was used to explore possible transport because the predominant wind flow pattern was from northeast to southwest (a Santa Ana wind flow regime).

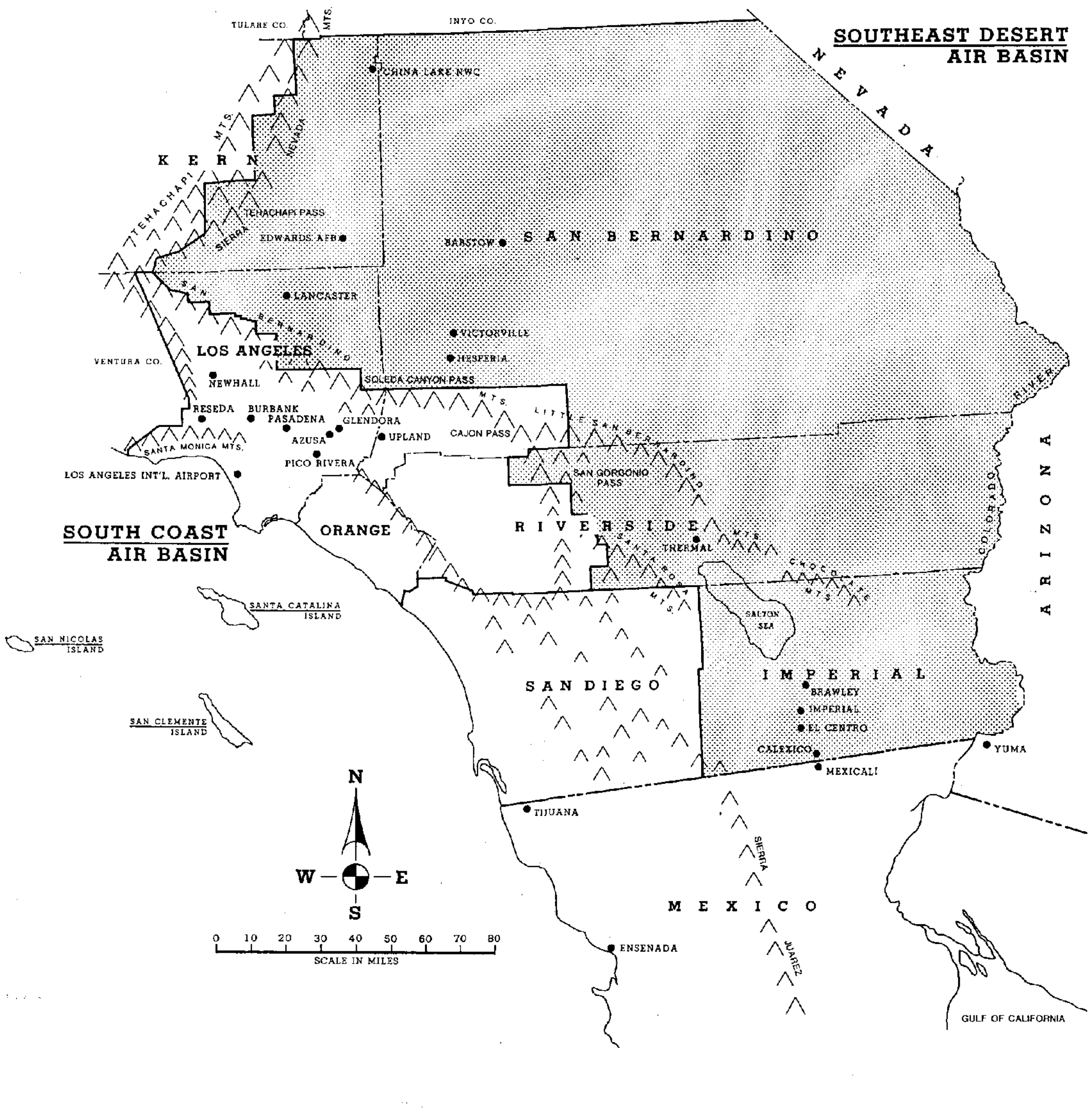
The staff reviewed all the days in the 1989-1991 period during which the state ozone standard was exceeded in the SCAB and a Santa Ana wind flow pattern prevailed. April 4-6, 1989, were chosen as a time when emissions from the SEDAB would be most likely to affect ozone concentrations in the SCAB because the Santa Ana wind flow was predominant (but light) during these three days. The staff used air quality analysis to support the conclusion that transport from the SEDAB is inconsequential.

3. Geographical Setting

Figure V.1 shows the geographical setting for this transport couple. The SEDAB includes all of Imperial County, the portion of Riverside County east of the San Bernardino Mountains, the portion of San Bernardino County east of the San Gabriel and San Bernardino Mountains, the portion of Los Angeles County northeast of the San Gabriel Mountains, and the portion of Kern County east of the San Gabriel and Tehachapi Mountains. The basin is bounded on the north by the San Bernardino-Inyo County line, on the northeast by the Nevada state line, on the east by the Arizona state line including the Colorado River, and on the south by the San Diego County and Mexican border. Figure V.1 shows the locations of important features in

FIGURE V.1

TRANSPORT COUPLE
SOUTHEAST DESERT TO SOUTH COAST



the Southeast Desert and South Coast Air Basins.

Many small mountain ranges dot the SEDAB--more in the East than in the West--with elevations greater than 5,000 feet. However, the topography of the basin is generally flat, sloping from 2,500 feet in the West to below sea level in the East. Overall, the SEDAB encompasses all of the Mojave Desert of southeastern California.

The SCAB includes all of Orange County, the portion of Riverside County west of the San Bernardino Mountains, and the portion of San Bernardino County west of the San Bernardino and San Gabriel Mountains, and the portion of Los Angeles County southwest of the San Gabriel Mountains. The basin is bounded on the north by the Ventura-Los Angeles County line, on the south by the Orange-San Diego County line, on the east by the San Bernardino Mountains, and on the west by the Pacific Ocean. Three important mountain passes lead from the SEDAB into the SCAB: Soledad Canyon Pass between the Sierra Pelona and the San Gabriel Mountains, Cajon Pass between the San Gabriel Mountains and the San Bernardino Mountains, and San Gorgonio Pass between the San Bernardino and the San Jacinto Mountains. These passes offer paths for the transport of pollutants between air basins. Soledad Canyon Pass and Cajon Pass are the main corridors considered for the possible SEDAB-SCAB transport couple because of their proximity to emissions in the Southeast Desert. Lancaster and Palmdale are located in the SEDAB near Soledad Canyon Pass, while Victorville, Hesperia, and Phelan border Cajon Pass.

4. Analysis

A Santa Ana wind flow pattern would need to persist for some time for pollutant transport to be possible from the SEDAB to the SCAB. All days during which a Santa Ana regime was observed at 4:00 a.m., 10:00 a.m., or 4:00 p.m. PST during the 1989-1991 study period were reviewed. There were 244 such days of which 44 days had ozone exceedances in the SCAB. However, 11 of these exceedance days, which occurred from January 1991 to March 1991, were eliminated from the analysis because of unusual and possibly inaccurate ozone measurements on those days. The Beverly Hills' monitoring site was the only station in the SCAB which observed ozone concentrations above the state standard during these 11 days. The concentrations at the Beverly Hills' monitoring site were twice as high as nearby monitoring sites and that site has been inoperative since March of 1991.

The three-day period (April 4-6, 1989) predominantly exhibited both light Santa Ana conditions and ozone concentrations over the state standard in the SCAB. Ozone concentrations of 19 pphm were found at Hawthorne and Beverly Hills on April 6, 1989. A sea breeze circulation, mostly confined to the coastal areas, occurred during the afternoon on all three days. A detailed air quality analysis was performed for this period. Isopleths (lines of equal concentration for a given time) and isochrones (lines in a chart connecting all points having the same time of occurrence of a particular phenomenon or of a particular value) of peak ozone concentrations were analyzed. If transport occurs, ozone peak concentrations in the SCAB would be greater closer to the SEDAB. In addition, the time of peak occurrence would be later the farther away from the SEDAB. These scenarios did not exist during this three-day period in April of 1989. The portion of the SCAB closest to the SEDAB observed ozone concentrations much lower than the rest of the SCAB and the time of peak ozone occurrence was, in many instances, later than the rest of the SCAB. The seabreeze observed in the afternoon on all three days indicates that the high ozone values near the coast were not due to emissions within the the SEDAB, but due to the emissions within the western portion of the SCAB. The afternoon seabreeze brings the air immediately off-shore, already containing pollutants from its earlier departure off-shore, back to the coastal areas of the South Coast Air Basin.[1] These analyses suggest that ozone exceedances resulted from local emissions within the SCAB and that there was no transport-identifiable impact from the SEDAB.

5. Emission Inventory

The 1989 estimated emissions compiled by the ARB staff[2] for the SCAB for NOx and ROG combined is 2,300 tons/day. The emission total in the SEDAB for NOx and ROG combined is 440 tons/day which is less than one-fifth of the emissions from SCAB.

6. References

1. Kauper, Erwin, K., 1977: San Diego Trajectory Study. Prepared for the SDAPCD.

2. Air Resources Board, 1991: Emissions Inventory 1989. ARB Staff Report prepared by the Emission Inventory Branch of the Technical Support Division, August 1991, 38 pp + 1 Appendix.

B. San Luis Obispo County to San Joaquin Valley

1. Summary and Recommendations

The staff analysis indicates that surface transport from the San Luis Obispo County (SLOC) to the San Joaquin Valley Air Basin (SJVAB) has the potential to occur during the morning before opposing winds from the SJVAB have enough strength to flow over the coastal range mountains and block transport from SLOC. However, the light transport winds from the west are not associated with state ozone standard exceedances in the SJVAB. The staff's analysis indicates that transport from SLOC does not contribute to state ozone standard exceedances in the SJVAB. The analysis further indicates that when the sea breeze is very weak, the transport of marine air into the SJVAB is diminished, and the chances for state ozone standard exceedances occurring on the southwestern side of the SJVAB due to local emissions are enhanced.

Since the current information indicates SLOC's transport to the SJVAB would be classified as "inconsequential", the staff recommends that the Board not identify this transport couple.

2. Conclusions

The staff believes that contribution of SLOC emissions to the ozone exceedances in the SJVAB is inconsequential. This conclusion is based on a four-day case study from data collected during the 1990 SJVAQS/AUSPEX, and San Luis Obispo County Regional Ozone Study (SLOCROS) field studies. The staff chose the August 3-6, 1990, period because it was the only episode during which state ozone standards were exceeded on the southwestern side of the SJVAB.

The surface and upper-level winds from the west opposed SJVAB outflow winds from the east during each day of the four day period. On August 5 ozone measurements exceeded the state standard at two remote sites (located near Tulare Lake and Devil's Den) on the southwestern side of the SJVAB. However, on August 5, the sea breeze was weakened significantly and there was no wind contribution from the west. By late in the afternoon on August 6, the sea breeze returned and no ozone exceedances occurred on the southwestern side of the SJVAB.

Vertical temperatures above Tulare Lake showed elevated warm layers in the late morning on August 5 which helped trap pollutants near the surface. Upper-level air quality data measured by aircraft showed a reservoir of ozone aloft over both the southwestern SJVAB and the SLOC sites. The staff believes that the SJVAB is the most likely source area for this upper-level ozone. Further investigations would be helpful to clarify the origin and destination of this persistent upper-level ozone.

3. Geographic Setting

Figure V.2 shows the locations of important geographical features referenced in this discussion. SLOC is located in the northern section of the South Central Coast Air Basin. It is bordered by Monterey County to the north, Santa Barbara County to the south, the Pacific Ocean to the west, and the San Joaquin Valley to the east. SLOC consists of three geographic regions: (1) the coastal plateau along the Pacific Ocean having 75% of the population and producing the highest emissions in the county; (2) the upper Salinas River valley in the northern section of the county having 23% of the population and historically measuring the highest ozone levels in the county; (3) the east county plain has only 2% of the county's population and the largest land area which consists mostly of the Carrizo Plain, a large drainage basin. The Carrizo Plain borders the Temblor Mountain range to the east which lies in a northwest-southeast direction along the western side of the SJVAB. The only major break in the range occurs at the Cholame Pass in the northern end of the mountain range.

The meteorology of SLOC and the SJVAB is highly influenced by the existence of a persistent high pressure area residing over the Pacific Ocean. Seasonal variations in the strength and location of the high pressure system along with circulations driven by land and sea temperature differences affect the local winds. The typical summer wind circulation pattern in SLOC consists of the daily sea breeze meeting the wind flow coming out of the San Joaquin Valley which peaks in the late afternoon. When the high pressure area moves inland, it causes air to sink and heat as it descends in the atmosphere. This subsidence heating aloft causes an elevated layer of air to be warmer than the air underneath and subsequently prevents any vertical mixing of air. The normal sea breeze pattern is shut down and stagnant conditions persist.

4. Analysis

b. Air Quality Assessment

The staff focused on data collected during the 1990 summer SJVAQS/ AUSPEX and SLOCROS field programs to utilize the additional upper-level wind, temperature, and air quality measurements. All days during the study period of July 7 - August 31, 1990, were examined for ozone exceedances on the southwestern side of the SJVAB. The staff chose August 3-6, 1990, to analyze the surface and upper-level meteorology because exceedances of the state ozone standard occurred during this period in the SJVAB.

Ozone exceedances occurred on the southwestern side of the SJVAB on August 5. At 5 p.m. an 11 pphm was recorded at Tulare Lake and at 7 p.m. On August 6, the southern SJVAB experienced many ozone exceedances but none were measured at the sites near the Cholame Pass.

Aircraft which flew in spiral patterns down to near the surface measured ozone vertically on the southwestern side of the SJVAB for August 5 and 6. On August 5 in middle of the afternoon, ozone concentrations were consistently above 10 pphm through the entire layer above Tulare Lake.

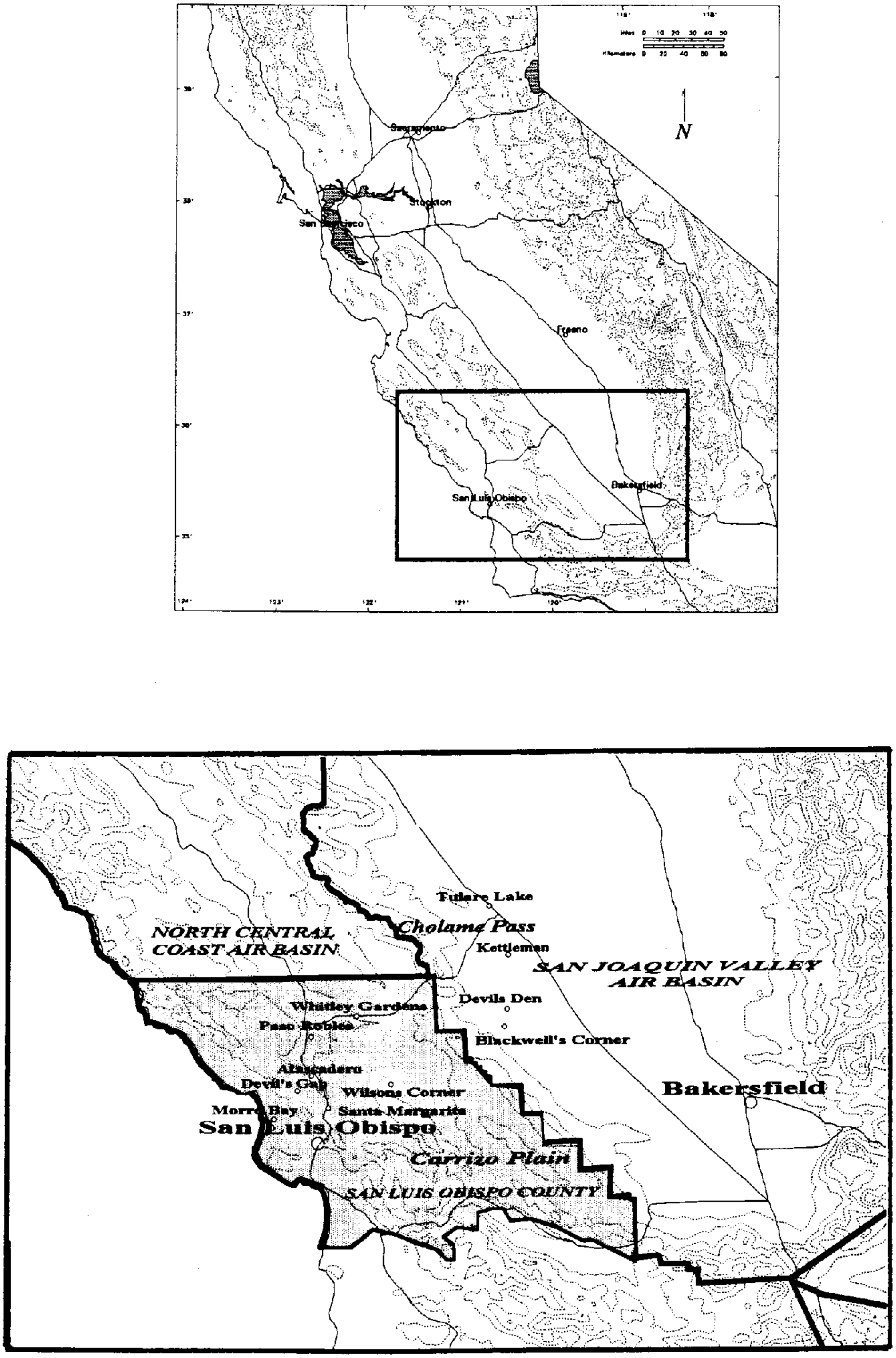


Figure V.2

Southwestern SJV and SLOCA Location Map

a. Meteorological Assessment

The daytime surface winds in the SJVAB for the four day period were essentially from the north. However, the winds in the morning on the southwestern side of the SJVAB for August 3,4, and 6 were from the west and southwest. On August 5, the morning winds were light and variable and showed no westerly component. The winds remained light and variable until the afternoon when the normal northerly winds resumed. The strong high pressure system centered over southwestern Nevada had the pronounced effect of shutting down normal surface wind circulations on this day. The winds aloft had a persistent northerly component throughout the four day period, but were lighter on August 5. These winds indicate that no upper-level air was transported from the SLOC during the entire four day period. Vertical temperatures measurements in the SJVAB on August 5 showed the presence of an elevated warmer layer which trapped pollutants beneath.

c. Discussion

The surface and upper-level meteorological data analyzed from August 3-6, 1990, indicates two opposing flows which maximized in the late afternoon. In the morning, a weak westerly breeze was able to flow into the SJVAB through the Cholame Pass. By the afternoon the sea breeze had intensified and it transported marine air mixed with emissions from the SLOC coastal plateau. It was opposed by winds flowing over the coastal mountains and through the Cholame Pass from the SJVAB in the afternoon. These opposing flows resulted in no net transport unless one of the two flows dominated. On August 5, the sea breeze strength was significantly diminished. Surface monitoring sites on the southwestern side of the SJVAB experienced no significant winds from the west and only northeasterly winds from upwind areas.

Measurements of upper-level ozone indicated a large source of ozone aloft over Tulare Lake on August 5. A high pressure system helped to diminish surface winds and create stagnant conditions in the SJVAB. Fumigation of upper-level ozone down to the surface possibly contributed to surface ozone exceedances. The lack of transported air from SLOC to the SJVAB on August 5 enhanced conditions for ozone formation. In addition, pollutants were transported from the north and northeast which helped contribute to ozone exceedances at Devil's Den and Tulare Lake, both being remote areas with no known sources of ozone precursors.

CHAPTER VI

1990 Transport Couples with Regulatory Changes

A. San Francisco Bay Area to Broader Sacramento Area

1. Summary and Recommendation

In 1990, the ARB found that the San Francisco Bay Area Air Basin's (SFBAAB) transport to the Broader Sacramento Area (BSA) was "significant" on some days and "inconsequential" on others. The staff's current analysis shows that, in addition to the previous findings, "overwhelming" transport from the San Francisco Bay Area Air Basin to the Broader Sacramento Area occurred on three days at Vacaville.

The staff recommends that the Board classifies the SFBAAB transport to certain parts of the BSA as "overwhelming". The staff also recommends that the air quality attainment plan of the San Francisco Bay Area Air Quality Management District contain sufficient measures to demonstrate attainment of the state ozone standard at Vacaville under conditions which promote overwhelming transport.

2. Conclusions

The staff concluded that transport of emissions from the SFBAAB overwhelmed the BSA site at Vacaville on September 14, 1989. This recommendation is based upon the wind flow patterns, the characterization of the exceedances, the emission inventory differences between the subject areas, and the proximity of the impacted BSA site to the basin boundary line. Vacaville exceeded the state ambient air quality standard for ozone on 5 days in 1989 and 1990. The site was discontinued in the fall of 1990. The 3 days which were studied in depth were chosen because the preponderance of data which were initially reviewed indicated that the exceedances on those days would more likely depict overwhelming transport than either of the 2 other days. The staff found that all 3 of the selected days were overwhelmed by transport from SFBAAB, however, 2 of those days, June 22, 1989 and July 10, 1990, are excluded as violations because the staff found them to be extreme concentrations.

3. Geographic Setting

Figure VI.1 shows the geographic setting of this couple. The BSA comprises the southern part of the Sacramento Valley and a part of the western slope of the Sierra Nevada. The BSA includes Sacramento County, the southern third of Sutter County, Yolo-Solano Air Pollution Control District, and the western portions of El Dorado and Placer Counties. For the purpose of assessing transport from the SFBAAB to the BSA, the focus of the BSA as a receptor was limited to the Yolo-Solano Air Pollution Control District. The SFBAAB comprises all or parts of nine counties. However, of these nine counties, Contra Costa, Marin, Napa, San Francisco Counties, the southern portion of Sonoma County, and the western portion of Solano County have the

FIGURE VI.1

TRANSPORT COUPLE
SAN FRANCISCO BAY AREA TO BROADER SACRAMENTO AREA

* Broader Sacramento Area includes Sacramento Metropolitan Air Quality Management District, Yolo-Solano Air Pollution Control District, the southern third of Sutter County Air Pollution Control District, and the western portions of El Dorado and Placer County Air Pollution Control District.

greatest potential to impact air quality in the BSA via transport.

