CONTROL OF HYDROCARBON EMISSIONS FROM STATIONARY SOURCES IN THE CALIFORNIA SOUTH COAST AIR BASIN

KVB 5804-714

FINAL REPORT, VOLUME I
(VOLUME II, APPENDIX)

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ABSTRACT

To provide detailed data for modeling the photochemical formation of atmospheric oxidants and information on which to base comprehensive control strategy, an inventory of gaseous organic emissions from stationary sources was conducted in the California South Coast Air Basin. Unlike most organic emissions inventories in the past, this one included the development of emission profiles, i.e., a breakdown of the individual organic species which contributed at least 1% of the total organic emissions from each source. Based on a comprehensive field sampling and laboratory GC-MS analytical program, as well as survey and literature data, 140 unique emission profiles were developed to describe hydrocarbon emissions for 740 SCC/SIC categories. The various profiles identified from one to thirty different species.

The inventory accounted for all known stationary source organic emissions including major and minor point sources, and area sources (oil production fields, architectural coatings, domestic solvent usage, etc.). The inventory was prepared in the EPA's Emission Inventory Subsystem (EIS) format. All sources were located by Universal Transverse Mercator (UTM) coordinates.

Also, a study of available control techniques for organic emission for various applications was performed. Control technique descriptions, application considerations and cost effectiveness data were compiled.

Finally, a prediction of emission trends based on expected growth and control strategies was made.

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SECTION 1.0

OVERVIEW

1.1 INTRODUCTION

Organic compounds emitted from stationary sources contribute to the formation of smog in the atmosphere. These compounds (often referred to as hydrocarbons) react photochemically with oxides of nitrogen, another pollutant, to form oxidants, a pollutant which irritates human tissue and causes damage to plant life. Organic pollutants also react with each other in the atmosphere to form long chain organic molecules which contribute to the atmospheric aerosol, another constituent of smog, which limits visibility. The ability of the various organic compounds to form oxidants or organic particulate matter varies with each specie of hydrocarbon and the measure of this ability is referred to as reactivity.

For some time scientists have been measuring the reactivity of organic compounds (with regard to both oxidant and aerosol formation) using smog chambers to simulate atmospheric conditions. Prior to this program, the actual hydrocarbon emissions from stationary sources had not been characterized by species. Only the total organic emissions or at best the methane/non-methane composition (also referred to respectively as "non-reactive" and "reactive" hydrocarbons) were available in existing inventories.

In order to develop an organic emission control strategy for the California South Coast Air Basin,* the ARB initiated this program to inventory organic compound emissions from stationary sources, investigate control technology and forecast emissions for the next ten years. The inventory would reveal which compounds are being emitted by various sources and where they are located. It would also specify the reactivity of those compounds according to a three-class scheme developed by the ARB. It was to account for all

*The South Coast Air Basin for the purposes of this study includes part of Santa Barbara, Ventura, Los Angeles, Orange, Riverside, and San Bernardino Counties.

organic emissions from point, area, anthropogenic, and natural sources. Sources were to be categorized by application (the ARB-specified application categories) and by location. Each source was to be located geographically by Universal Transverse Mercator (UTM) coordinates, and the sources were to be grouped into ten-kilometer grid squares. Other portions of the study would reveal what could be done to reduce the objectionable species.

Later in the program, a requirement was added to present the inventory data in the Emission Inventory Subsystem, Permit and Registration (EIS/P&R) format. EIS/P&R (hereafter referred to as EIS -- a computerized data system) was developed by the EPA to be used by all local and state agencies for their own records as well as to provide data to a national data bank. Another added requirement was the reporting of emissions, specie by specie, for each one kilometer grid square in the Basin.

1.2 SUMMARY AND CONCLUSIONS

In order to accomplish these objectives, the first steps were to prepare a preliminary inventory of total organics (without specific species), to identify the major sources, and to determine the distribution of emissions among the various source types.

Next, a field test program was conducted to characterize emissions from sources selected on the basis of the preliminary inventory, emphasizing those source types comprising the greater amount of the emissions. Organic species contributing at least 1% of the total organic composition were identified using GC/MS analysis. Over 600 samples were collected and analyzed from various equipment in the following locations:

Adhesives Mfg. Plant
Aircraft Plant (2)
Appliance Plant (2)
Asphalt Plant
Auto Body Shop (2)
Automobile Plant (2)
Chemical Plant (2)
Dry Cleaning Plant
Equipment Mfg. (2)
Gas Compressor Plant
Gas Pumping Station
Gasoline Station
Landfill
Magnetic Tape Plant
Oil Field (2)
Oil Refinery (3)
Packaging Mfg. Plant
Printing Plant (2)
Roofing Kettle
Rubber Mfg.
Solvent Mfg. Plant
Steel Mill
Utility Boiler
Utility Gas Turbine

Equipment tested included:

Adhesive Spray Booth
API Separator (6)
Asphalt Paving
Basic Oxygen Furnace
Blast Furnace
Charcoal Adsorbers (4)
Chemical Mill
Chemical Process
Chemical Transfer
Coke Oven
Compressors (28)
Cooling Tower (2)
Degrease Tank (11)
Dip Tank
Dry Clean Tumbler
Drying Ovens (8)
Fiberglass Impregnation (2)
Filling Rack
Flow Coater (2)
Gravure Press (5)
Heater Treater
I.C. Engines (6)
Incinerator (10)
Lithograph (3)
Open Hearth Furnace
Paint Booth (32)
Precip. Outlets
Printed Circuit Board Proc.
Process Heater (3)
Pumps