The Coast Range has a northwest-southeast alignment and acts as a barrier between the cool, moist, marine air along the California coast and the hot dry air in the Sacramento Valley. Frequently, maximum coastal SFBAAB temperatures are in the high 50's (^{o}F) in the SFBAAB and in the high 90's (^{o}F) in the BSA. The Carquinez Strait which provides a gap in the Coast Range, is the predominant geographic feature influencing the potential for pollutant transport from the SFBAAB to the BSA. The marine air routinely flows through the Carquinez Strait and into the delta region of the Sacramento River. The magnitude of this marine air influx is controlled largely by the depth of the marine layer compared to the height of the Coast Range and the atmospheric pressure gradient between the SFBAAB and the BSA.

During the summer, a thermal low pressure area frequently develops over the Sacramento and San Joaquin Valleys which causes air to flow from the SFBAAB into the BSA. Consequently, Travis Air Force Base, located in the Fairfield area on the northern edge of the delta, typically has strong southwesterly winds and thereby serves as an indicator of marine air intrusion to the BSA. This characteristic regional air flow has the potential to transport ozone and ozone precursors from the SFBAAB to the BSA.

4. Analysis

In 1990, the staff did an assessment that led to the conclusion that the transport from the SFBAAB to BSA was "significant" on some days and "inconsequential" on others. The staff's current assessment of transport from the SFBAAB to the western portions of the BSA was based on data for 1989 through 1990. Both air quality and meteorological data were used in the transport analysis during the study period from both the SFBAAB and BSA.

Meteorological data used in this study consisted of wind speed and wind direction from meteorological monitoring stations throughout the SFBAAB and BSA operated by the Department of Defense, the National Weather Service, the Federal Aviation Administration, the Air Resources Board, the Department of Water Resources, the air pollution control districts, and the Weather Network, Inc.

Air quality data from the SFBAAB and the BSA were examined with a focus on sites at Oakland, Richmond, Vallejo, Fairfield, Vacaville, Davis, Broderick, Sacramento at T Street, Citrus Heights, Folsom, and Auburn. All sites are along a common trajectory path during episodes of strong marine air intrusion from the SFBAAB to the BSA.

The site at Vacaville was the main focus of this analysis as it is situated immediately east of the basin boundary line between the SFBAAB and the BSA. However, the days available for study were limited because the air quality monitor at Vacaville was discontinued in the fall of 1990. The ARB staff began the assessment of identifying overwhelming transport days at Vacaville by first identifying the days during 1989-1990 which exceeded the state ozone standard. The staff then performed an air quality, meteorological, and emissions inventory analysis on Vacaville exceedances to determine the source air basin(s) and degree of emissions impact.

The staff identified 5 days during 1989-1990 in which the daily maximum ozone concentrations exceeded the state ozone standard at Vacaville. The extreme concentration value for Vacaville is 10 pphm. Any daily peak concentration at that station that is greater than 10 pphm is considered extreme and, therefore, not a violation. Three of the 5 exceedance days were greater than 10 pphm and were identified as extreme concentrations as defined by Title 17 CCR 70300. Although these exceedances do not count as violations they were included in this transport analysis as examples of transport to establish the conditions under which transport occurs. Table VI.1, below, lists the dates of the peak ozone concentration during the study period.

TABLE VI.1

Dates of Ozone Exceedances during Study Period at Vacaville

September 14, 1989	10 pphm
June 22, 1989	11 pphm
July 6, 1989	12 pphm
July 7, 1989	10 pphm
July 10, 1990	11 pphm

The staff screened these 5 days for overwhelming transport impact. The staff began this screening by first identifying days in which the peak hourly ozone concentration occurred at successively later times of the day at San Francisco, Vallejo, Fairfield, and then Vacaville. This occurrence of peak ozone concentrations at progressively later times of the day for the sites further along the transport path suggests prevailing air flow movement of an ozone and ozone precursor-rich air mass from the SFBAAB to Vacaville. Three of the five exceedance days at Vacaville exhibited this pattern of successively later occurrences of the hour of peak ozone concentrations between the SFBAAB and Vacaville.

Table VI.2 illustrates the progressive increase in ozone concentrations between the SFBAAB and Vacaville. Included in the table are sites downwind from Vacaville which indicate the dispersion of air in the valley as it gets further beyond Vacaville. Sites are arranged from top to bottom as they are physically from southwest to northeast. As the marine air moves emissions out of the SFBAAB, ozone measurements in areas of greater emission concentrations such as Oakland and Richmond remain below the state ambient air quality standard. The exceedances occur progressively later at the Solano County sites of Vallejo, Fairfield, and finally Vacaville. There are no more exceedances downwind due to the diffluent air flow pattern which takes place after the marine air has transited the

TABLE VI.2

Maximum Ozone Concentrations (pphm), Exceedance Durations, and Hour of Max Ozone Concentration (exceedance durations and hour of max ozone expressed in time of day)

Site	6-22-89 max/dur		hour of max 03	9-14-89 max/dur		hour of max 03	7-10-90 max/dur		hour of max 03
Oakland	4	--	--	4	--	--	5	--	--
Richmond	7	--	--	6	--	--	5	--	--
Vallejo	10	1300	1300	8	--	--	11	14-1500	1400
Fairfield	10	14-1500	14-1500	10	1300	1300	10	12-1400	12-1400
Vacaville	11	15-1600	1500	10	1400	1400	11	14-1500	1500
Davis	not	avail.		not	avail.		9	--	--
Broderick	7	--	--	8	--	--	8	--	--
Sac. T.St.	6	--	--	7	--	--	7	--	--
Cit. Hgts.	10	1200	1200	8	--	--	9	--	--
Folsom	12	11-1400	12-1300	11	12-1500	1300	7	--	--
Auburn	not	avail.		9	--	--	9	--	--

coastal range. This is supported by the lower ozone concentrations measured in Davis and Broderick which are downwind from Vacaville and upwind of the next major emission concentrations located in the BSA.

5. Emission Inventory

The most recent emission inventory data available is the 1989 statewide, air basin, and county totals compiled by the ARB staff[1]. While such emission totals provide only general information, they were useful for determining the relative difference in emissions between various areas. This information provided a general indication of the potential for the emissions in each area to contribute to ozone concentrations.

Ozone precursor emissions consist primarily of emissions of reactive organic gases (ROG) and nitrogen oxides (NOx). Based on the 1989 emission inventory data, the ARB staff estimates that ozone precursor emissions in the BSA are approximately 350 tons per day (see Table VI.3, page VI.6).

The 1989 emission inventory data indicate that the ozone precursor emissions in the SFBAAB are approximately 1370 tons per day. The emissions

TABLE VI.3

1989 Emissions Inventory
Tons per Day

Area	ROG	NOx	ROG + NOx
BSA	180	170	350
BSA (part - Yolo and Solano only)	34	36	70
SFBAAB	790	580	1370
SFBAAB (part - including Solano, Contra Costa, San Francisco, Sonoma, Marin, Napa)	400	267	667
Ratios			
SFBAAB:BSA	4	3	4
SFBAAB (part):BSA (part)	12	7	10

in the SFBAAB are 4 times that of the emissions in the BSA. However, under conditions when transport occurs, the emission areas of interest are San Francisco, Contra Costa, Napa, Marin, Solano (SFBAAB portion), and Sonoma (SFBAAB portion) Counties impacting Solano (BSA portion) and Yolo Counties. The emissions from the focused upwind area are approximately 10 times greater than the emissions from the focused downwind area.

The staff did not make a quantitative determination of the relative contributions of the emissions in western portion of the BSA versus the contribution of the emissions in the SFBAAB to the ozone exceedances at Vacaville. The staff could not make a quantitative determination because the emission data are not sufficiently resolved spatially or temporally. The staff made a qualitative conclusion, however, that when ozone and ozone precursor emissions in the SFBAAB were transported to Vacaville, the transported ozone and ozone precursor emissions had an overwhelming impact on Vacaville ozone concentrations.

6. Summary of Previous Transport Studies

Previous tracer and air quality studies have indicated the potential for transport of ozone and ozone precursors from the SFBAAB to the BSA on days when the state standard is exceeded in the BSA.[2,3] In 1990, the ARB staff[4] analyzed ozone exceedance days in the BSA for the period 1986 through 1988. This analysis led the staff to conclude that the exceedances were primarily due to emissions originating within the BSA, but that emissions in the SFBAAB typically are transported into the BSA where they can contribute to maximum ozone concentrations. This analysis did not review the exceedance days in Vacaville, but concentrated on the maximum exceedance days at monitors located further into the BSA (that is, the City of Sacramento vicinity).

A jointly funded project by the ARB and the NOAA Wave Propagation Laboratory (WPL)[5] was begun in 1991 to study atmospheric transport corridors and processes using new remote sensing technology. The remote sensing technology in the form of a wind profiler and Radio Acoustic Sounding System (RASS) were set up in northern California in 1991 and southern California in 1992 to create a data base of vertical profiles of winds and temperatures along air pollutant transport corridors. In addition, supplemental meteorological instrumentation was added to the wind profiler and RASS network so that mixing layer depths could be inferred and the dynamics of local circulations along terrain-dominated transport corridors could be better understood.

The 1991 network studied the transport of air pollutants from the SFBAAB Air Basin into the Broader Sacramento Area, the Upper Sacramento Valley, and the North Central Coast Air Basin. The 1991 study of the SFBAAB to Sacramento Valley corridor occurred in the months of May to November. The network of profilers were located at Arbuckle, Tracy, Oroville, Pleasant Grove, Rancho Seco, near Travis AFB, and UC Davis. The WPL will carry out analyses of the data collected to improve the understanding of the meteorological processes that influence pollutant transport and dispersion between the SFBAAB and Sacramento Valley and within the Sacramento Valley. The data base and subsequent analysis are scheduled for completion in January 1994.

7. References

1. Air Resources Board, 1991: Emission Inventory 1989. ARB Staff Report prepared by the Emission Inventory Branch of the Technical Support Division, August 1991, 38 pp + 1 Appendix.

2. Giorgis, R. B., 1983: Meteorological Influences on Oxidant Distribution and Transport in the Sacramento Valley. Thesis, M.S. in Eng., UC-Davis, 315 pp.

3. Lehrman, D., Smith, T., Reible, D. D., and Shair, F. H., 1981: A Study of the Origin and Fate of Air Pollutants in California's Sacramento Valley, Vols. I & II. Final Rep. MRI 81 FR--1842, Prepared for ARB, Meteor. Res., Inc., 25 pp and 210 pp, respectively.

4. Air Resources Board, 1990: Assessment and Mitigation of the Impacts of Transported Pollutants on Ozone Concentrations within California. ARB staff report prepared by Technical Support Division and Office of Air Quality Planning and Liaison, June 1990, 179 pp. + 2 Appendices.

5. Neff, W. D., and J. M. Wilczak, 1991: A Multi-Year Observational Study of Atmospheric Transport Corridors and Processes in California. Unsolicited research proposal submitted to the ARB by the NOAA Wave Propagation Laboratory, January 10, 1991, 34 pp + Attachments.

B. San Francisco Bay Area to San Joaquin Valley

1. Summary and Recommendations

In 1990, the ARB found that the San Francisco Bay Area Air Basin's (SFBAAB) transport to the San Joaquin Valley Air Basin (SJVAB) was "significant" on some days and "inconsequential" on others. The staff has since conducted further studies which indicate that transport from the SFBAAB was the sole cause for ozone exceedances at Crow's Landing, a site about 20 miles into the SJVAB. Therefore, the staff now recommends that the Board find that overwhelming transport from the SFBAAB to the SJVAB occurred at Crow's landing. The staff also recommends that the air quality plan of the Bay Area Air Quality Management District contain sufficient measures to demonstrate attainment at Crow's Landing in the SJVAB under conditions which promote overwhelming transport.

2. Conclusions

A transport analysis was conducted for a state ozone standard exceedance occurring at Crow's Landing on August 6, 1990. A surface wind trajectory indicated that the air reaching Crow's Landing at the time of an ozone standard exceedance originated in the SFBAAB and did not pass over any significant emission sources in the SJVAB before arrival at Crow's Landing. The staff believes this is evidence for overwhelming transport from the SFBAAB to a portion of the SJVAB.

Additional studies were done for state ozone standard exceedances on August 6, 1990, at Stockton and Turlock. Although trajectory studies showed that the air mass arriving at these monitoring sites at the time of the exceedances also originated in the SFBAAB, the trajectories had moved across significant emission sources in the SJVAB. The staff believes that combined emissions of ozone precursors from both the SFBAAB and the SJVAB contributed to these exceedances.

3. Geographical Setting

The locations of important features in the SFBAAB and the SJVAB are shown in Figure VI.2. The SJVAB includes all of San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, and Tulare Counties, and the western portion of Kern County. The SFBAAB lies to the west and northwest of the SJVAB. Emissions transported from Contra Costa, Marin, Napa, San Francisco, and Sonoma Counties and the western portion of Solano County in the SFBAAB have the highest potential impact on ozone concentrations in the northwestern portion of the SJVAB.

The routine influx of marine air through the Carquinez Strait and into the delta region of the San Joaquin River is the dominant feature influencing air flow and the probable path for pollutant transport from the SFBAAB to the SJVAB. The magnitude of the pollutant influx into the SJVAB is controlled largely by the depth of the marine layer compared to the height of the Coast Ranges and the atmospheric pressure gradient between the

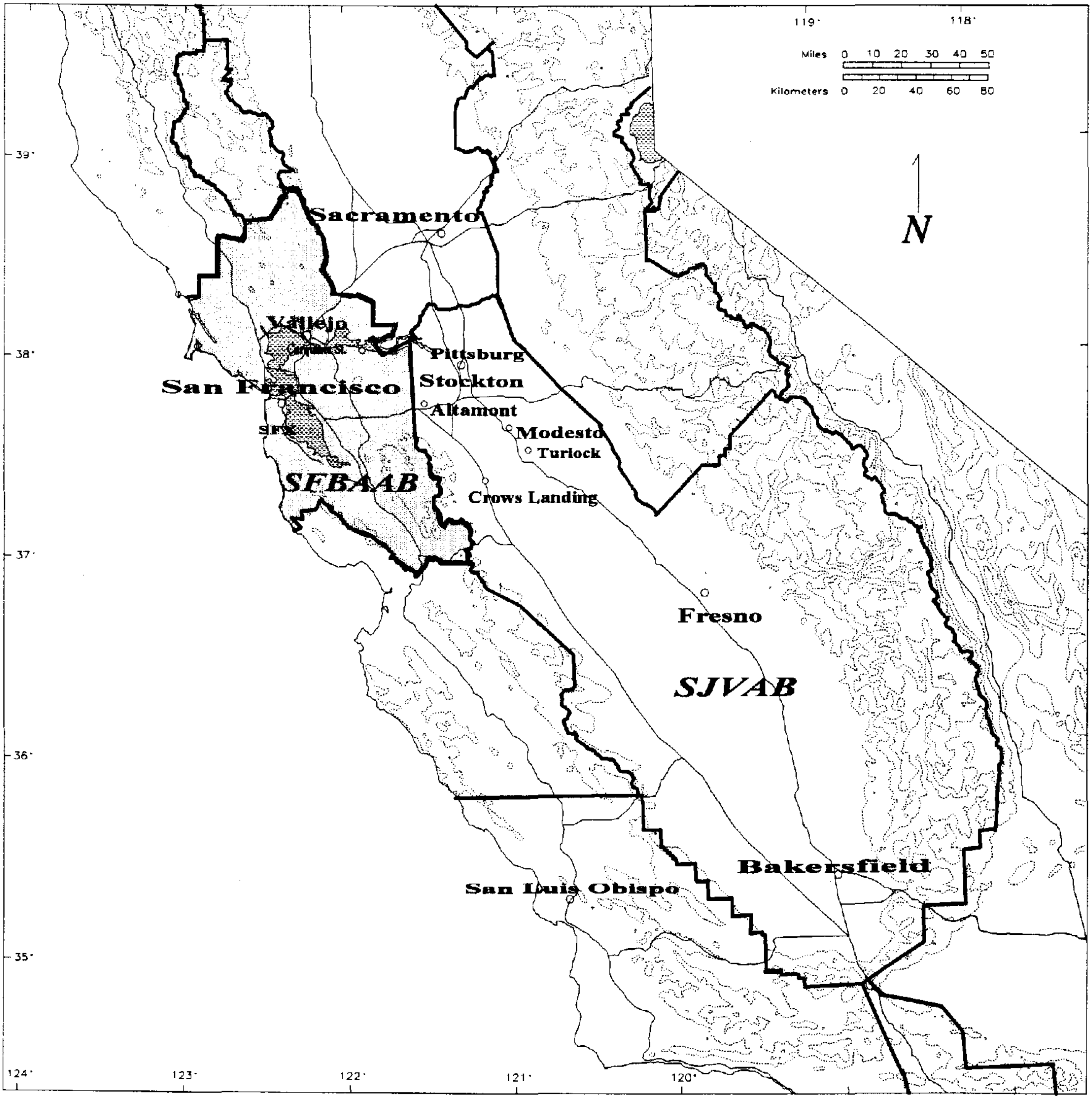


Figure VI.2

SFBAAB and SJVAB Location Map

SFBAAB and the SJVAB. During the summer, a thermal low pressure area develops over the Central Valley and air generally flows into the SJVAB through a gap in the Coast Ranges.

The Coast Ranges have a northwest-southeast alignment and present an effective barrier between the cool, moist, marine air along the coast and the hot, dry air in the Central Valley. When the depth of the marine layer exceeds the height of the Coast Ranges (2,000 to 3,000 feet), cool marine air can spill into the SJVAB.

4. Analysis

a. Trajectory Analysis

The staff chose August 6, 1990, to analyze transport from the SFBAAB to the SJVAB because there were multiple sites in the SJVAB with exceedances and there was a rich database collected during the SJVAQS/AUSPEX field studies. At 3 p.m. on August 6, the ozone concentrations at the following stations exceeded state standards:

1.	Stockton	12 pphm
2.	Turlock	10 pphm
3.	Crow's Landing	10 pphm

Trajectories were calculated backward from 3 p.m. from these stations to find the origins of these polluted air masses. The wind field for calculating trajectories was obtained from a 2-dimensional diagnostic model using the database collected during the 1990 SJVAQS.

The air mass arriving at Crow's Landing at 3 p.m. August 6 came from the vicinity of the San Francisco airport about 21 hours earlier and traveled in a southeasterly direction to the SJVAB. Since this air mass did not pass over any significant emission sources in the SJVAB, the ARB staff believes that the exceedance at Crow's Landing was due to transport from the SFBAAB.

The air masses arriving at Stockton and Turlock at 3 p.m. on August 6 also originated in the SFBAAB on August 5. These trajectories also headed in a southeasterly direction to the SJVAB. However, these air masses pass over significant emissions of ozone precursors in the SJVAB. Therefore, the staff concludes that the ozone exceedances in Stockton and Turlock are caused by emissions from both air basins.

b. Upper-Level Winds

The staff also examined upper-level winds for indications of transport aloft. The analysis shows that ozone was transported aloft from the SFBAAB southeast to the western side of the SJVAB. These upper-level winds were westerly in the early morning on August 6, and changed to northwesterly by mid-morning and then remained light and northerly to northwesterly until 7 p.m. on August 6. These upper level winds were consistently from the SFBAAB and moving air in the direction of Crow's

Landing. The staff believes these conclusions corroborate the results from the surface wind analyses and substantiate that transport from the SFBAAB to the Crow's Landing area was overwhelming on August 6.

Figures VI.3 and VI.4 show vertical ozone and temperature profiles obtained from aircraft spirals made in the early morning and afternoon near Crow's Landing and Altamont, respectively. The vertical ozone patterns at both sites are remarkably similar. Ozone concentrations above Crow's Landing were less than the standard in the morning, but above the standard in the afternoon. Since winds were from the SFBAAB towards Crow's Landing, this is an indication that ozone above the standard was transported from the SFBAAB.

In addition to the meteorological studies, tracer data obtained during the 1990 SJVAQS/AUSPEX was analyzed.[1] The results showed that tracer gas released from Pittsburg on August 3, 1990, between 6 and 10 a.m. was detected at Stockton between 4 and 8 p.m. and at Modesto between 6 and 8 p.m. of the same day. The tracer gas released from San Jose on August 3, 1990, between 6 and 10 a.m. was observed at Crow's Landing and Modesto around 8 p.m. This is conclusive evidence that pollutants emitted near Pittsburg and San Jose are transported to portions of the SJVAB. These results do not indicate any particular level of transport but do not contradict earlier conclusions.

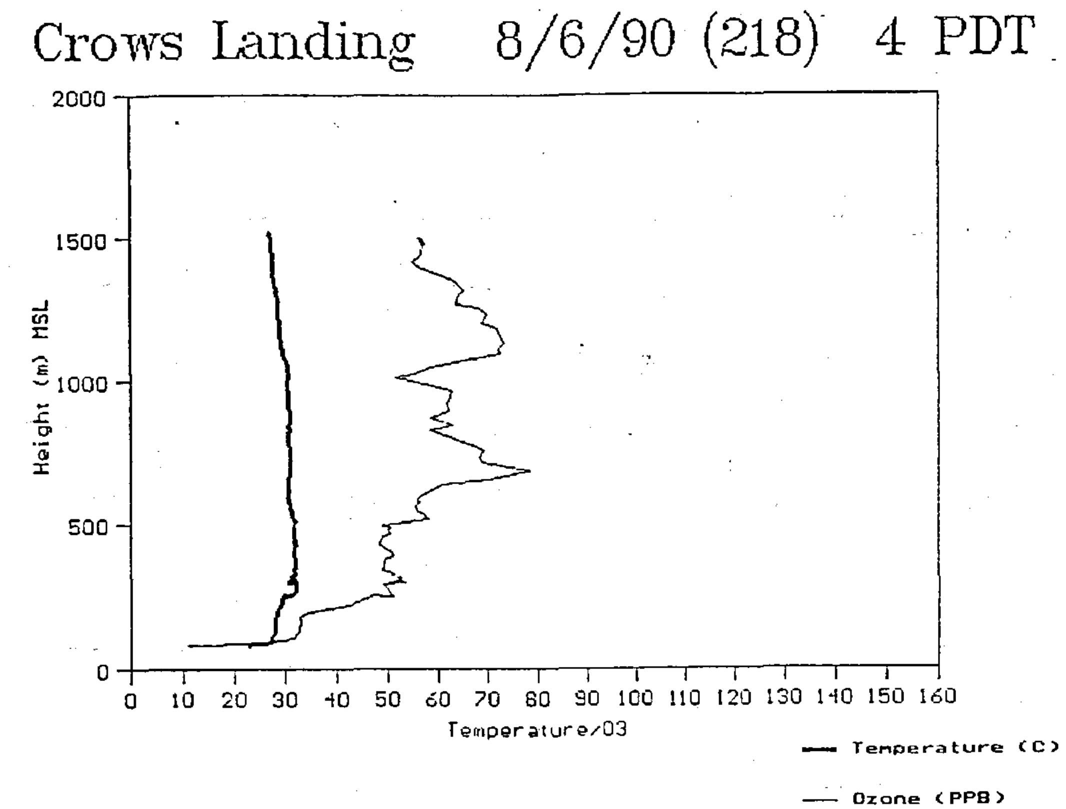
5. Emission Inventory

Based on 1989 emission data, the SJVAB emissions of ozone precursors, namely reactive organic gases (ROG) plus oxides of nitrogen (NOx), are 190 tons/day less than those for the SFBAAB. The SFBAAB basinwide emissions are 1370 tons/day of ROG plus NOx while the emissions for the SJVAB total 1180 tons/day. Both areas have similar totals of ozone precursor emissions. For transport couples where emissions are similar, overwhelming transport is likely only to occur near the downwind basin boundary with the upwind basin before significant emissions from the downwind basin can accumulate in a particular air parcel. Crow's Landing is only 20 miles from the SFBAAB.

6. References

1. San Joaquin Valley Air Quality Study. Draft report to ARB, ARB contract no. 8833, Tracer Technologies, San Marcos, CA, July 1991.

FIGURE VI.3


Crows Landing 8/6/90 (218) 4 PDT
2000
1500
1000
500
0
Height (m) MSL
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
Temperature/O3
Temperature (C)
Ozone (PPB)

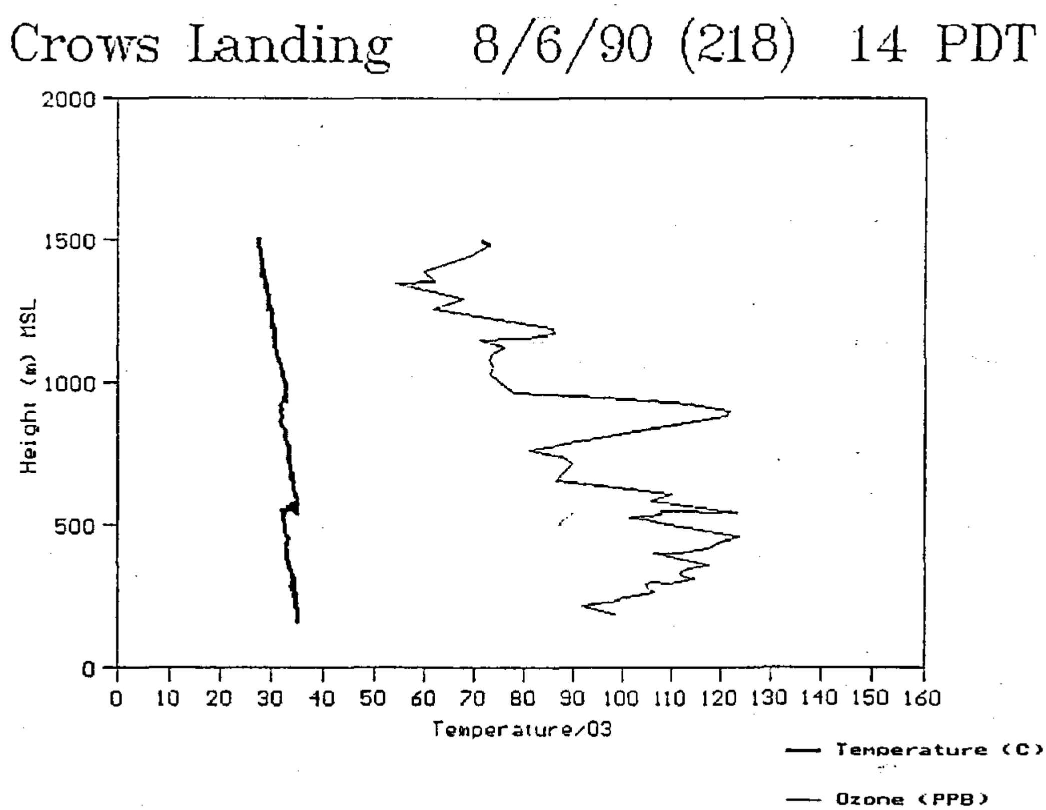
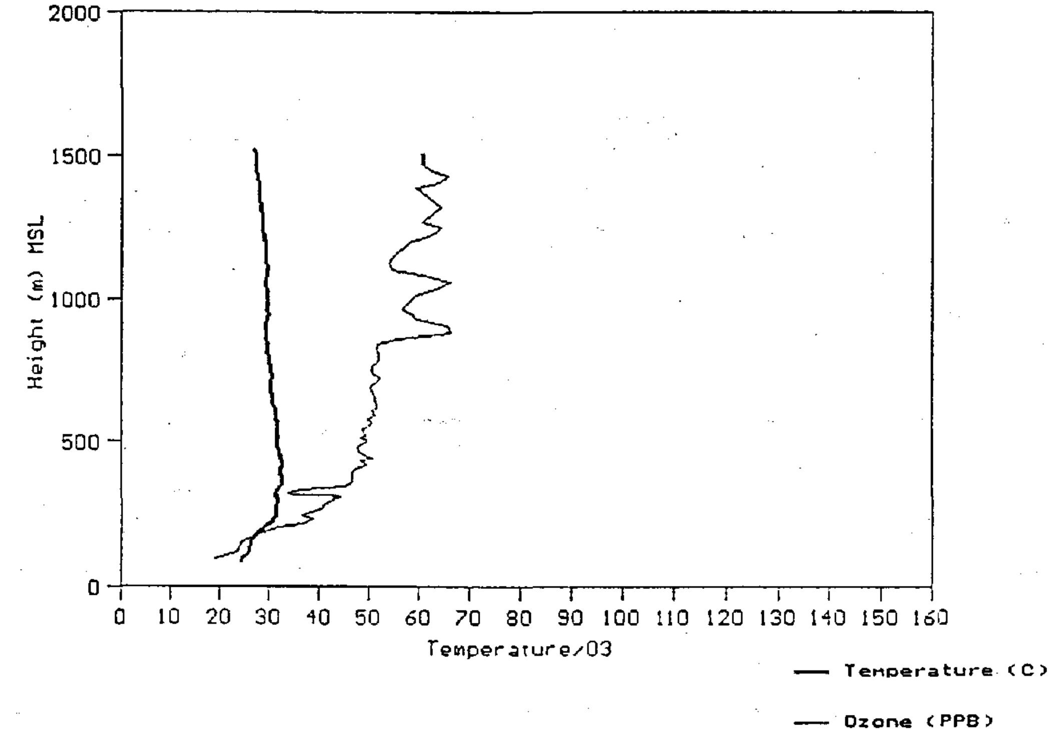
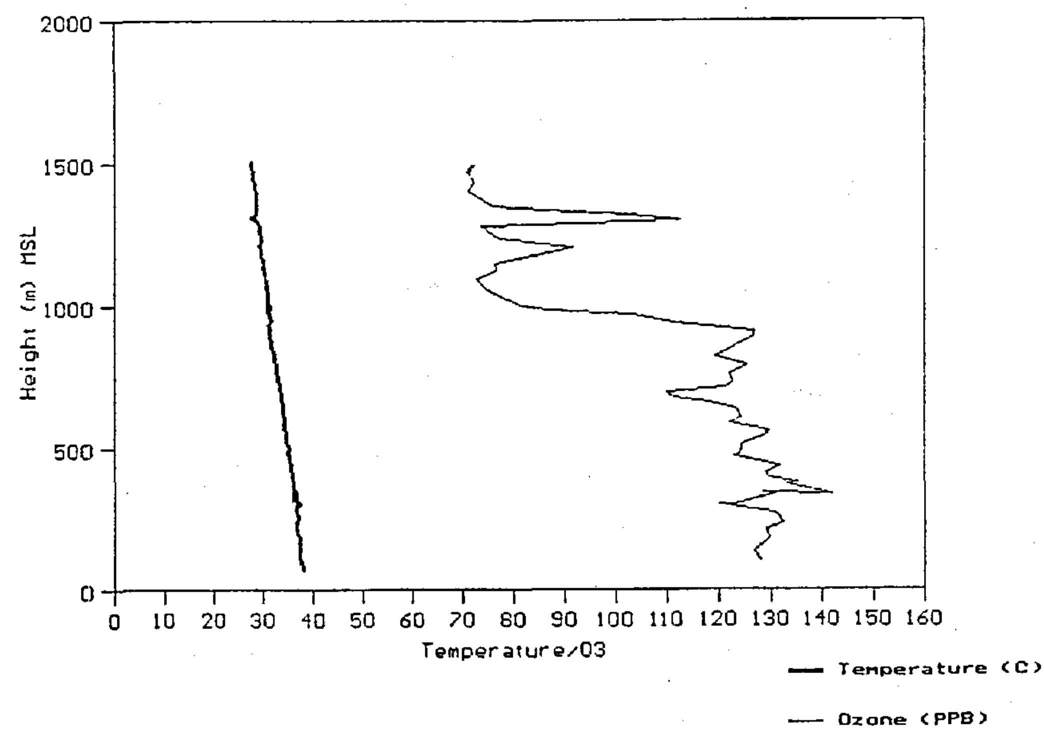

Crows Landing 8/6/90 (218) 14 PDT
2000
1500
1000
500
0
Height (m) MSL
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160
Temperature/O3
Temperature (C)
Ozone (PPB)

FIGURE VI.4

Altamont 8/6/90 (218) 5 PDT



Altamont 8/6/90 (218) 14 PDT



CHAPTER VII

1990 TRANSPORT COUPLES WITHOUT REGULATORY CHANGES

A. South Coast to Southeast Desert

1. Summary and Recommendations

During the August 1990 ARB hearing, the Board found that transport from the South Coast Air Basin (SCAB) to the Southeast Desert Air Basin (SEDAB) was "overwhelming" on some days and "inconsequential" on others. The staff has conducted analyses since that hearing that also identifies days with "significant" transport from the SCAB to Imperial County .

The staff recommends that the Board continues to classify the South Coast Air Basin's transport to San Bernardino County as "overwhelming" on some days and "inconsequential" on others. Transport to Imperial County is also recommended to be classified as "significant." Transport classified as significant does not require changes to the mitigation regulation.

2. Conclusions

In 1990 the Board found both overwhelming and inconsequential transport for the SEDAB. The staff still believes that the contribution of South Coast Air Basin emissions to exceedances of the state ozone standard in the Southeast Desert Air Basin can be both overwhelming and inconsequential for San Bernardino County. This conclusion was supported by a new case study day representing inconsequential transport, September 15, 1989. Staff also found significant transport into the Imperial County portion of the SEDAB. June 26, 1990, represents a day with significant transport to Imperial County. For each day, the staff constructed trajectories which support the case for inconsequential and significant transport, respectively.

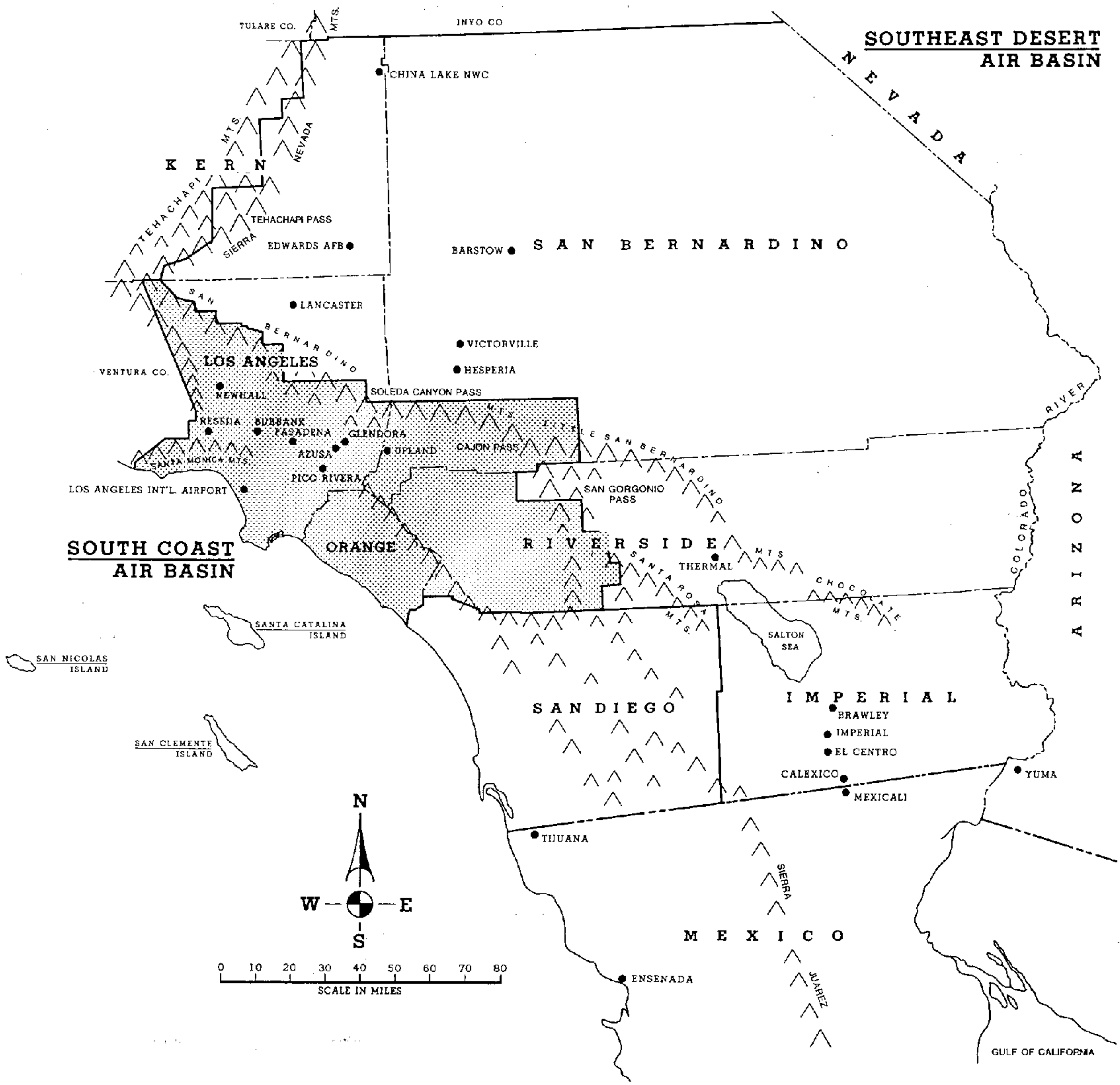
3. Geographical Setting

Figure VII.1 shows the location of major features for this transport couple. The SEDAB includes all of Imperial County, the portion of Riverside County east of the San Bernardino Mountains, the portion of San Bernardino County east of the San Gabriel and San Bernardino Mountains, the portion of Los Angeles County northeast of the San Gabriel Mountains, and the portion of Kern County east of the San Gabriel and Tehachapi Mountains at the southern end of the Sierra Nevada. The basin is bounded on the north by the San Bernardino-Inyo County line, on the northeast by the Nevada state line, on the east by the Arizona state line including the Colorado River, and on the south by the Mexican border.

Many small mountain ranges dot the SEDAB--more in the east than in the west--with elevations greater than 5,000 feet. However, the topography of the basin is generally flat, and sloping from 2,500 feet in the west to

FIGURE VII.1

TRANSPORT COUPLE
SOUTH COAST TO SOUTHEAST DESERT



below sea level in the east. The SEDAB includes all of the Mojave Desert of southeastern California.

The SCAB includes all of Orange County, the portion of Riverside County west of the San Bernardino Mountains, the portion of San Bernardino County west of the San Gabriel and San Bernardino Mountains, and the portion of Los Angeles County southwest of the San Gabriel Mountains. The basin is bounded on the west by the Pacific Ocean. Three important mountain passes lead into the SEDAB from the SCAB: Soledad Canyon between the Sierra Pelona and the San Gabriel Mountains, Cajon Pass between the San Gabriel Mountains and the San Bernardino Mountains, and San Gorgonio Pass between the San Bernardino Mountains and the San Jacinto Mountains. These passes offer paths for the transport of pollutants between air basins.

The SCAB is shaped like an amphitheater with elevations ranging from greater than 5,000 feet at the mountain ridgelines on the north, east, and south to sea level at the coastal and west-central area of the basin.

4. Analysis

The staff's analysis is based on a review of all 474 of the days during which the state ozone standard was exceeded (ozone exceedance days) in the SEDAB during 1989 through 1991. Two of these days were chosen for detailed analyses (case studies): September 15, 1989, and June 26. 1990.

In the Air Resources Board's June 1990 transport assessment[1], August 2, 1986, was chosen as a day to explore for possible overwhelming transport based on the ozone concentrations in the SEDAB and the SCAB, and because the predominant wind flow pattern in the SCAB was a sea breeze (i.e. a pattern conducive to transporting pollutants from the SCAB to the SEDAB). The staff used trajectories to support the conclusion that the SCAB contributed overwhelmingly to the exceedances of the state ozone standard in San Bernardino County.

The staff also concluded in 1990 that emissions in San Bernardino County are enough to produce ozone concentrations that exceed the state standard without transport. September 15, 1989, represents such a day.

Trajectories were also used to support the conclusion that the SCAB contributed significantly to the exceedances of the state standard in Imperial County due to the strong onshore flow in the SCAB. June 26, 1990, represents such a day.

a. Overwhelming Transport to San Bernardino County

Because the SCAB's transport to San Bernardino County was already documented and presented to the Board to be overwhelming in the ARB's previous assessment, no further examples were selected for the current study period (1989-1991). Please refer to section J of the Air Resources Board's June 1990 staff report entitled, "Assessment and Mitigation of the Impacts of Transported Pollutants on Ozone Concentrations within California."

b. Significant Transport to Imperial County

The state ozone standard was exceeded in El Centro on 13 days during 1989-1991. The peak concentration during this period, 11 pphm, was observed on 4 different days for a total of 5 hours. The screening of days for analysis for Imperial County was quite similar to that done for San Bernardino County. All of the exceedance days at El Centro were reviewed. Onshore flow in the South Coast Air Basin in conjunction with northerly flow in the Imperial Valley are indicative of transport from the SCAB to Imperial County via the San Gorgonio Pass. June 26, 1990, represents an exceedance day with this type. This kind of meteorological condition exists about 30 percent of the time during the summer months of June, July, and August (Hayes, 1984)[2].

At the El Centro site the ozone concentration reached 10 pphm during the 9 p.m.--10 p.m. hour. The preceding hour recorded 7 pphm, while 9 pphm followed the exceedance hour. Some degree of transport is indicated due to the time of exceedance. Locally generated ozone usually peaks by 3:00 pm.

The staff prepared a backward trajectory to find the source of the transport. Wind speed and direction were plotted for every hour between 4 a.m. and the time of exceedance. A backward trajectory from El Centro at the time of the exceedance was constructed using the streamline techniques. The trajectory indicates that the polluted air traveled from the SCAB through the San Gorgonio Pass to Palm Springs during the 11 a.m.-- 12 noon hour. Because of this, it is quite evident that the SCAB's morning emissions contributed to the exceedance at El Centro.

However, the ARB staff does not find evidence that the contribution from the South Coast Air Basin is overwhelming. The staff believes that the distance is too far to consider the SCAB overwhelming for an exceedance of 10 pphm. More importantly, there are too many emission sources along the transport route. The Coachella Valley in Riverside County has significant emissions because of two major highways--highway 111 and highway 86. In addition, there are significant emissions north of El Centro within Imperial County. Based on these analyses, the staff concluded that the contribution of ozone and ozone precursor emissions from the South Coast Air Basin to the exceedances of the state ozone standard at El Centro in Imperial County is significant.

c. Inconsequential Transport to San Bernardino County

To select days for a case study, the ARB staff reviewed **all** ozone exceedance days that occurred at Barstow during 1989-1991. Barstow was chosen as the focus because it is close enough to data sources to allow reliable analyses and far enough away from basin boundaries to be subject to inconsequential transport. In choosing a day for a case study, the staff reviewed recommendations by Sonoma Technology Incorporated (STI)[3]. **All** exceedance days which had meteorological conditions unfavorable for transport (i.e. light to calm winds) were considered for further analysis. September 15, 1989, was one of **many** days which fit the above criteria.

Based on historical data (1977-1981), the meteorological condition on September 15, 1989, are prevalent about 35% of the time[2].

To study the exceedance event further, the staff prepared a detailed backward wind flow trajectory. Wind speed and direction were plotted for each hour for **48** hours prior to the exceedance time. Each hour of plotted data was analyzed using streamline techniques. A backward trajectory was manually constructed from Barstow from the 11:00 a.m.--12 noon hour. The trajectory indicates the parcel of air originated only about 40-50 miles northeast of Barstow 24 hours earlier. Extending the trajectory 48 hours before the exceedance occurred indicates that the air originated near the California-Nevada border about 20-30 miles northwest of Needles. The trajectory does not indicate transported air from any area outside of the SEDAB.

It is unlikely the September 15, 1989, exceedance at Barstow was caused by transport aloft because the upper air winds at Edwards Air Force Base were calm or very light--(2-4 knots) and variable. These analyses suggest that the state ozone standard exceedance at Barstow was the result of locally generated emissions and that transported emissions from the SCAB were inconsequential.

5. Emission Inventory

The most recent emission inventory data available is the 1989 statewide, air basin, and county totals compiled by the ARB staff[4]. Emissions in the SCAB are largely due to large scale urbanization including the associated mobile and heavy industrial sources. The total emissions in the SCAB for NOx and ROG combined are 2,300 tons/day. Emissions in the SEDAB are largely due to several large stationary source associated with raw materials processing such as gas, cement, and granite, and industrial sources dealing with chemicals. The total SEDAB emissions for NOx and ROG combined are 440 tons/day. Although the emissions in the SCAB are more than five times larger than the emissions from the SEDAB, there are several individual stationary sources of significant emissions in SEDAB which have the potential to cause local exceedances.

6. References

1. Air Resources Board, 1990: Assessment and Mitigation of the Impacts of Transported Pollutants on Ozone Concentrations within California. ARB Staff Report prepared by the Technical Support Division and the Office of Air Quality Planning and Liaison, June 1990, 179 pp + 2 Appendices.

2. Hayes, T., Kinney, J., Wheeler, N. (1984): California Surface Wind Climatology. ARB Staff report, June 1989.

B. Broader Sacramento Area to Upper Sacramento Valley

1. Summary and Recommendation

The reassessment of this couple was performed because the boundaries between the Broader Sacramento Area (BSA) and Upper Sacramento Valley (USV) were changed by the Air Resources Board (ARB) in May 1992. As a result of the boundary change, Yuba City is now in the USV rather than in the BSA. The staff's new analysis focused on transport impacts on Yuba City. The analysis shows that transport from the BSA occurred on some of the 29 days during 1990 through 1992 when the state ozone standard was exceeded at Yuba City.

The staff recommends that the Board classifies the Broader Sacramento Area's transport to the Upper Sacramento Valley at Yuba City as "overwhelming" on some days. Since the staff classified transport as "overwhelming" in the previous assessment, the Broader Sacramento Area is already required to demonstrate attainment in the Upper Sacramento Valley under conditions which promote transport. However, now districts in the BSA will have to include Yuba City in the attainment demonstration.

2. Conclusions

The staff has found that the contribution of the BSA emissions to exceedances of the state ozone standard at Yuba City on at least one day is overwhelming. The staff's conclusion is based on an analysis of air quality and meteorological data for the 29 days during 1990 through 1992 when the state ozone standard was exceeded at Yuba City.

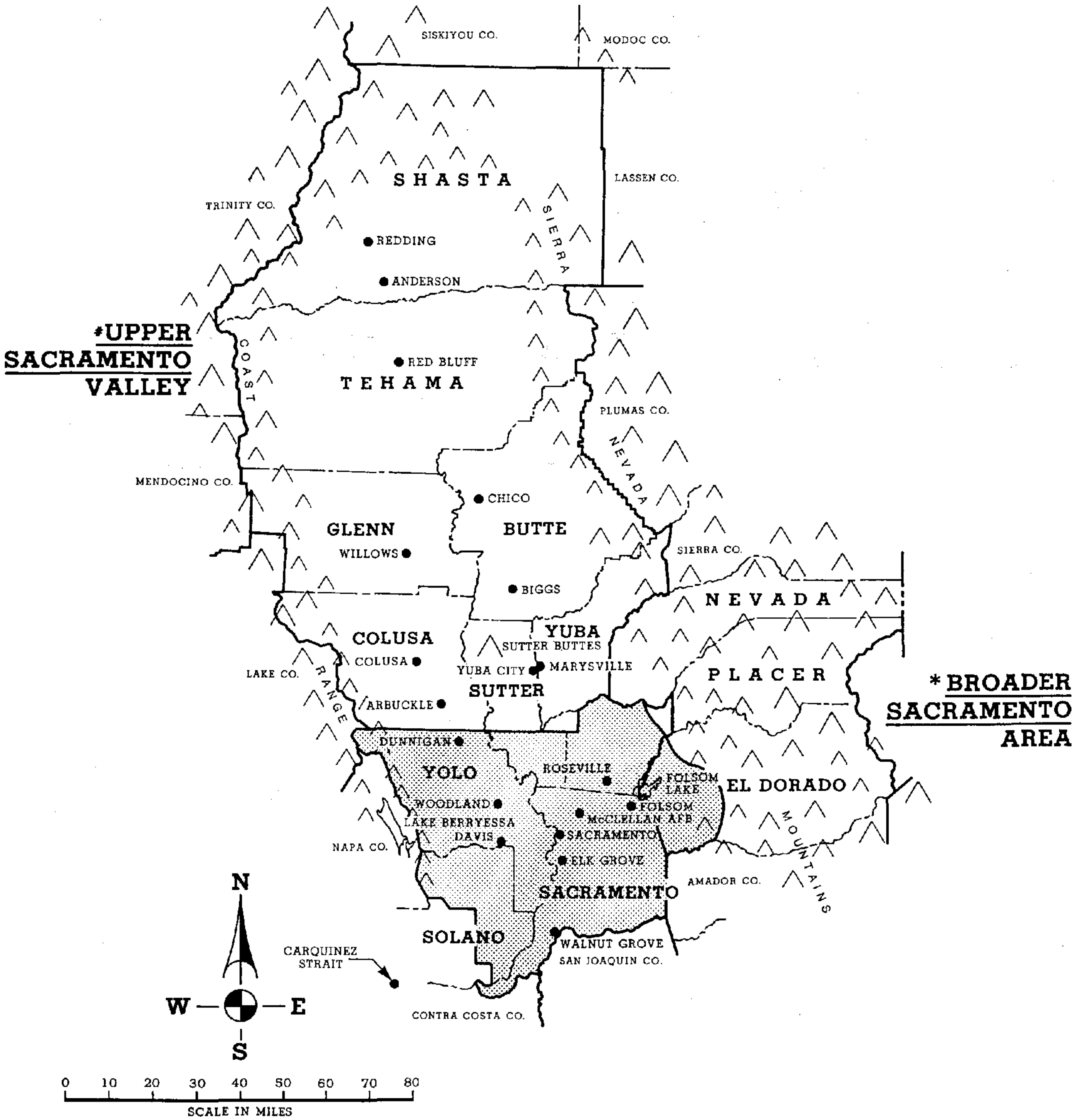
3. Geographic Setting

The USV, located in the central and northern portion of the Sacramento Valley, is part of the Sacramento Valley Air Basin. The USV includes Butte, Colusa, Glenn, Shasta, Tehama, Yuba Counties, and the northern two-thirds of Sutter County. The BSA comprises the southern portion of the Sacramento Valley and a portion of the western slope of the Sierra Nevada. The BSA includes Sacramento County, the southern third of the Sutter County, the Yolo-Solano Air Pollution Control District, and the western portions of El Dorado and Placer Counties. A map of the two areas is provided in Figure VII.2.

The definition of the BSA differs from the original 1990 assessment due to the Air Resources Board adoption of amendments to section 70500, Title 17, California Code of Regulations in May 1992. The amendments were designed to minimize the economic impact of previously adopted transport mitigation regulations in certain portions of the Sacramento Valley and Mountain Counties Air Basins, by adjusting the boundaries of the BSA within which the regulations applied. Yuba County and the northern portion of Sutter County became a part of the USV. Nevada County and the mountainous and less populated regions of the El Dorado County and Placer County were removed from the BSA.

FIGURE VII.2

TRANSPORT COUPLE
BROADER SACRAMENTO AREA TO UPPER SACRAMENTO VALLEY



\# Upper Sacramento Valley includes Colusa, Butte, Glenn, Shasta, Yuba, and Tehama Counties and the northern two thirds of Sutter County.

* Broader Sacramento Area includes Sacramento Metropolitan Air Quality Management District, Yolo-Solano Air Pollution Control District, the southern third of Sutter County Air Pollution Control District, and the western portions of El Dorado and Placer County Air Pollution Control Districts.

The dominant topographic features influencing air flow and potential transport from the BSA to the USV are the Coast Range, the Sierra Nevada, and the Sacramento Valley. Both the Coast Range and Sierra Nevada are oriented northwest to southeast.

Except in the area of the Carquinez Strait, the Coast Range provides an effective barrier to marine air from the west. The Carquinez Strait, located southwest of the Sacramento Valley, provides a gap in the Coast Range through which cool marine air routinely flows into the Sacramento Valley. This air flow is driven by the prevailing northwest winds from the Pacific Ocean and by the low air pressure formed as the valley air is heated by the sun-warmed ground, especially in summer. This flow of marine air frequently results in transport from the BSA to the USV.

The Sacramento Valley is a long, broad, flat area with no significant geographic features to impede air flow from the BSA to the USV. In the northern portion of the Sacramento Valley, the terrain rises to a plateau which forms another outlet for valley air. The most notable geographic feature in the Sacramento Valley is the Sutter Buttes, located near the boundary of the BSA and the USV. However, the Sutter Buttes have little impact on air flow because of their limited size relative to the width of the valley. On the eastern side of the Sacramento Valley, the Sierra Nevada rise gradually from the valley floor.

4. Analysis

The staff's assessment of transport from the BSA to the USV was based on data for 1990 through 1992. Both air quality and meteorological data were used in the transport analysis during this period. Ozone air quality data were available from Yuba City in the USV for the time period January 1, 1990 through December 31, 1992, except for a five week period between July 12, 1992 and August 16, 1992. The gap in data was due to instrument malfunction. In addition, ozone data were available for the remainder of the USV and the BSA during this period.

Meteorological data used in this study consisted of wind speed and wind direction from various meteorological monitoring stations throughout the Sacramento Valley operated by the Department of Defense, the National Weather Service, the Federal Aviation Administration, the Air Resources Board, the Department of Water Resources, the air pollution control districts, and the Weather Network, Inc.

The ARB staff began the assessment of identifying overwhelming transport days at Yuba City in the USV by first identifying the days during 1990-1992 which exceeded the state standard for ozone. The staff then performed a meteorological and emission inventory analysis on Yuba City exceedances to determine the source air basin(s) and degree of emissions impact.

The staff identified 29 days during 1990-1992 in which the daily maximum ozone concentrations exceeded the state standard at Yuba City.

Table VII.1 lists the date, concentration, and hour of the peak ozone concentration for each of these 29 exceedance days.

Before initiating a meteorological analysis of exceedance days at Yuba City, the staff evaluated the exceedance days as to whether the daily peak concentration met the criteria of an extreme concentration (see Chapter III for discussion on extreme concentrations). The extreme concentration value for Yuba City based on data for 1989-1991 is 11 pphm. Those days with concentrations greater than the extreme concentration value for each site were deleted from the transport assessment. The only station-day deleted was August 18, 1992. The extreme concentration "filter" reduced the number of exceedance days from 29 to 28 for evaluation.

The staff then proceeded to screen these 28 days during 1990-1992 for overwhelming transport impact. The staff began this screening by identifying days in which the peak hour of the ozone concentration occurred at successively later hours along the transport path from downtown Sacramento, to Sacramento-Del Paso, to Sacramento-Earhart, to North Highlands, to Pleasant Grove, and then to Yuba City. This timing of peak hour ozone concentrations suggests the movement in the prevailing air flow of an ozone and ozone precursor rich air mass from Sacramento to Yuba City. Seven of the 28 exceedance days at Yuba City exhibited the successive occurrence of the hours of peak ozone concentration from Sacramento to Yuba City. These 7 days are noted in Table VII.2.

The air flow charts drawn at 0400, 1000, and 1600 PST by ARB meteorologists were reviewed by the staff for these 7 days. Four of these 7 days showed evidence of airflow from Sacramento to Yuba City on at least one of the three charts per day. These 4 days are also noted in Table VII.2. Back trajectory analyses were then conducted by the staff for 2 of these 4 potential overwhelming transport impact days.

a. September 18, 1991

The staff found on September 18, 1991, that the trajectory originated in the northern portion of the greater Sacramento metropolitan area around the hours of maximum morning motor vehicle emissions and arrived at Yuba City by mid afternoon. The spatial pattern of the daily maximum ozone concentration exceeding the state standard for September 18, 1991 depicts an arc from Sacramento-Del Paso to Sacramento-Earhart to North Highlands to Auburn to Yuba City. This pattern is consistent with ozone precursors from Sacramento drifting north and east as they form ozone.

The staff concluded that Yuba City was impacted overwhelmingly by ozone precursor emissions and ozone from the BSA on September 18, 1991, because the trajectory was same-day transport originating from the greater Sacramento area during peak morning emissions and the hour of peak concentration occurred at successively later hours along the transport path. This conclusion is supported by an emission analysis showing ozone precursor emissions in the BSA are much greater than those in northern Sutter plus Yuba Counties.

Table VII.1

Yuba City Ozone Exceedance Days
During 1990-1992

Exceedance Date	Peak Ozone Concentration (pphm)	Hour of Peak Ozone Concentration (PST)
10-04-90	10	1300
02-26-91	10	1700
07-30-91	10	13-1600
09-04-91	10	1600
09-18-91	11	1600
10-04-91	10	15-1600
05-05-92	11	1700
05-07-92	10	1600
05-31-92	10	1400
06-02-92	10	14-1700
06-03-92	10	1300
06-04-92	10	1200
06-23-92	11	1300
07-25-92	10	1300
07-28-92	10	16-1700
07-31-92	10	1300
08-01-92	11	1400
08-11-92	10	12-1300
08-12-92	10	1400
08-15-92	11	13-1400
08-17-92	10	1200
08-18-92	12	1300
08-19-92	10	1200
08-20-92	10	1500
08-25-92	10	1600
08-27-92	10	13-1500
09-21-92	10	13-1500
09-29-92	11	1600
10-13-92	10	1500

Table VII.2

Yuba City Exceedance Days,
Criteria for Overwhelming Transport

Yuba City Exceedance Days	Days Meeting Successive Timing Criteria	Airflow Criteria Met at least One Hour(1)	Potential Overwhelming Day(2)	Overwhelming Transport Day(3)
10-04-90				
02-26-91				
07-30-91		X		
09-04-91	X	X	X	
09-18-91	X	X	X	YES
10-04-91		X		
05-05-92	X			
05-07-92				
05-31-92				
06-02-92	X	X	X	Inconclusive
06-03-92				
06-04-92				
06-23-92				
07-25-92				
07-28-92	X			
07-31-92				
08-01-92				
08-11-92		X		
08-12-92		X		
08-15-92				
08-17-92		X		
08-18-92				
08-19-92		X		
08-20-92	X	X	X	
08-25-92				
08-27-92				
09-21-92		X		
09-29-92	X			
10-13-92		X		

(1) Based on ARB meteorologist drawn air flow charts at 0400, 1000, and 1600 PST daily.
(2) Based on both successive timing and airflow criteria being met.
(3) Back trajectory showed transport from Sacramento metropolitan area to Yuba City.

b. June 2, 1992

For June 2, 1992, the staff found that 10-hour back trajectories ending at the first hour (1400 PST) of the peak concentration originated just 10 miles south of Yuba City, still within the USV area. However, a back trajectory ending at the last hour (1700 PST) of the peak concentration originated from the Sacramento metropolitan area. Because the earlier back trajectory originated in the USV, the case for overwhelming transport was not as clear. As a result, the staff dropped the June 2, 1992, exceedance day from further consideration and called the transport analysis inconclusive.

5. Emission Inventory

The most recent emission inventory data available are the 1989 statewide, air basin, and county totals compiled by the ARB staff[1]. While such emission totals provide only general information, they were useful for determining the relative difference in emissions between various areas. This information provided a general comparison of the relative potentials for the emissions in each area to contribute to ozone concentrations in Yuba City.

Ozone precursor emissions primarily consist of emissions of reactive organic gases (ROG) and nitrogen oxides (NOx). Based on the 1989 emission inventory data, the ARB staff estimates that ozone precursor emissions in the BSA are approximately 350 tons/day. Northern Sutter and Yuba County emissions of ROG+NOx in the Upper Sacramento Valley are approximately 40 tons per day. These were compared with BSA emissions of 350 tons per day. The BSA ozone precursor emissions are about 9 times greater than the ozone precursor emissions for Yuba and northern Sutter Counties in the Upper Sacramento Valley.

The staff did not make a quantitative determination of the relative contributions of the emissions in Yuba and northern Sutter Counties versus the contribution of the emissions in BSA to the ozone exceedances at Yuba City. Based on the inventory comparisons, the staff made a qualitative conclusion, however, that if ozone and ozone precursor emissions in the BSA were transported to Yuba City, the transported ozone and emissions could have an overwhelming impact on Yuba City ozone concentrations.

6. Summary of Previous Transport Studies

Several research groups have studied the transport of ozone and ozone precursors in the Sacramento Valley. The studies most important to this analysis are summarized here. Bell and Waggoner[2] studied the 1960 fall agricultural burn season and measured oxidant, soiling index, hydrocarbons, and visibility. They concluded that metropolitan Sacramento, Roseville, and Woodland were the most significant sources of oxidant, hydrocarbons, and particulate matter in the BSA. Futhermore, they concluded that on the days studied, ozone exceedances were related "entirely to these urban sources."

In another study, H. B. Schultz[3] studied wind patterns in the Sacramento Valley. Schultz analyzed winds above the surface up to 2,000 feet at the Walnut Grove TV tower and the Sutter Buttes and up to 3,000 feet at several pibal balloon launch sites. These winds were above the influence of the terrain. Schultz found the speed of the winds at about 500 feet above the ground could be as high as 20 to 30 mph when the surface wind speeds were only 5 to 10 mph. The presence of strong upper air winds indicates pollutants could be carried aloft long distances at times when surface conditions do not indicate such transport.

Schultz also described a unique, localized wind pattern in the lower portion of the Sacramento Valley. This wind pattern has since been termed the "Schultz Eddy." The "Schultz Eddy" flows to the east-northeast in a counter-clockwise direction from Davis to Sacramento where it curves to the north-northwest from Sacramento to Dunnigan, and then curves to the south-southeast from Dunnigan to Woodland and Davis. During the summer, the "Schultz Eddy" frequently begins around sunrise and continues until about noon. The "Schultz Eddy" is an important mechanism for transporting ozone and ozone precursors to the west side of the Sacramento Valley from the Sacramento metropolitan area. The term Sacramento metropolitan area is used here to refer to the contiguous urbanized area around the City of Sacramento and extends from West Sacramento to Folsom and from Elk Grove to Rocklin.

The ARB staff[4] also studied ozone concentrations downwind of the Sacramento metropolitan area. The time period of the study included July and August 1978. The results indicated evidence of transport from the Sacramento metropolitan area to Willows and Chico in the USV.

In yet another study, Lehrman et al.[5] studied ozone concentrations, air flow (via tracer releases), and the upper air during August 1980. Lehrman confirmed that the "Schultz Eddy" often transported ozone and ozone precursors from the Sacramento metropolitan area to Colusa and Arbuckle in the Sacramento Valley and then back southward and eastward to Sacramento. Lehrman also demonstrated that pollutants from the Sacramento metropolitan area can be transported far into the USV. He found tracer material released at Sacramento between 6 a.m. and 11 a.m., present at Marysville and Colusa between 1 p.m. and 2 p.m., at Willows between 3 p.m. and 6 p.m., and at Redding between midnight and daybreak. Lehrman also found evidence of tracer material lingering in the Sacramento Valley overnight at heights up to 2,500 feet. This suggests that pollutants could be mixed down to the surface the next day as the air heats up and mixing takes place.

Giorgis[6] also studied the potential for transport in the Sacramento area. His study indicated there was a contribution from emission sources within the Sacramento Valley to high ozone concentrations in the Sacramento Valley. Giorgis concluded that:

> "... the contribution to Sacramento Valley oxidant levels from Bay Area precursor emissions is secondary to contributions from sources in the Valley. ... high oxidant

concentrations at most Sacramento Valley stations result from stagnation or transport from Sacramento."

The ARB staff[7] compiled brief summaries of air pollutant transport studies to aid in the identification of potential source-receptor air basins in California. The staff noted that in one transport study that tracer material released at Vallejo reached Sacramento and continued as far north as Chico. Forward trajectories constructed by the ARB staff also demonstrated the potential of transport from the BSA to the USV. As a result of these trajectories, the staff concluded that some transport occurs from the BSA to the USV.

The ARB staff[8] analyzed ozone exceedance days in the USV for the period 1986-1988. The staff analyzed these days to determine whether the days were due primarily to local emissions in the USV or due to transported emissions from the upwind air basin(s). The staff found that transport from the BSA to the USV occurred on at least 57 Of the 63 days when the state ozone standard was exceeded during 1986 through 1988 in the USV. Emissions were sufficient within the USV on these 57 days to result in a significant impact on the exceedances in the USV. In addition, the staff's analysis shows that for the remaining six days, three days had evidence of inconsequential transport from the BSA and three days had insufficient evidence to determine whether transport had occurred from the BSA.

In a subsequent analysis of ozone exceedances in the USV for 1987, the ARB staff[9] found that the contribution of transport from the BSA to Arbuckle and Willows in the USV was overwhelming on one day. The staff based the finding on trajectory analysis, and the fact that the west side of the USV has limited emissions of ozone precursors.

A study by Roberts[10] was ordered by ARB to clarify the first set of transport designations. In this study, Roberts evaluated the transport contribution of ozone precursors to ozone exceedances in three downwind air basins including the USV. Three approaches to assessing the transport contribution were used by Roberts which included flux estimates, trajectory, and trajectory with precursor emissions. The trajectory with precursor emissions method quantified the upwind basins contribution. This method used an emissions box model along surface trajectories to estimate the transport contribution of ozone precursors in the SFBAAB and BSA on exceedance days in the USV for 1987 and 1988. Estimates of the transport contribution were made with and without ozone precursor chemical reactions and deposition. For transport trajectories arriving at Redding, the northernmost monitoring site, the ozone precursor contribution estimates were over 80 percent from the USV. However, at monitoring sites further south, the contributions for transport trajectories from upwind air basins increased. For trajectories arriving at Red Bluff on the exceedance days, the USV contributed about 60 percent of the NOx and ROG precursors, with the San Francisco Bay area and BSA contributing 15-20 percent. For trajectories arriving at Chico, the USV and BSA contributed 30-40 percent each, with the San Francisco Bay area contributing 15-25 percent.

Roberts concluded that for all the ozone exceedance days studied in the USV for 1987-1988 none of the transport days had overwhelming contributions from the upwind air Basin(s) (the overwhelming day in 1987 identified by ARB staff[9] was not included in the Roberts analyses).

Pankratz[11] under an ARB contract instrumented 5 levels of an existing 1600 foot TV tower at Walnut Grove and the summit of the Sutter Buttes. The goal of the project was to study the temporal and vertical ozone patterns at the two locations, as well as investigate the possibility of using a single "switching" analyzer to perform monitoring at all 5 levels of the Walnut Grove TV Tower by sequentially obtaining samples from each level. Two months of simultaneous monitoring at both locations in 1992 indicated instances of sustained high concentrations of ozone aloft. The spatial extent of the high ozone aloft occurred simultaneously at Walnut Grove and Sutter Buttes on a few consecutive days. However, Pankratz did not include any wind analysis to show that transport aloft was the cause of the spatial pattern.

Roberts[12] under an ARB contract developed and compiled eight methods to quantify the upwind air basin emissions contribution to the downwind air basin ozone and ozone precursor concentration. These methods were then applied to the SFBAAB and BSA as source basins and the USV as the receptor air basin. To collect the necessary data to apply all the 8 methods, Roberts conducted an air monitoring and tracer field study during the summer of 1990. Due to a relatively ozone clean summer and a time competing field study in the San Joaquin Valley, only marginally high ozone days were intensively sampled. The eight methods were applied to days in which intensive field data were collected, as well as to historical periods prior to 1990.

Roberts preliminary findings were that the most reliable approaches to quantifying ozone and ozone precursor transport to the USV would be to apply both the 2-D flux plane and tracers of opportunity analysis methods. However, intensive field measurements would be needed in utilizing these two methods. Otherwise, if only data from the existing air monitoring network is available, the only method feasible is the precursor contribution estimates for NOx and ROG using surface trajectories. This method was described in Roberts[10].

A jointly funded project by the ARB and NOAA Wave Propagation Laboratory (WPL)[13] was begun in 1991 to study atmospheric transport corridors and processes utilizing new remote sensing technology. The remote sensing technology in the form of a wind profiler and Radio Acoustic Sounding System (RASS) were set up in northern California in 1991 and southern California in 1992 to create a data base of vertical profiles of winds and temperatures along air pollutant transport corridors. In addition, supplemental meteorological instrumentation was added to the wind profiler and RASS network so that mixing layer depths could be inferred and the dynamics of local circulations along terrain-dominated transport corridors could be better understood.

The 1991 network concentrated on the transport of air pollutants from the SFBAAB to the North Central Coast Air Basin (NCCAB), as well as from the SFBAAB to the BSA and USV. The 1991 study of the SFBAAB to Sacramento Valley corridor occurred in the months of May to November. The network of profilers were located at Arbuckle, Tracy, Oroville, Pleasant Grove, Rancho Seco, near Travis AFB, and UC Davis. The WPL will carry out analyses of the data collected to improve the understanding of the meteorological processes that influence pollutant transport and dispersion between the SFBAAB and Sacramento Valley and within the Sacramento Valley. The data base and subsequent analysis are scheduled for completion in January 1994.

7. References

1. Air Resources Board, 1991: Emission Inventory 1989. ARB Staff Report prepared by the Emission Inventory Branch of the Technical Support Division, August 1991, 38 pp + 1 Appendix.

2. Bell, G. B. and N. E. Waggoner, 1961: A Field Study of Air Pollution in the Lower Sacramento Valley During the 1960 Fall Season. Rep., Dept. of Public Health & UC Div. of Ag. Sci., 66 pp.

3. Schultz, H. B., 1975: Meso-climatic Wind Patterns and Their Application for the Abatement of Air Pollution in the Central California Valley. Final Rep. CARB Project No. 111, Dept. of Ag. Eng., UC-Davis, 56 pp. + 3 Appendices.

4. Duckworth, S. and D. Crowe, 1979: Ozone Patterns on the Western Sierra Nevada slope: Downwind of Sacramento During the Summer of 1978. Report prepared by the Aerometric Analysis Branch, ARB, Sacramento, 28 pp.

5. Lehrman, D., T. Smith, D. D. Reible, and F. H. Shair, 1981: A Study of the Origin and Fate of Air Pollutants in California's Sacramento Valley, Vols. I & II. Final Rep. MRI 81 FR-1842, Prepared for ARB by Meteorology Research, Inc., 25 pp. and 210 pp. respectively.

6. Giorgis, R. B., 1983: Meteorological Influences on Oxidant Distribution and Transport in the Sacramento Valley. Thesis, M.S. in Eng., UC-Davis, 315 pp.

7. Air Resources Board, 1989: Proposed Identification of Districts Affected by Transported Air Pollutants which Contribute to Violations of the State Ambient Air Quality Standard for Ozone. Staff Report, ARB/Meteorology Section (principle author), October 1989, 57 pp. + 4 Appendices.

8. Air Resources Board, 1990: Assessment and Mitigation of the Impacts of Transported Pollutants on Ozone Concentrations within California. ARB Staff Report prepared by the Technical Support Division and Office of Air Quality Planning and Liaison, June 1990, 179 pp. + 2 Appendices.

9. Air Resources Board, 1990: Assessment and Mitigation of the Impacts of Transported Pollutants on Ozone Concentrations within California, Supplement to the June 1990 Staff Report. ARB Staff Report prepared by the Air Quality Analysis Section of the Technical Support Division, August 9, 1990, 16 pp.

10. Roberts, P. T., S. Musarra, T. B. Smith, and F. W. Lurmann, 1992: A Study to Determine the Nature and Extent of Ozone and Ozone Precursor Transport in Selected Areas of California. STI Final Report No. STI-90060-1162-FR prepared for ARB by Sonoma Technology, Inc., April 1992 under Contract No. A932-129, 219 pp. + 1 Appendix.

11. Pankratz, D. V. and D. Bush, 1993: The Study of Temporal and Vertical Ozone Patterns at Selected Locations in California. Final Report No. AV-R-93/6000 prepared for ARB by AeroVironment, Inc., February 1993, 55 pp. + 6 Appendices.

12. Roberts, P. T., H. H. Main, L. R. Chinkin, S. F. Musarra, and T. Stoeckenius, 1993: Methods Development for Quantification of Ozone and Ozone Precursor Transport in California. Draft Final Report No. STI-90100-1233-DFR-2 prepared for ARB by Sonoma Technology, Inc. under ARB Contract No. A932-143, March 1993, 189 pp. + 5 Appendices.

13. Neff, W. D., and J. M. Wilczak, 1991: A Multi-Year Observational Study of Atmospheric Transport Corridors and Processes in California. Unsolicited research proposal submitted to the ARB by the NOAA Wave Propagation Laboratory, January 10, 1991, 34 pp + Attachments.

C. San Francisco Bay Area to North Central Coast

1. Summary and Recommendations

The 1990 transport assessment classified transport from the San Francisco Bay Area Air Basin (SFBAAB) to the North Central Coast Air Basin (NCCAB) as "overwhelming" on some days and "significant" on others. A reassessment of this transport couple was performed because of the availability of new data from the Pinnacles monitoring site. The staff's recent analysis shows that transport from the SFBAAB occurred on the 26 days during 1990 through June 1992 when the state ozone standard was exceeded in the NCCAB.

The staff recommends that the Board continue to classify the transport from the SFBAAB to the NCCAB as "overwhelming" on some days and "significant" on some others. Since the staff classified transport as "overwhelming" and "significant" in the previous assessment, no additional mitigation is required of the SFBAAB.

2. Conclusions

The staff has found that the contribution of the SFBAAB emissions to exceedances of the state ozone standard in the NCCAB on a few days is inconclusive, is significant on a few days, and on other days is overwhelming. The staff's conclusions are based on an analysis of air quality and meteorological data for the 26 days during 1990 through June 1992 when the state ozone standard was exceeded in the NCCAB.

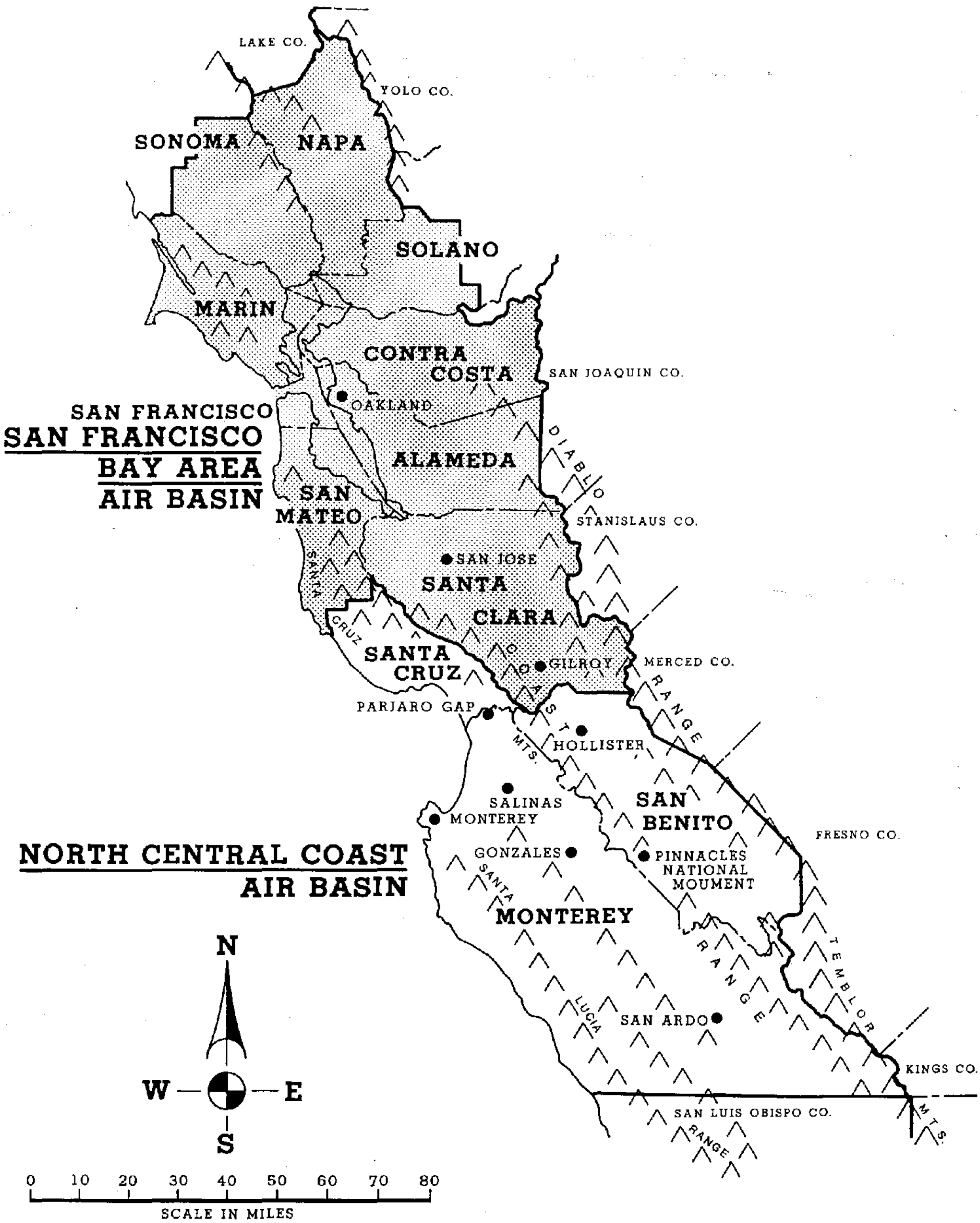
3. Geographic Setting

The NCCAB includes Monterey, San Benito, and Santa Cruz Counties. The SFBAAB comprises Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, and Santa Clara Counties and parts of Solano and Sonoma Counties. A map of these areas is provided in Figure VII.3.

The dominant geographic feature influencing air flow in the SFBAAB and the NCCAB is the Coast Range. The Coast Range comprises a series of parallel northwest to southeast oriented ridges and valleys. The ridges range in elevation from 2,000 feet at the coast to over 3,000 feet inland. Between the ridges lie the San Francisco Bay, the Santa Clara Valley, the San Benito Valley, and the Salinas Valley. Beginning at the south end of the San Francisco Bay, the Santa Clara Valley extends southeastward for 35 miles from San Jose until it merges with the San Benito Valley at the Santa Clara County line. The San Benito Valley extends southeastward from the Santa Clara County line for approximately 35 miles to the Pinnacles National Monument. The Santa Clara-San Benito Valley combination gently slopes upward from an elevation of 80 feet at San Jose to an elevation of 300 feet at Hollister, 45 miles southeast of San Jose. The two valleys without any physical barrier to the flow of air between them provide the topographic setting for transport from the SFBAAB into the NCCAB.

FIGURE VII.3

TRANSPORT COUPLE
SAN FRANCISCO BAY AREA TO NORTH CENTRAL COAST



The Salinas Valley lies to the west of and parallel to the San Benito River Valley. The Salinas Valley extends approximately 75 miles southeastward from Salinas to San Ardo. The ridge dividing the Salinas Valley and the San Benito Valley ranges in elevation from 200 feet at the Pajaro Gap northwest of Hollister to 3,400 feet northeast of Gonzales.

4. Analysis

The staff's assessment of transport was based on data for 1990 through June 1992 ("study period"). Both air quality and meteorological data were used in the transport analysis during the study period. Ozone air quality data were available from 7 monitoring sites in the NCCAB and operated by the Monterey Bay Unified Air Pollution Control District (MBUAPCD). During the study period, 26 days exceeded the state ozone standard within the NCCAB. Moreover, four air monitoring stations exceeded the ozone standard, and Pinnacles topped the group with 22 days of ozone exceedances. In addition, ozone data were available for the SFBAAB, San Joaquin Valley Air Basin (SJVAB), and South Central Coast Air Basin.

Meteorological data used in this study consisted of wind speed, wind direction, and sea-level atmospheric pressure from the Department of Defense, the National Weather Service, the Federal Aviation Administration, the U. S. Coast Guard, the National Oceanic and Atmospheric Administration data buoys, the National Park Service, the air pollution control districts, and from private industrial meteorological monitoring stations.

The ARB staff began the assessment of the impact of transported emissions on ozone concentrations in the NCCAB by first identifying those air monitoring stations in the NCCAB which exceeded the state standard for ozone during the study period. The staff then performed a meteorological and emissions inventory analysis to determine the source air basin(s) and degree of emissions impact.

Before initiating a meteorological analysis of exceedance days in the NCCAB, the staff evaluated the exceedance days as to whether the peak daily concentration met the criteria of an extreme concentration (see Chapter III for discussion on extreme concentrations). Those concentrations greater than the extreme concentration values for each station were deleted from the transport assessment. The extreme concentration "filter" reduced the number of exceedance days considered during the study period from 26 to 21 for evaluation.

Additional exceedance days were eliminated from the assessment when the exceedance day appeared to be due to overwhelming transport impact. Since the ARB staff[1,2] had already established that transported emissions from the SFBAAB could have an overwhelming impact on NCCAB, only those exceedance days which appeared to be due to local emissions were evaluated. A simple method was developed to identify overwhelming days. The presence of winds from between 271 and 089 degrees on the day of and day before the exceedance at Pinnacles was used to identify 10 NCCAB exceedance days as having overwhelming transport. Predominant winds from the two north quadrants at Pinnacles suggest that the SFBAAB or San Joaquin Valley likely had overwhelming transport impact. Upon applying this additional "filter" to the list of exceedance days, the number of exceedance days which tend to not be days of overwhelming transport was reduced from 21 to 11 days.

Meteorological, air quality, and source contribution analyses were conducted for the 11 days suspected as impacted by significant or inconsequential transport. A back trajectory analysis was started at the hour of the peak ozone concentration for each exceedance day and extended back in time for at least 12 hours. Some of the back trajectories were extended back in time up to 37 hours in order to identify the source region. The back trajectories were constructed manually from hourly hand plotted wind observations. Where wind information was nonexistent, wind directions were estimated based on hourly surface isobaric charts, and wind speeds were interpolated or extrapolated from observations.

In addition to the trajectory analyses, the spatial extent of ozone exceedances on NCCAB exceedance days were examined; ARB and National Weather Service weather charts were examined; near sea-level, profiler measurements, ridge and mountain top winds were examined for surface and aloft transport potential; the spatial distribution of the daily maximum temperatures were examined to determine the extent of the marine layer intrusion into the coastal and inland valleys of the SFBAAB and NCCAB; and the temperature inversion and wind data for Oakland were examined for marine layer thickness and transport potential. These data types were examined to validate the trajectory analyses.

Also, a qualitative evaluation of the transported contribution of emissions to the exceedance location in the NCCAB was conducted using the trajectory analyses and emission inventory data. A qualitative evaluation determined whether the transport contribution was inconsequential, significant, or overwhelming. The transport was deemed as inconsequential if the back trajectory stayed within the NCCAB. A significant determination was made if the back trajectory originated in an upwind air basin, but also passed through significant source areas of the NCCAB. An overwhelming determination was made if the back trajectory originated in an upwind air basin and passed over a region of insignificant local emissions.

Table VII.3 summarizes the staff's analysis. One exceedance day at Pinnacles of 11 pphm, May 7, 1990 which the staff classified as inconclusive, and one exceedance day of 10 pphm on September 24, 1991, at Hollister which the staff classified as affected by significant transport from the SFBAAB and are described below. Readers are referred to the ARB Technical Report[3] for a detailed discussion of the staff's analyses for the all days.

TABLE VII.3

Source Air Basin(s) of NCCAB
Ozone Exceedances and SFBAAB Transport Contribution

Exceedance Date	Exceedance Location	Peak Ozone Conc.)	Hour(s) of Peak Ozone Concentration (PST)	Source Air Basin	SFBAAB Transport Contribution
05-07-90	Pinnacles	11	1800	Inconclusive	Inconclusive
05-08-90	Pinnacles	10	1400	Inconclusive	Inconclusive
07-11-90	Hollister	10	1300	SFBAAB & NCCAB	Significant
07-11-90	Pinnacles	11	1000	SFBAAB	Overwhelming
07-12-90	Pinnacles	10	1500-1600	SFBAAB	Overwhelming
07-18-90	Pinnacles	11	1700	SFBAAB	Overwhelming
08-10-90	Pinnacles	10	1800	SFBAAB	Overwhelming
06-09-91	Pinnacles	10	1800	SFBAAB	Overwhelming
09-04-91	Pinnacles	10	1600	SFBAAB	Overwhelming
09-24-91	Hollister	10	1300-1400	SFBAAB & NCCAB	Significant
09-24-91	Pinnacles	10	1800	SFBAAB & NCCAB	Significant
05-04-92	Pinnacles	10	1600	SFBAAB	Overwhelming
06-03-92	Pinnacles	11	1800	SFBAAB	Overwhelming

a. May 7, 1990

Pinnacles exceeded the state standard for ozone on May 7, 1990 with the maximum concentration of 11 pphm occurring at 1800 PST. Pinnacles was the only location to exceed throughout central California on May 7, 1990.

Wind data from two San Francisco Bay Area Air Quality Management District (SFBAAQMD) meteorological tower sites identify the wind flow at elevated levels. The Mt. Hamilton wind data suggest that flow aloft was conducive to the transport of air pollutants from the SFBAAB to the NCCAB via the Santa Clara Valley during the late morning, afternoon, and evening hours. The Mt. Pise wind data also suggest that the flow aloft was conducive to the transport of air pollutants from the SFBAAB to the offshore areas of the SFBAAB and northwest coastal area of the NCCAB during the morning hours.

Wind data from the San Jose, San Martin, Gilroy and Pinnacles air monitoring stations identify whether the surface winds were conducive to demonstrating surface transport through the Santa Clara Valley from San Jose. The surface wind data suggest that transport of pollutants from the SFBAAB could have been transported as far as Gilroy during the late morning and early afternoon hours. However, without Hollister wind data for this day and some of the Pinnacles wind data missing from morning to early afternoon, its difficult to judge whether surface transport of SFBAAB pollutants made it to Hollister and then to Pinnacles. A convergence zone in the Santa Clara Valley set up by 1500 PST on May 7 between San Jose and Gilroy, thereby shutting off any possibility of surface transport southward from the SFBAAB to the NCCAB.

A fairly strong inversion (9 degrees C) was based at 700 feet with a top at 2300 feet at 0400 PST on May 7, 1990 at Oakland. The low height of the inversion base suggests that surface emissions were concentrated in a shallow layer. The 1600 PST inversion base and top lowered to 400 feet and 1500 feet, respectively. The inversion intensity decreased to only 2 degrees C. Winds at the surface were moderately strong and from the west-northwest, but at 3000 feet were light and blew from the east. The Oakland inversion data and winds suggest that SFBAAB emissions were trapped below the 700 feet level and could have transported southward toward the NCCAB based on the afternoon winds. However, the highest inversion base for May 7 was 700 feet at Oakland (718 feet-msl) which would suggest that Pinnacles (1100 feet-msl) was above the influence of the marine layer.

The staff prepared an isotherm analysis of the daily maximum temperature on May 7, 1990 for the central California region. The Pinnacles daily maximum temperature of 90 degrees Fahrenheit is similar to the daily maximum temperatures in the San Joaquin Valley and Gilroy area. The Salinas and San Benito Valleys were engulfed in modified marine air as evidenced by daily maximum temperatures in the 70's and low 80's. Temperatures were 7 degrees Fahrenheit cooler at Hollister (83 degrees F) than Gilroy (90 degrees F), which are 12 miles apart at a similar elevation and in adjacent valleys. The analysis further suggests that Pinnacles was not in the marine layer which engulfed the majority of the NCCAB.

The back trajectory indicated that air parcels which arrived at the Pinnacles at the time of the maximum concentration originated from just east of the Farallon Islands at 0800 PST that same day and from San Jose at 0800 PST that same day. The trajectory indicates that air parcels from off the coast of the SFBAAB traveled southeastward off the coast and then came into the Monterey Bay. The parcels then traveled into the San Benito Valley from the Monterey Bay via the Pajaro Gap. Once the parcels reached the San Benito Valley they converged with air parcels moving southward from the SFBAAB via the Santa Clara Valley. The air parcels then continued the journey to the Pinnacles through the San Benito and Bear Valleys. Whether the flow splits off to the Santa Clara Valley or not in the back trajectory analysis is dependent on the estimated wind speed and direction between Pinnacles and Hollister for 1500-1800 PST. If the winds were stronger, the trajectory arrives at Hollister during the presence of the convergence zone between Gilroy and San Jose. In this case, the trajectory never backs into the Santa Clara Valley, but instead only backs into the Monterey Bay area through the Pajaro Gap. This sensitivity to estimated winds, along with the lack of valid wind data from Hollister and missing data from Pinnacles (0800-1400 PST) casts some uncertainty on the validity of the trajectory path.

The maximum ozone concentration of 8 pphm at Gilroy occurred at 1500-1600 PST, and took place at the same time the wind direction shifted from northwesterly to southeasterly (1500 PST). This suggests that the NCCAB was the source of emissions, not the SFBAAB. Moreover, the occurrence of the time of maximum ozone concentration at 1200-1300 pm for Hollister seems to imply local sources only. A progressive timing of the maximum ozone concentration is indicative of transport from the SFBAAB to the NCCAB via the Santa Clara Valley.

Reviewing the aloft data from Oakland and Vandenburg AFB, there does not appear to be a strong case for transport from the SFBAAB to the NCCAB. The weak southerly flow at 850 mb (~5000 feet msl) at Oakland during the afternoon, but northerly during the morning suggests that transport was only possible during the early morning hours of May 7. The few hours of southwest to west flow (1500-1700 PST) following the 7 hours of missing data from Pinnacles is in agreement with the Oakland 850 mb flow and seems to support the lack of transport from the SFBAAB to the NCCAB. The trajectory analysis suggests the possibility of transport, but is based on insufficient data. The presence of the marine layer in the Salinas Valley and San Benito Valley, but not at Pinnacles, suggests that Pinnacles was not impacted by emissions within the NCCAB. Pinnacles was the only location throughout central and northern California to exceed the ozone standard, suggesting no local or transported source for the emissions impacting Pinnacles. As a result of the analyses, the staff concluded that the data was not conclusive enough to determine the transport contribution of emissions impacting Pinnacles from the SFBAAB on May 7, 1990. However, the staff could not rule out that transport aloft did occur.

b. September 24, 1991

Hollister exceeded the state standard for ozone on September 24, 1991 with the maximum concentration of 10 pphm occurring at 1300-1400 PST. Along with Hollister, several other locales exceeded the standard on September 24. The spatial pattern of ozone exceedance location alone, suggests transport impact of emissions from the SFBAAB to the NCCAB.

Wind data from one SFBAAQMD meteorological tower site identify the wind flow at elevated levels. Winds at Mt. Hamilton blew from a variety of directions on September 24, 1991. Additional wind data aloft were available for this exceedance day from a network of wind profilers in the NCCAB for a special transport study jointly funded by the ARB and NOAA[4]. Wind profilers with data for this episode were located at Moss Landing, Hollister, and Bear Valley. The preliminary wind profiler data from Hollister combined with the Mt. Hamilton wind data suggest that Hollister could have been impacted by emissions from the SFBAAB during the period of maximum ozone concentrations at Hollister, 1300-1400 PST, due to the few hours of moderate northwest winds, 1100-1600 PST, on September 24, 1991.

Wind data from the San Jose, San Martin, Gilroy, and Hollister air monitoring stations, along with wind measurements in the Pajaro River Canyon identify whether the surface winds were conducive to surface transport through the Santa Clara Valley from San Jose to Hollister, as well as surface transport from the Monterey Bay to Hollister via the Pajaro Gap. The surface wind data suggest that there was transport of emissions from the SFBAAB to the NCCAB via the Santa Clara Valley, but only for 5 hours, from 1100 to 1600 PST. In addition, the surface wind data suggest that there was transport of emissions from the Monterey Bay to Hollister via the Pajaro Gap from 1000 to 2100 PST.

A strong inversion (14 degrees C) was based at the surface with a top at 2600 feet at 0400 PST. The height of the inversion base near the surface, along with the surface wind from the north-northeast at 0400 PST suggest that surface emissions were trapped near the surface and could have transported southward towards the NCCAB. The 1600 PST inversion base and top moved to 700 feet and 1200 feet, respectively. The inversion intensity decreased to 3 degrees C., surface winds from the northwest. The Oakland inversion data and winds suggest that SFBAAB emissions could have been trapped below the 700 feet level and transported southward toward the NCCAB.

The isotherm analysis for the central California region showed that the Hollister daily maximum temperature of 99 degrees Fahrenheit was similar to the daily maximum temperatures in the San Joaquin Valley, southern and eastern San Francisco Bay Area, Santa Clara Valley, Scotts Valley, the upper Salinas Valley near King City, and the Pinnacles area. There was only evidence of the marine layer in the immediate NCCAB coastal area. Pinnacles daily maximum temperature was 100 degrees Fahrenheit. The analysis suggests that Hollister was not in the marine layer which engulfed mostly the immediate coastal area of the NCCAB.

A back trajectory indicated that air parcels which arrived at Hollister, during the period of the maximum concentration, originated from off the coast of the SFBAAB near the Farallon Islands the previous day, as well as the San Jose area during the morning commute on September 24. Due to the convergence of wind at Hollister from airflow coming from the Santa Clara Valley and from the Monterey Bay via the Pajaro Gap, two back trajectories were constructed. Both trajectories suggest that morning emissions in the San Jose area and Monterey Bay area contributed to the exceedance at Hollister at the time of the daily maximum concentration.

Based on the spatial extent of the area of ozone exceedances, the inversion data, the maximum temperature analysis, and the trajectory analysis the staff concluded that the emissions contributing to the ozone exceedance at Hollister came from both the SFBAAB and the NCCAB on September 24, 1991. Due to emissions from both air basins contributing to the exceedance at Hollister, the staff concluded that the contribution of emissions from the SFBAAB was significant.

5. Emission Inventory

The most recent emission inventory data available is the 1989 statewide, air basin, and county totals compiled by the ARB staff[5]. While emission totals provide only general information, they were useful for determining the relative difference in emissions between various areas. The staff used this information to gain a general indication of the potential for upwind and downwind areas to contribute to ozone concentrations.

Ozone precursor emissions consist primarily of emissions of reactive organic gases (ROG) and nitrogen oxides (NOx). The 1989 emission inventory data, as shown in Table VII.4, indicate that ozone precursor emissions in the SFBAAB are 1,370 tons/day. This is more than seven times the ozone precursor emissions for the NCCAB (179 tons/day).

Santa Clara and San Mateo Counties are the two counties in the SFBAAB located closest to the NCCAB and therefore have the greatest potential for impacting air quality in the NCCAB, especially San Benito County. When the ozone precursor emissions for the two SFBAAB counties are compared to those for San Benito County, the disparity is even greater than for the entire air basins. Ozone precursor emissions for Santa Clara and San Mateo counties (442 tons/day) are 34 times those for San Benito County (13 tons/day). In addition, ozone precursor emissions for Santa Clara and San Mateo counties are over 7 times those for San Benito and Santa Cruz Counties (60 tons/day).

The staff did not make a quantitative determination of the relative contribution of the emissions in San Benito County versus the contribution of the emissions in Santa Clara and San Mateo Counties to the ozone concentrations measured at Hollister and Pinnacles. The staff could not make a quantitative determination because the emission data are not resolved spatially or temporally and air quality models were not available for these areas. The staff concluded that the emissions in San Benito County did not

TABLE VII.4

Emissions Comparison by Air Basin and County
Based on 1989 Emission Inventory

Area	ROG	NOx	Total
	Emissions (Ton/Day)		
San Francisco Bay Area Air Basin	790	580	1370
Santa Clara County	180	130	310
San Mateo County	74	58	132
North Central Coast Air Basin	90	89	179
San Benito County	6	7	13
Santa Cruz County	28	19	47
Monterey County	56	63	119
Ratio			
SFBAAB:NCCAB	8.8	6.5	7.7
Santa Clara+San Mateo:San Benito	42.3	26.9	34.0
Santa Clara+San Mateo:San Benito+Santa Cruz	7.5	7.2	7.4

significantly contribute to ozone exceedances at Hollister and Pinnacles.

6. Summary of Previous Transport Studies

Previous studies have shown strong evidence of transport from the SFBAAB to the NCCAB. Preliminary studies such as Blumenthal, et al.[6] demonstrated the movement of air pollutants from the SFBAAB southeastward past San Jose.

Dabberdt[7] in a 1980 field study found transport up the Santa Clara Valley to Hollister although the occurrence was sporadic. He found that the movement of two separate marine air masses, one eastward from Monterey Bay and the other southeastward through the Santa Clara Valley, apparently sets up a convergence zone in the northern San Benito Valley (refer to discussion in assessments section). He found on most occasions that the marine air from the Monterey Bay inhibited material transported from the SFBAAB from going south of Gilroy. On other occasions, he saw the marine intrusion break down for short periods enabling transport of air from the SFBAAB to Hollister.

Dabberdt also found no significant ozone transport from Los Gatos to Scotts Valley and Aptos. He detected another transport route where significant amounts of ozone and ozone precursors were transported offshore from San Mateo County into the NCCAB where ozone exceedances were measured at several locations in the NCCAB.

The ARB staff[1] found in an analysis of air monitoring data for ten ozone exceedance days during 1986-1988 at Hollister, that all ten days had the SFBAAB as the source region with the primary transport route the Santa Clara Valley. The contribution of SFBAAB emissions to exceedances at Hollister was found to be overwhelming, due to the large difference in precursor emissions between the upwind adjacent counties in the SFBAAB and the San Benito County.

In a subsequent analysis of ozone exceedance days at Hollister, Davenport, and Carmel Valley in 1989, the ARB staff[2] found that Hollister's one ozone exceedance day was the result of ozone precursor emissions from both the SFBAAB and the NCCAB. The SFBAAB contribution had reached Hollister via the offshore route instead of the Santa Clara Valley. As the SFBAAB air mass was transported along the coast and then into the Monterey Bay to Hollister, significant precursors from Monterey Bay sources were added to this air mass before reaching Hollister. As a result of these significant emissions, the contribution of precursor emissions impacting Hollister from the SFBAAB and local basins was found to be significant.

The ARB staff also found that all exceedances at Carmel Valley in 1989 were the result of significant transport contributions from the SFBAAB. The main transport route was along the coastal waters of the SFBAAB to the Monterey Peninsula. The contribution was found to be significant because the trajectory of air from the SFBAAB to Carmel Valley had crossed over significant local ozone precursor emissions in the Monterey Peninsula area. The ARB also found that the exceedances of the ozone standard at Davenport in 1989 were the result of overwhelming amounts of precursor emissions transported from the SFBAAB along the coastal waters.

Douglas[8] examined the effect of emissions reductions in the SFBAAB on ozone levels in the NCCAB and SJVAB. Douglas found that emissions trends and ozone trends analyses indicated that emission reductions have not resulted in a detectable trend in the seasonal average daily maximum ozone concentration in the SFBAAB nor the NCCAB on either transport or non-transport days. This finding occurred even though there have been significant reductions in emissions in the SFBAAB between 1979 and 1988. However, flux-plane calculations suggest that elimination of anthropogenic SFBAAB emissions would significantly decrease ozone concentrations in the downwind air basins during transport-conducive meteorological conditions. Douglas' categorization of high-ozone days showed that during the period 1979-1988, transport from the SFBAAB to the NCCAB was possible on more than 65 percent of the days. The analyses suggest that continued reductions (beyond current levels) in SFBAAB emissions may eventually have a positive impact on ozone levels in the NCCAB.

Roberts[9] under an ARB contract evaluated the transport contribution of ozone precursors to ozone exceedances in three downwind air basins including the NCCAB. Roberts used trajectory and other data analysis techniques to evaluate the transport contribution of the SFBAAB on ozone exceedance days in the NCCAB for 1990.

Roberts found that for Hollister and Pinnacles, transported pollutants could arrive via either the Santa Clara Valley or Monterey Bay. In addition, ozone violation days were identified with both local and transport contributions. However, locally designated days for Pinnacles might have been reclassified as transport if wind data aloft were available for the analysis. In addition, Roberts identified that only local sources contributed to ozone concentrations at Carmel Valley in 1990; however, there were no violations of the state standard at that monitor for 1990.

AeroVironment, Inc.[10] performed a preliminary data analysis to determine the effect of transport on exceedances measured at several air monitoring stations within the NCCAB for the period 1990-1991. AeroVironment concluded that transport from sources outside of the NCCAB had an overwhelming influence for all the exceedances at Hollister. The 1990 exceedances could be attributed to transport from the SFBAAB via the Santa Clara Valley. The 1991 exceedance appeared to be caused by fumigation from an elevated pollution layer located over California. Transport up the coast from Southern California appeared to have an overwhelming influence on both Davenport exceedances during the the two-year period. Transport played an overwhelming role for both exceedances at Santa Cruz. The first exceedance occurred due to transport from the SFBAAB via the coast down the Santa Clara Valley then over the coast range to Santa Cruz. The second occurrence was due to transport up the coast from Southern California. The Carmel Valley exceedance was inconclusive due to the lack of data, however, conditions were good for transport from the SFBAAB and over portions of the NCCAB. Finally, transport from SJVAB occurred on 13 exceedance days at Pinnacles. Four exceedance days at Pinnacles were due to overwhelming transport of emissions down the Santa Clara Valley from the SFBAAB. Analysis of the 3 remaining exceedance days was inconclusive.

Ludwig[11] applied cluster, empirical orthogonal function, and regression analyses to characterize ozone and weather patterns associated with high ozone concentration in the San Francisco and Monterey Bay areas. Preliminary findings indicated that all the days exceeding the federal standard at Pinnacles satisfied certain meteorological criteria, while none of the remaining 121 days with federal exceedances in other parts of the NCCAB and SFBAAB met all the same criteria. The meteorological criteria, based on nine variables, suggested that ozone concentrations greater than 12 pphm at Pinnacles reflected conditions aloft. As a result, Ludwig concluded that Pinnacles must be within or just below the inversion. The air in the inversion is isolated from conditions at the surface, so Ludwig found it very difficult to characterize the origins of the air arriving at Pinnacles from surface observations, even when augmented by the Oakland sounding information. Cluster analysis showed in all cases that a high ozone region in the SFBAAB was separated from high Pinnacles ozone by an intrusion of lower concentration from Monterey Bay through Carmel Valley and Salinas to Hollister. Ludwig concluded that the distance separating Pinnacles from the major source regions of the SFBAAB suggests that if transport is the cause of the high concentration at Pinnacles, it is due to a multiday process with the observed light winds.

Umeda[12] combined a mesocale wind model with a Lagrangian particle model to construct trajectories associated with ten ozone episodes at Pinnacles. The trajectories verified the occurrence of transport of morning emissions at San Jose in the SFBAAB to Pinnacles via the Santa Clara and San Benito Valleys. Late afternoon Sacramento emissions taken aloft by Sierra upslope flows were found to travel to the Pinnacles area over the nighttime hours. Umeda also found that the Gabilan Range shelters the Pinnacles from the sea breeze allowing greater influence from inland sources during periods of prevailing offshore flow. Pacheco Pass was found to be a frequent pathway for offshore flow during the episodes. There was found some overnight sea breeze connection between the SFBAAB and the Pinnacles, but the evidence was not substantial.

A jointly funded project by the ARB and NOAA Wave Propagation Laboratory (WPL)[4] was begun in 1991 to study atmospheric transport corridors and processes utilizing new remote sensing technology. The remote sensing technology in the form of the wind profiler and Radio Acoustic Sounding System (RASS) were set up in northern California in 1991 and southern California in 1992 to create a data base of vertical profiles of winds and temperatures along air pollutant transport corridors. In addition, supplemental meteorological instrumentation was added to the wind profiler and RASS network so that mixing layer depths could be inferred and the dynamics of local circulations along terrain-dominated transport corridors could be better understood.

The 1991 network concentrated on the transport of air pollutants from the SFBAAB to the NCCAB, as well as from the SFBAAB to the Broader Sacramento Area and Upper Sacramento Valley. The 1991 study of the SFBAAB to NCCAB corridor occurred during the months of August through November. The focus of the study was to collect and study the transport of air aloft into the NCCAB, specifically along the Santa Clara Valley corridor to Hollister and Pinnacles. In addition, local transport from the Monterey Bay will be investigated. The network of profilers were located at Bear Valley (Just east of Pinnacles), Tracy, Hollister, Moss Landing, and near Travis AFB. The RASS equipment was installed near Travis AFB and collated with the wind profiler. The WPL will carry out analyses of the data collected, as well as prepare the data base. The project is scheduled for completion in January, 1994.

7. Comparison of Transport Assessments

Transport assessments for the NCCAB during ozone exceedance periods have been conducted by several groups. In particular the May 7, 1990 exceedance day at Pinnacles and September 24, 1991 day at Hollister were assessed by both the ARB staff and AeroVironment[9]. Both the ARB staff and AeroVironment assessments found the data inconclusive for the May 7, 1990 exceedance at Pinnacles. However, for the September 24, 1991 exceedance at Hollister, ARB staff and AeroVironment had different conclusions as to the source of emissions impacting Hollister. AeroVironment based the origin of emissions impacting Hollister as originating from the San Joaquin Valley and from fumigation of ozone layers aloft, while the ARB staff concluded that the emissions impacting Hollister at the time of the maximum ozone concentration was from both the SFBAAB and NCCAB.

AeroVironment based their conclusion on the evaluation of 11 transport criteria. Criteria pointing to the San Joaquin Valley as to the source of emissions included the geographic extent of exceedances, time of the daily maximum ozone concentration, and time series analysis.

ARB staff based their conclusions on the evaluation or analysis of 7 transport criteria. Criteria pointing to both the SFBAAB and NCCAB as to the source of emissions included the geographic extent of exceedances, the maximum temperature analysis, the Oakland inversion data, and back trajectory.

AeroVironment based the determination of the source region mainly on the air quality data, while ARB staff based the determination of the source region on both air quality data and the meteorological analyses including the trajectory analysis.

8. References

1. Air Resources Board, 1990: Assessment and Mitigation of the Impacts of Transported Pollutants on Ozone Concentrations within California. ARB Staff Report prepared by the Technical Support Division and Office of Air Quality Planning and Liaison, 179 pp. + 2 Appendices.

2. Air Resources Board, 1990: Assessment and Mitigation of the Impacts of Transported Pollutants on Ozone Concentrations within California, Supplement to the June 1990 Staff Report. ARB Staff Report prepared by the Air Quality Analysis Section of the Technical Support Division, August 9, 1990, 16 pp.

3. Gouze, S. C., 1993: Transport of Air Pollutants to the North Central Coast Air Basin. Technical Report, ARB, July 1993.

4. Neff, W. D., and J. M. Wilczak, 1991: A Multi-Year Observational Study of Atmospheric Transport Corridors and Processes in California. Unsolicited research proposal submitted to the ARB by the NOAA Wave Propagation Laboratory, January 10, 1991, 34 pp + Attachments.

5. Air Resources Board, 1991: Emission Inventory 1989. ARB Staff Report prepared by the Emission Inventory Branch of the Technical Support Division, August 1991, 38 pp + 1 Appendix.

6. Blumenthal, D. L., W. H. White, R. L. Peace, T. B. Smith, 1974: Determination of the Feasibility of the Long-Range Transport of Ozone or Ozone Precursors. Pub. No. EPA-450/3-74-061, Final Rep., Contract No. 68-02-1462, Meteorological Research Inc., 282 pp + 4 Appendices.

7. Dabberdt, Walter F., 1983: Ozone Transport in the North Central Coast Air Basin - Executive Summary. Final Rep., SRI Projects 1898 and 4637, ARB Contract No. A9-143-31, SRI Internat'l., 36 pp.

8. Douglas, S. G., T. E. Stoeckenius, B. S. Austin, J. R. Emery, C. A., and C. Daly, 1991: Impacts of Changes in Precursor Emission from the San Francisco Bay Area on Ozone in the North Central Coast and San Joaquin Valley Air Basins. Final Report prepared by System Applications International under ARB Contract No. A932-133, 104 pp.

9. Roberts, P. T., S. Musarra, T. B. Smith, F. W. Lurmann, 1992: A Study to Determine the Nature and Extent of Ozone and Ozone Precursor Transport in Selected Areas of California. STI Final Report No. STI-90060-1162-FR prepared for ARB by Sonoma Technology, Inc., April 1992 under Contract No. A932-129, 219 pp. + 1 Appendix.

10. AeroVironment, 1993: Analysis of the Transport of Ozone into the North Central Coast Air Basin. AeroVironment Report No. AV-R-93/6010 prepared for the Monterey Bay Unified Air Pollution Control District, February 1993, 21 pp. + 1 Appendix.

11. Ludwig, F. L., J. Jiang, and J. Chen, 1993: Monterey Bay Area Transport Study: Volume 1 - Classification of Ozone and Weather Patterns Associated with High Ozone Concentrations in the San Francisco and Monterey Bay Areas. Preliminary Report prepared for the U.S. Environmental Protection Agency by SRI and the Bay Area Air Quality Management District, March 1993, 70 pp.

12. Umeda, T., 1993: Monterey Bay Area Transport Study: Volume 2-Trajectory Analysis. Draft Report prepared for the U.S. Environmental Protection Agency by the Bay Area Air Quality Management District, March 24, 1993, 74 pp.

D. San Joaquin Valley to Southeast Desert

1. Summary and Recommendations

A study of transport from the San Joaquin Valley to the Southeast Desert prepared by Sonoma Technology, Inc. (STI)[1] reinforces the Board's 1990 findings that local emissions in the Southeast Desert Air Basin (SEDAB) can cause exceedances of the state ozone standard on some days, without regard to the transport contribution from the San Joaquin Valley Air Basin (SJVAB).

The staff recommends that the Board continues to classify the transport from the SJVAB to the SEDAB as "overwhelming" on some days and "inconsequential" on others.

2. Conclusions

The staff believes that there is no evidence to indicate that a change from the previously identified transport classification should be made.

3. Summary of Previous Research

STI studied data from Trona for years 1980 through 1990. They found ozone exceedances observed only in June through September with peak number of exceedances in August, and two distinct diurnal peaks at 1100 and 1900 PST. STI suggests the earlier peak may be carry-over from the previous day or may include significant local effects, while the later 1900 PST peak is indicative of transport. This conclusion by STI confirms ARB staff's previous conclusion, that the exceedances can be caused by either transported pollutants or by local sources.

Since the 1990 San Joaquin Valley Air Quality Study contained only a small portion of the SEDAB in its domain, it will not be helpful for evaluating transport impacts on the SEDAB (once the study's data are available in final form). However, the NOAA/ARB[2] research studies undertaken in the summer of 1992 will provide a database of air quality and meteorological conditions which should allow the ARB to assess the wind flow for this transport couple.

The Kern County Air Pollution Control District plans to locate a new air monitoring site in the Kern County portion of the SEDAB; this should help with future evaluations of this transport couple.

4. References

1. Sonoma Technology, Inc. 1992. A Study to Determine the Nature and Extent of Ozone and Ozone Precursor Transport in Selected Areas of California. Prepared for the California Air Resources Board, April 1992.

E. South Coast to San Diego

1. Summary and Recommendations

The analysis for this couple continues to be a joint ARB/District staff effort. San Diego County Air Pollution Control District (SDCAPCD) staff reviews meteorology and air quality daily to determine the contribution of transport from the South Coast Air Basin (SCAB) . The ARB staff reviewed SDCAPCD's procedures and analysis on days of special interest. The studies continue to show that transport from the SCAB may be overwhelming, significant, and inconsequential to state ozone standard exceedances in the San Diego Air Basin (SDAB), depending on meteorology.

The staff recommends that no changes be made to the findings adopted by the Board at its August 1990 hearing. Transport from the SCAB to the SDAB should continue to be classified as "overwhelming" on some days, "significant" on some other days and "inconsequential" on others.

2. Conclusions

The staff has not found information that would change the 1990 ARB findings. Therefore, the staff recommends the previous classifications be continued.

The NOAA/ARB[1] radar wind profiler research studies undertaken in the summer of 1992 will provide a database which may allow the ARB to better assess the three-dimensional wind flow for this transport couple.

3. References

1. NOAA/ARB (in work). A Study to Observe Mesoscale Transport Winds in California. Database should be ready in 1993.

F. Couples With No New Assessment

Seven of the transport couples included in the June 1990 transport assessment report have not been further studied. The staff reviewed recent air quality data which did not indicate a change in the previous assessment. The findings of the first assessment for these seven couples are presented here. Also presented is information about studies in progress that may assist the staff with future assessments and could affect the findings.

1. South Coast to South Central Coast

Photochemical grid modeling was used to study the impact of transported pollutants from the South Coast Air Basin on ozone concentrations in the South Central Coast Air Basin. The modeling study showed that the impact of transported pollutants from the South Coast Air Basin to the South Central Coast Air Basin is "significant" on some days and "inconsequential" on others.

2. South Central Coast to South Coast

Photochemical grid modeling was used to study the impact of transported pollutants from the South Central Coast Air Basin on ozone concentrations in the South Coast Air Basin. The modeling study showed that the impact of transported pollutants from the South Central Coast Air Basin to the South Coast Air Basin is "significant" on some days and "inconsequential" on others.

3. San Joaquin Valley to Broader Sacramento Area

Data analysis techniques were used to study the impact of transported pollutants from the San Joaquin Valley Air Basin on ozone concentrations in the Broader Sacramento Area. The analysis showed that the impact of transported pollutants from the San Joaquin Valley Air Basin to the Broader Sacramento Area is "significant" on some days and "inconsequential" on others.

The SJVAQS/AUSPEX will provide a database to apply photochemical grid modeling for future studies on this couple.

4. San Joaquin Valley to Great Basin Valleys

Data analysis techniques were used to study the impact of transported pollutants on ozone concentrations in the Great Basin Valleys Air Basin. The analysis showed that the impact of transported pollutants to the Great Basin Valleys Air Basin is mainly from the San Joaquin Valley Air Basin. The impact of transported pollutants from the San Joaquin Valley Air Basin to the Great Basin Valleys Air Basin is "overwhelming".

5. Broader Sacramento Area to San Joaquin Valley

Data analysis techniques were used to study the impact of transported pollutants from the Broader Sacramento Area on ozone concentrations in the San Joaquin Valley Air Basin . The analysis showed that the impact of transported pollutants from the Broader Sacramento Area to the San Joaquin Valley Air Basin is "significant" on some days and "inconsequential" on others.

The SJVAQS/AUSPEX will provide a database to apply photochemical grid modeling for future studies on this couple.

6. Broader Sacramento Area to San Francisco Bay Area

Data analysis techniques were used to study the impact of transported pollutants from the Broader Sacramento Area on ozone concentrations in the San Francisco Bay Area Air Basin. The analysis showed that the impact of transported pollutants from the Broader Sacramento Area to the San Francisco Bay Area Air Basin is "significant" on some days and "inconsequential" on others.

7. California Coastal Waters to South Central Coast

Photochemical grid modeling was used to study the impact of transported pollutants from California Coastal Waters on ozone concentrations in the South Central Coast Air Basin. The modeling study showed that the impact of transported pollutants from California Coastal Waters to the South Central Coast Air Basin is "significant".

CHAPTER VIII

Recommendations for Further Research

Not all the questions about transport of air pollutants and precursors have been answered with this update to the 1990 Transport Assessment. Through the process of putting this update together, the staff has identified areas that need further research. This includes data collection to understand and assess transport aloft, assessment of potential new couples, photochemical modeling to quantify upwind contributions, data collection along transport routes, and analysie of existing data from field studies. This section discusses the staff's recommendations for further research.

A. Transport Aloft

Ozone formed during summer daytime hours disperses throughout the mixed layer which can be several thousand feet deep. Most of this ozone becomes separated from the mixed layer when nighttime inversions form. The presence of these ozone "reservoirs" have been revealed by aircraft measurements made during intensive field studies in the South Coast, Southeast Desert, San Joaquin Valley, and Sacramento Valley Air Basins. There has been some discussion presented in this report concerning analysis of upper-level winds and air quality, but most of the transport analyses are based on surface transport because there are considerably more surface data. It is likely that upper-level transport may dominate the overall transport of ozone and precursors throughout California.

Photochemical grid models use three dimensional wind fields and therefore are able to use all available upper-level wind and air quality data for the episodes modeled. When models are not available, techniques for analyzing upper-level wind and air pollutant data need to be assessed and if needed, new techniques developed.

There is considerable upper-level wind and air quality data available for use in transport studies in some areas of the state. In addition to the data acquired in the intensive field studies, the ARB has contracted with NOAA's Wave Propagation Laboratory[1] to measure upper-level winds in many corridors downwind of major metropolitan areas. The ARB has also contracted with AeroVironment to collect upper-level air quality and wind data between the San Francisco area and Sacramento. The staff recommends that future analysis efforts should be focused on integrating into the transport assessment the upper-level aerometric data that will be available by mid 1994.

Past studies of air quality aloft have been done by outfitting aircraft with instrumentation or placing monitors on towers. Siting monitors in high terrain also offers a way to measure upper-level air quality when the site is not affected by upslope winds.

Remote sensing studies may offer several advantages over currently used methods. Aircraft can cover large upper-level volumes but the measurements represent very short averaging times. Towers are ideal for measuring longer averaging times of the vertical pollutant structure of the atmosphere above a point. It is difficult to determine the volume of air that the tower represents. High terrain sites are single point measurements but can also record air quality over long averaging times. Remote sensing may be able to define upper-level air quality for a large volume as well as for any averaging time desired. The staff also recommends that the existing database be assessed to determine if new aloft data is needed and if so, to determine the best means for collection.

B. Specific Couples for Transport Research

Table 2 included with the October 1989 Staff Report[2], listed specific areas to be considered for transport identification and assessment. The transport couples with highest priority have been studied and are discussed in Chapter IV and V of this report. Couples considered by the staff to have lower priority but are recommended to be considered for inclusion in the next triennial update are:

1. North Central Coast to San Joaquin Valley
2. South Coast to San Joaquin Valley
3. San Diego to Southeast Desert
4. San Francisco Bay Area to Upper Sacramento Valley
5. South Central Coast to North Central Coast
6. San Joaquin Valley to North Central Coast
7. San Joaquin Valley to San Francisco Bay Area

The remaining couples that were listed in Table 2 mentioned above, are not recommended for further research. The staff does not recommend further research into the transport of pollutants to the Lake Tahoe Air Basin. This is because the Lake Tahoe Air Basin was recently redesignated as attainment for the state ozone standard. The staff does not recommend further research into transport from the North Central Coast Air Basin to San Francisco Bay Area Air Basin or to the San Joaquin Valley Air Basin because the staff has not seen any evidence to suggest transport impacts. Since the 1989 staff report which identified transport couples, the San Joaquin Valley Air Basin has been identified as the upwind area to Great Basin Valleys Air Basin. Therefore, no further research is planned for Great Basin Valley Air Basin. Finally, since neither the districts nor the State of California has jurisdiction over the California Coastal Waters, there is no further research planned for transport of pollutants from the Coastal Waters.

C. Photochemical Grid Modeling

The staff was not able to quantify the upwind transport contribution to downwind areas in the 1990 assessment because the modeling tools and data sets were not available. Likewise, the staff was not able to quantify contributions in the current assessment. However, the staff believes that quantification is ultimately needed to divide equitably the mitigation responsibilities between the upwind and downwind areas.

Since the first transport assessment was reported in August 1990, there have been several intensive field studies to support development of photochemical grid models. Models being developed for the San Joaquin and Sacramento Valleys will support transport assessment for a number of transport couples. These models are not ready for use in this assessment, but the staff recommends that photochemical models be used for transport assessment when they become ready.

There are three modeling areas used for southern California: the South Coast, San Diego, and South Central Coast Air Basins. The staff recommends that a study be conducted to include these three domains in a single modeling domain for southern California to accommodate future transport studies.

D. Data Analysis

Innovative analytical techniques may be added to the data analysis techniques currently used for transport assessment. The ARB contracted with Sonoma Technology, Inc.[4] to develop analytical methods for quantification of ozone and ozone precursor transport. The final report is due in the summer of 1993. The staff recommends that these new methods be further evaluated in order to be incorporated, where appropriate, into future transport studies.

Currently the analyses of meteorological, air quality, and emissions data are integrated and spatially plotted by hand. This is a resource intensive effort. The staff recommends that computer tools be developed to assist the staff in data analyses for future transport assessments. Such tools that could be developed are Geographic Information Systems and trajectory models. Although there are some trajectory models available now, they need refining to incorporate wind flows in complex terrain, such as in the foothills of the Sierra Nevada and the Mountain Counties Air Basin. These tools would meet many other ARB needs, as well.

The staff also recommends increased monitoring of meteorology and ozone concentrations to improve the data available for analysis. The staff and research contractors have identified transport corridors from one area to another. Some of these corridors lack sufficient meteorological and air quality data for a complete transport assessment. The staff recommends that more monitors be sited in these transport corridors particularly on ridges that usually act as barriers to the transport of pollutants. Monitors could be placed in areas such as, but not limited to, Crow's Landing between the San Francisco Bay Area and the San Joaquin Valley Air Basins, Vacaville between the San Francisco Bay Area and Sacramento Valley Air Basins, the Tehachapi Range between the San Joaquin Valley and Southeast Desert Air Basins, Grapevine between the San Joaquin Valley and South Coast Air Basins, Pacheco Pass between the San Joaquin Valley and North Central Coast Air Basins, and Santa Catalina Island between the South Coast and San Diego Air Basins.

E. References

1. Neff, W. D., and J. M. Wilczak, 1991: A Multi-Year Observational Study of Atmospheric Transport Corridors and Processes in California. Unsolicited research proposal submitted to the ARB by the NOAA Wave Propagation Laboratory, January 10, 1991, 34 pp. + Attachments.

2. Air Resources Board, 1989: Proposed Identification of Districts Affected by Transported Air Pollutants which Contribute to Violations of the State Ambient Air Quality Standard for Ozone. Staff Report, ARB/Meteorology Section (principle author), October 1989, 57 pp. + 6 Appendices.

STATE OF CALIFORNIA PETE WILSON, Governor

AIR RESOURCES BOARD
2020 L STREET
P.O. BOX 2815
SACRAMENTO, CA 95812

February 19, 1993

Dear Sir or Madam:

Public Workshop to Discuss the Assessment and Mitigation of the Impacts of Transported Pollutants on Ozone Concentrations in California: a Triennial Update

The Air Resources Board staff has scheduled a public workshop to discuss the identification of transport couples and the assessment of impacts of transported pollutants on ambient ozone concentrations within California, as required by the California Clean Air Act (Health and Safety Code (HSC) Section 39610) and as amended by AB 2783, Sher.

The workshop will be held at the time and location identified below:

DATE : March 23, 1993

TIME : 10:00 am - 3:00 pm

PLACE: Air Resources Board
Hearing Room, Lower Level
2020 L Street
Sacramento, California

Major topics for discussion include:

(1) changes resulting from AB 2783, Sher;

(2) identification of new transport couples; and

(3) review of transport couples previously identified.

An agenda for the workshop appears on the reverse side of this notice.

The purpose of the meeting is to obtain information and comments related to the above topics. Should you have any questions, please contact Don McNerny, Modeling and Meteorology Branch Chief, at (916) 322-6048.

Sincerely,

Terry McGuire, Chief
Technical Support Division

AGENDA

10:00 Introductory Remarks (CCAA/AB 2783 Impacts)

10:15 Overview of Assessment Methods

10:30 Identification and Assessment of Potential New Transport Couples

1. Broader Sacramento Area to Mountain Counties
2. San Joaquin Valley to Mountain Counties
3. San Francisco Bay Area to Mountain Counties
4. Mexico to Southeast Desert
5. Mexico to San Diego
6. Southeast Desert to South Coast
7. San Luis Obispo to San Joaquin Valley
8. San Joaquin Valley to San Luis Obispo

11:30 Potential Identification of Overwhelming Transport And Changes to Mitigation Responsibilities

1. San Francisco Bay Area to Broader Sacramento
2. San Francisco Bay Area to San Joaquin Valley
3. Broader Sacramento to Upper Sacramento Valley

12:00 Lunch

1:15 Update to Previous Transport Assessments

1. South Coast to San Diego
2. South Coast to Southeast Desert
3. South Coast to South Central Coast
4. South Central Coast to South Coast
5. San Joaquin Valley to Southeast Desert
6. California Coastal Waters to South Central Coast
7. San Francisco Bay Area to North Central Coast
8. Broader Sacramento Area to San Joaquin Valley
9. San Joaquin Valley to Broader Sacramento Area
10. Broader Sacramento Area to San Francisco Bay Area
11. San Joaquin Valley to Great Basin Valley

2:00 Further Research

2:20 Discussion

3:00 Adjourn

Please note that public parking is available on the roof of the parking garage that is located across the street from the Air Resources Board. The cost is $2.00 a day, payable at the security desk in the lobby of the ARB building.

APPENDIX B

March 23, 1993 Transport Workshop Participants

Steve Birdsall
Imperial County APCD
150 S. 9th Street
El Centro, CA 92243-2801
(619) 339-4314

Doug Quetin
Monterey Bay Unified APCD
24580 Silver Cloud Court
Monterey, CA 93940
(408) 647-9411

Bob Dowell
San Joaquin Valley Unified APCD
1997 Tuolumne St., Suite 200
Fresno, CA 93721
(209) 497-1080

Dario Levaggi
Bay Area AQMD
939 Ellis Street
San Francisco, CA 94109

Ken Corbin
Feather River AQMD
463 Palora Avenue
Yuba City, CA 95991
(916) 634-7660

Brigitte Jaensch
CalTrans
1050 20th Street
Sacramento, CA 95814
(916) 324-1663

Cathy Reheis
WSPA
901 Tower Way, Suite 300
Bakersfield, CA
(805) 321-0884

Steve Hemingen
Bay Area Council
200 Pine Street
San Francisco, CA 94104
(415) 771-6000

Brenda Mohn
Naval Air Weapons Station
China Lake, CA
(619) 927-1513

George Kostyreo
BNA California
770 L Street, Suite 910
Sacramento, CA 95814
(916) 852-7016

Teresa Boriolo
Santa Rosa, CA 95401

Cindy Tuck
CCEEB
770 L Street, Suite 1150
Sacramento, CA 95814

Elisa R. Garin
Calaveras County APCD
576 E. St. Charles Street
San Andreas, CA 95249
(209) 754-6399

Scott Folwankow
WSPA
2300 Clayton Rd., Suite 1440
Concord, CA 94520
(510) 825-9388

James Sandberg
Bay Area AQMD
939 Ellis Street
San Francisco, CA 94109
(415) 981-6600

David Ligh
Unocal Corp.
1201 W. 5th Street, Room MM-J
Los Angeles, CA 90017
(213) 977-7206

Hyle Otten
DuPont
915 L Street, #1020
Sacramento, CA 95814
(916) 443-6670

Walter Arenstein
Placer County APCD
11464 B Avenue, Dewitt Center
Auburn, CA 95603
(916) 889-7130

John Ching
Sacramento Metropolitan AQMD
8411 Jackson Road
Sacramento, CA 95826
(916) 386-7054

Dick Smith
San Diego County APCD
9150 Chesapeake Drive
San Diego, CA 92123
(619) 694-3303

Tim L. Sturdavant
San Diego Industrial Environ. Assoc.
7777 Alvarado Rd.
La Brea, CA
(619) 691-2276

David Bush
AeroVironment
635 Skyline Ct.
Placerville, CA 95667
(916) 642-2312

Paul Solomon
PG&E
3400 Crow Canyon Road
San Ramon, CA 94583
(510) 266-5899

Kit Wagner
Alpine Geophysics
826 Parkhaven
Sacramento, CA
(916) 428-7070

Roxanne Keith
Amador County APCD
108 Court Street
Jackson, CA 95642
(209) 223-6406

Johny Davis
CalTrans
P. O. Box 911
Marysville, CA 95901
(916) 741-4564

Bob Ramirez
San Bernardino County APCD
15428 Civic Drive
Victorville, CA 92592
(619) 243-8920

Hal Brown
San Diego County APCD
9150 Chesapeake Drive
San Diego, CA 92123
(619) 694-3355

Don Lehrman
T & B Systems
856 2nd Street
Santa Rosa, CA 95404
(707) 826-2775

Dick Thuillier
PG&E, Meteorological Services
77 Beale St., Room 1605B
San Francisco, CA 94106
(415) 973-4412

S. D. Ziman
Chevron
1003 W. Cutting
Richmond, CA
(510) 242-1530

Steve Burke
Valley Air Focus
2509 Descanjo
Modesto, CA
(209) 521-5056

M. J. Wilson
WZI
4700 Stockdale
Bakersfield, CA
(805) 326-1112

Dan Phelan
Balia
155 Jackson, #305
San Francisco, CA 94115
(415) 288-2739

Doug Shumway
Mitsubishi Cement
5808 St. Hwy. 18
Lucerne Valley, CA 92356
(619) 248-5136

Carol Bohnenkamp
EPA
75 Hawthorne
San Francisco, CA 94610
(415) 744-1298

Clifford Burg
P.D.C.A.
3504 Walnut Avenue
Carmichael, CA 95608
(916) 972-1055

Kirk Fauver
FHWA
801 I Street
Sacramento, CA 95842
(916) 551-1297

Jerry Hinck
URS Consultants
2710 Gateway Oaks Dr., Suite 250N
Sacramento, CA 95833
(916) 929-2346

Lyle Chinkin
Sonoma Tech
(707) 527-9372

E. Leong
ABAG
P. O. Box 2050
Oakland, CA
(510) 464-2935

Paul Turek
Glenn County APCD
P. O. Box 351
Willows, CA 95988
(916) 934-6500

Patti Boekamp
City of San Diego
1222 First Avenue, MS 503
San Diego, CA 92101
(619) 533-3943

Scott Bohning
EPA
75 Hawthorne
San Francisco, CA 94610
(415) 744-1293

Sandra Duval
CTA
1251 Deacon Blvd.
West Sacramento, CA 95691
(916) 373-3502

Kayode Kadara
San Bernardino County APCD
15428 Civic Drive
Victorville, CA 92392
(619) 242-8920

Paul Roberts
STI
Santa Rosa, CA
(707) 527-9372

M. N. Tsunezumi
Shell Oil
P. O. Box 711
Martinez, CA
(510) 313-3735

APPENDIX C

PROPOSED TEXT OF REGULATION
IDENTIFYING AREAS WHICH ARE IMPACTED
BY TRANSPORTED AIR POLLUTANTS

Amend Subchapter 1.5, Article 5, Section 70500, Title 17, California Code of Regulations, to read as follows (proposed additions are underlined and in italics, proposed deletions are struck out):

Article 5. Transported Air Pollutants

70500. Transport Identification

(a) Purpose.

This regulation identifies the areas in which transported air pollutants from upwind areas cause or contribute to a violation of the state ambient air quality standard for ozone and the areas of origin of the transported pollutants. All areas identified in the table are the air basins except as otherwise specifically described and defined.

(b) Definitions.

(1) "California Coastal Waters" includes the area between the California coastline and a line starting at the California-Oregon border at the Pacific Ocean; thence to 42.0 degrees North, 125.5 degrees West; thence to 41.0 degrees North, 125.5 degrees West; thence to 40.0 degrees North, 125.5 degrees West; thence 39.0 degrees North, 125.0 degrees West; thence to 38.0 degrees North, 124.5 degrees West; thence to 37.0 degrees North, 123.5 degrees West; thence to 36.0 degrees North, 122.5 degrees West; thence to 35.0 degrees North, 121.5 degrees West; thence to 34.0 degrees North, 120.5 degrees West; thence to 33.0 degrees North, 119.5 degrees West; thence to 32.5 degrees North, 118.5 degrees West; and ending at the California-Mexican border at the Pacific Ocean.

(2) "Upper Sacramento Valley" includes the Colusa, Butte, Glenn, Tehama, and Shasta County Air Pollution Control Districts, and that area of the Feather River Air Quality Management District, which is north of a line connecting the northern border of Yolo County to the Southwestern tip of Yuba County, and continuing along the southern Yuba County border to Placer County.

(3) "Broader Sacramento Area" includes the Sacramento Metropolitan Air Quality Management District; the Yolo-Solano Air Pollution Control District; the portions of the El Dorado

County Air Pollution Control District included in 1990 U.S. Census Tracts 306.01, 307, 308.01,308.02, 308.03, 308.04, 309.01, 309.02, 310, 311, 312, 315.01, and 315.02; the portions of the Placer County Air Pollution Control District included in 1990 U.S. Census Tracts 203, 204, 205, 206.01, 206.02, 206.03, 207.01, 207.02, 207.03, 208, 209, 210.01, 210.02, 211.01, 211.02, 212, 213.01, 213.02, 214, 215.01, 215.02, 216, 218.01, and 218.02; and that area of the Feather River Air Quality Management District which is south of a line connecting the northern border of Yolo County to the southwestern tip of Yuba County, and continuing along the southern Yuba County border to Placer County.

(c)a Transport Identification Tablea

OZONE IMPACTED BY TRANSPORT:		AREAS OF ORIGIN OF TRANSPORT:
1.a	North Central Coasta	San Francisco Bay Area
2.a	South Central Coasta	South Coast
		California Coastal Waters
		San Joaquin Valley
3.a	South Coasta	South Central Coast
4.a	San Diegoa	South Coast
		Me[illegible]
5.a	Upper Sacramento Valley	Broader Sacramento Area
6.a	Broader Sacramento Areaa	San Francisco Bay Area
		San Joaquin Valley
7.a	San Joaquin Valleya	San Francisco Bay Area
		Broader Sacramento Area
8.a	Great Basin Valleys	~~Undetermined~~ *San Joaquin Valley*
9.a	Southeast Deserta	South Coast
		San Joaquin Valley
		Mexico
10.a	San Francisco Bay Areaa	Broader Sacramento Area
11.	*Mountain Counties*	*Broader Sacramento Area*
		San Joaquin Valley
		San Francisco Bay Area

Note: Authority cited: Sections 39600, 39601, 39610(a), Health and Safety Code. Reference: Section 39610(a), Health and Safety Code.

APPENDIX D

PROPOSED TEXT OF REGULATIONS
FOR MITIGATING THE UPWIND EMISSIONS
ON DOWNWIND OZONE CONCENTRATIONS

Amend Subchapter 1.5, Article 6, Section 70600, Title 17, California Code of Regulations, to read as follows (proposed additions are underlined and in italics, proposed deletions are struck out)[1]:

ARTICLE 6. TRANSPORT MITIGATION

70600. Emissions Control Requirements

Districts within the areas of origin of transported air pollutants, as identified in section 70500 (c), shall include sufficient emission control measures in their attainment plans for ozone adopted pursuant to Chapter 10 of the Health and Safety Code, Part 3, Division 26, beginning with section 40910, to mitigate the impact of pollution sources within their jurisdictions on ozone concentrations in downwind areas. At a minimum, the attainment plans for districts within the air basins or areas specified below shall conform to the following requirements:

(a) Broader Sacramento Area (as defined in section 70500 (b)(3)) shall:

(1) require the adoption and implementation of best available retrofit control technology, as defined in Health and Safety Code section 40406, on all existing stationary sources of ozone precursor emissions as expeditiously as practicable. At a minimum, the plan shall provide for the adoption of rules that represent best available retrofit control technology for source categories that collectively amount to 75 percent of the 1987 actual reactive hydrocarbon emission inventory for permitted stationary sources, and 75 percent of the 1987 actual nitrogen oxides emissions inventory for permitted stationary sources, no later than January 1, 1994.

1. At a March 11, 1993 public hearing, the Air Resources Board approved various amendments to section 70600. These amendments have not yet been formally approved by the Office of Administrative Law. To avoid confusion, the March 11, 1993 amendments have been included in the text of section 70600 shown here, but these amendments have not been separately highlighted. The full text of the March 11, 1993 amendments can be found in Appendix F of the Staff Report.

(2) include measures sufficient to attain the state ambient air quality standard for ozone by the earliest practicable date within the Upper Sacramento Valley _and that portion of the Mountain Counties Air Basin north of the Amador-El Dorado County border and south of the Sierra-Plumas County border_, except as provided in the Health and Safety Code section 41503(d), during air pollution episodes which the state board has determined meet the following conditions:

(A) are likely to produce a violation of the state ozone standard in the Upper Sacramento Valley _or that portion of the Mountain Counties Air Basin north of the Amador-El Dorado County border and south of the Sierra-Plumas County border; and_

(B) are dominated by overwhelming pollutant transport from the Broader Sacramento Area; and

(C) are not measurably affected by emissions of ozone precursors from sources within the Upper Sacramento Valley _or that portion of the Mountain Counties Air Basin north of the Amador-El Dorado County border and south of the Sierra-Plumas County border_.

(b) San Francisco Bay Area Air Basin shall:

(1) require the adoption and implementation of best available retrofit control technology, as defined in Health and Safety Code section 40406, on all existing stationary sources of ozone precursor emissions as expeditiously as practicable. At a minimum, the plan shall provide for the adoption of rules that represent best available retrofit control technology for source categories that collectively amount to 75 percent of the 1987 actual reactive hydrocarbon emission inventory for permitted stationary sources, and 75 percent of the 1987 actual nitrogen oxides emissions inventory for permitted stationary sources, no later than January 1, 1994.

(2) include measures sufficient to attain the state ambient air quality standard for ozone by the earliest practicable date within the North Central Coast Air Basin, _that portion of the Broader Sacramento Area west of the Yolo-Sacramento County border, and that portion of Stanislaus County west of Highway 33_, except as provided in the Health and Safety Code section 41503(d), during air pollution episodes which the state board has determined meet the following conditions:

(A) are likely to produce a violation of the state ozone standard in the North Central Coast Air Basin, _or that portion of the Broader Sacramento Area west of the_

Yolo-Sacramento County border, or that portion of Stanislaus County west of Highway 33; and

(B) are dominated by overwhelming pollutant transport from the San Francisco Bay Area Air Basin; *and*

(C) are not measurably affected by emissions of ozone precursors from sources within the North Central Coast, *or that portion of the Broader Sacramento Area west of the Yolo-Sacramento County border, or that portion of Stanislaus County west of Highway 33*.

(c) San Joaquin Valley Air Basin shall:

(1) require the adoption and implementation of best available retrofit control technology, as defined in Health and Safety Code section 40406, on all existing stationary sources of ozone precursor emissions as expeditiously as practicable. At a minimum, the plan shall provide for the adoption of rules that represent best available retrofit control technology for source categories that collectively amount to 75 percent of the 1987 actual reactive hydrocarbon emission inventory for permitted stationary sources, and 75 percent of the 1987 actual nitrogen oxides emissions inventory for permitted stationary sources, no later than January 1, 1994.

(2) include measures sufficient to attain the state ambient air quality standard for ozone by the earliest practicable date within the Southeast Desert Air Basin, ~~and~~ the Great Basin Valleys, *and that portion of the Mountain Counties Air Basin south of the Amador-El Dorado County border*, provided in the Health and Safety Code section 41503(d), during air pollution episodes which the state board has determined meet the following conditions:

(A) are likely to produce a violation of the state ozone standard in the Southeast Desert Air Basin, or the Great Basin Valleys, *or that portion of the Mountain Counties Air Basin south of the Amador-El Dorado County border; and*

(B) are dominated by transported pollutants from the San Joaquin Valley Air Basin; and

(C) are not measurably affected by emissions of ozone precursors from sources within the Southeast Desert Air Basin, or the Great Basin Valleys, *or that portion of the Mountain Counties Air Basin south of the Amador-El Dorado County border*.

(d) South Central Coast Air Basin south of the Santa Barbara-San Luis Obispo County border shall, for sources located in that portion of the Basin:

(1) require the adoption and implementation of best available retrofit control technology, as defined in Health and Safety Code section 40406, on all existing stationary sources of ozone precursor emissions as expeditiously as practicable. At a minimum, the plan shall provide for the adoption of rules that represent best available retrofit control technology for source categories that collectively amount to 75 percent of the 1987 actual reactive hydrocarbon emission inventory for permitted stationary sources, and 75 percent of the 1987 actual nitrogen oxides emissions inventory for permitted stationary sources, no later than January 1, 1994.

(e) South Coast Air Basin shall:

(1) require the adoption and implementation of best available retrofit control technology, as defined in Health and Safety Code section 40406, on all existing stationary sources of ozone precursor emissions as expeditiously as practicable. At a minimum, the plan shall provide for the adoption of rules that represent best available retrofit control technology for source categories that collectively amount to 75 percent of the 1987 actual reactive hydrocarbon emission inventory for permitted stationary sources, and 75 percent of the 1987 actual nitrogen oxides emissions inventory for permitted stationary sources, no later than January 1, 1994.

(2) include measures sufficient to attain the state ambient air quality standard for ozone by the earliest practicable date within the South Central Coast Air Basin south of the Santa Barbara-San Luis Obispo County border, the San Diego Air Basin, and the Southeast Desert Air Basin, except as provided in the Health and Safety Code section 41503(d), during air pollution episodes which the state board has determined meet the following conditions:

(A) are likely to produce a violation of the state ozone standard in the South Central Coast Air Basin south of the Santa Barbara-San Luis Obispo County border, or the San Diego Air Basin, or the Southeast Desert Air Basin; *and*

(B) are dominated by transported pollutants from the South Coast Air Basin; and

(C) are not measurably affected by emissions of ozone precursors from sources within the South Central Coast

PROPOSED TEXT OF REGULATIONS
FOR MITIGATING THE IMPACT OF UPWIND EMISSIONS
ON DOWNWIND OZONE CONCENTRATIONS.

Amend Subchapter 1.5. Air Basins and Air Quality Standards, of Chapter 1, Title 17, California Code of Regulations, sections 70600 and 70601, as follows:

ARTICLE 6. TRANSPORT MITIGATION

70600. Emission Control Requirements

Districts within the areas of origin of transported air pollutants, as identified in section 70500(c), shall include sufficient emission control measures in their attainment plans for ozone adopted pursuant to Chapter 10 of the Health and Safety Code, Part 3, Division 26, beginning with section 40910, to mitigate the impact of pollution sources within their jurisdictions on ozone concentrations in downwind areas. At a minimum, the attainment plans for districts within the air basins or areas specified below shall conform to the following requirements:

~~1.~~(a) Broader Sacramento Area (as defined in section 70500(b)(3)) shall:

(~~a~~1) require the adoption and implementation of best available retrofit control technology, as defined in Health and Safety code section 40406, on all existing stationary sources of ozone precursor emissions as expeditiously as practicable. At a minimum, the plan shall provide for the adoption of rules that represent best available retrofit control technology for source categories that collectively amount to 75 percent of the 1987 actual reactive hydrocarbon emission inventory for permitted stationary sources, and 75 percent of the 1987 actual nitrogen oxides emissions inventory for permitted stationary sources, no later than January 1, 1994.

~~(b2) provide for a permitting program designed to achieve no net increase in emissions of ozone precursors from all new or modified permitted stationary sources that have the potential to emit 10 tons per year or more of either oxides of nitrogen or reactive organic gases. Such program shall be adopted and implemented no later than July 1, 1991.~~

(~~c~~~~1~~2) include measures sufficient to attain the state ambient air quality standard for ozone by the earliest practicable date within the Upper Sacramento Valley, except as provided in Health and Safety Code section 41503(d), during air pollution episodes which the state board has determined meet the following conditions:

(~~1~~A) are likely to produce a violation of the state ozone standard in the Upper Sacramento Valley;

(~~2~~B) are dominated by overwhelming pollutant transport from the Broader Sacramento Area; and

(~~3~~C) are not measurably affected by emissions of ozone precursors from sources located within the Upper Sacramento Valley.

~~2.~~(b) San Francisco Bay Area Air Basin shall:

(~~a~~1) require the adoption and implementation of best available retrofit control technology, as defined in Health and Safety Code section 40406, on all existing stationary sources of ozone precursor emissions as expeditiously as practicable. At a minimum, the plan shall provide for the adoption of rules that represent best available retrofit control technology for source categories that collectively amount to 75 percent of the 1987 actual reactive hydrocarbon emissions inventory for permitted stationary sources, and 75 percent of the 1987 actual nitrogen oxides emissions inventory for permitted stationary sources, no later than January 1, 1994.

~~(b2) provide for a permitting program designed to achieve no net increase in emissions of ozone precursors from all new or modified permitted stationary sources that have the potential to emit 10 tons per year or more of either oxides of nitrogen or reactive organic gases. Such program shall be adopted and implemented no later than July 1, 1991.~~

(~~c~~2) include measures sufficient to attain the state ambient air quality standard for ozone by the earliest practicable date within the North Central Coast Air Basin, except as provided in Health and Safety Code section 41503(d), during air pollution episodes which the state board has determined meet the following conditions:

(~~1~~A) are likely to produce a violation of the state ozone standard in the North Central Coast Air Basin;

(~~2~~B) are dominated by overwhelming pollutant transport from the San Francisco Bay Area Air Basin; and

(~~3~~C) are not measurably affected by emissions of ozone precursors from sources located within the North Central Coast Air Basin.

~~3.~~(c) San Joaquin Valley Air Basin shall:

(~~a~~1) require the adoption and implementation of best available retrofit control technology, as defined in Health and Safety Code section 40406, on all existing stationary sources of ozone precursor emissions as expeditiously as practicable. At a minimum, the plan shall provide for the adoption of rules that represent best available retrofit control technology for source categories that collectively amount to 75 percent of the 1987 actual reactive hydrocarbon emissions inventory for permitted stationary sources, and 75 percent of the 1987 actual nitrogen oxides emissions inventory for permitted stationary sources, no later than January 1, 1994.

~~(b2) provide for a permitting program designed to achieve no net increase in emissions of ozone precursors from all new or modified permitted stationary sources that have the potential to emit 10 tons per year or more of either oxides of nitrogen or reactive organic gases. Such program shall be adopted and implemented no later than July 1, 1991.~~

(~~c3~~2) include measures sufficient to attain the state ambient air quality standard for ozone by the earliest practicable date within the Southeast Desert Air Basin and the Great Basin Valleys, except as provided in Health and Safety Code section 41503(d), during air pollution episodes which the state board has determined meet the following conditions:

(~~1~~A) are likely to produce a violation of the state ozone standard in the Southeast Desert Air Basin or the Great Basin Valley;

(~~2~~B) are dominated by transported pollutants from the San Joaquin Valley Air Basin; and

(~~3~~C) are not measurably affected by emissions of ozone precursors from sources located within the Southeast Desert Air Basin or the Great Basin Valleys, as applicable.

~~4.~~(d) South Central Coast Air Basin south of the Santa Barbara-San Luis Obispo County border shall, for sources located in that portion of the Basin:

(~~a~~1) require the adoption and implementation of best available retrofit control technology, as defined in Health and Safety Code section 40406, on all existing stationary sources of ozone precursor emissions as expedituously as practicable. At a minimum, the plan shall provide for the adoption of rules that represent best available retrofit control technology for source categories that collectively amount to 75 percent of the 1987 actual reactive hydrocarbon emissions inventory for permitted stationary sources, and 75 percent of the 1987 actual nitrogen

~~(b2) provide for a permitting program designed to achieve no net increase in emissions of ozone precursors from all new or modified permitted stationary sources that have the potential to emit 10 tons per year or more of either oxides of nitrogen or reactive organic gases. Such program shall be adopted and implemented no later than July 1, 1991.~~

~~5.~~<u>(e)</u> South Coast Air Basin shall:

(a<u>1</u>) require the adoption and implementation of best available retrofit control technology, as defined in Health and Safety Code section 40406, on all existing stationary sources of ozone precursor emissions as expeditiously as practicable. At a minimum, the plan shall provide for the adoption of rules that represent best available retrofit control technology for source categories that collectively amount to 75 percent of the 1987 actual reactive hydrocarbon emissions inventory for permitted stationary sources, and 75 percent of the 1987 actual nitrogen oxides emissions inventory for permitted stationary sources, no later than January 1, 1994.

~~(b2) provide for a permitting program designed to achieve no net increase in emissions of ozone precursors from all new or modified permitted stationary sources. Such program shall be adopted and implemented no later than July 1, 1991.~~

(~~c3~~<u>2</u>) include measures sufficient to attain the state ambient air quality for ozone by the earliest practicable date within the portions of the South Central Coast Air Basin south of the Santa Barbara-San Luis Obispo County border, the San Diego Air Basin, and the Southeast Desert Air Basin, except as provided in Health and Safety Code section 41503(d), during air pollution episodes which the state board has determined meet the following conditions:

(~~1~~<u>A</u>) are likely to produce a violation of the state ozone standard in the South Central Coast Air Basin south of the Santa Barbara-San Luis Obispo County border, or in the San Diego Air Basin, or in the Southeast Desert Air Basin;

(~~2~~<u>B</u>) are dominated by transported pollutants from the South Coast Air Basin; and

(~~3~~<u>C</u>) are not measurably affected by emissions of ozone precursors from sources located within the South Central Coast Air Basin south of the Santa Barbara-San Luis Obispo County border, or the San Diego Air Basin, or the Southeast Desert Air Basin, as applicable.

NOTE: **AUTHORITY CITED: SECTIONS 39601, 39610(b), HEALTH AND SAFETY CODE. REFERENCES CITED: SECTIONS 39610, ~~40911(b),~~ 40912, 40913, 40921 AND 41503, HEALTH AND SAFETY CODE.**

70601. Procedure For Limiting the Application of Best Available Retrofit Control Technology

A district may exclude one or more sources from the requirement to apply best available retrofit control technology as transport mitigation pursuant to section 70600 provided that the district plan prepared pursuant to Part 3, Chapter 10 (commencing with section 40910) of Division 26 of the Health and Safety Code and approved by the Board pursuant to Part 4, Chapter 1 (commencing with section 41500) of Division 26 of the Health and Safety Code demonstrates that:

(a) emissions from the source, because of its location, do not contribute to ozone violations in any downwind area; or

(b) emissions reductions from the source are not needed to attain the ozone standard in any downwind area; or

(c) the district is implementing an alternative emission reduction strategy pursuant to section 40914 of the Health and Safety Code and that strategy will be at least as effective and as expeditious as the transport mitigation requirements specified in section 70600.

NOTE: **AUTHORITY CITED: SECTIONS 39601, 39610(b), HEALTH AND SAFETY CODE. REFERENCES CITED: SECTIONS 39610, ~~40911(b),~~ 40912, 40913, 40921 AND 41503, HEALTH AND SAFETY CODE.**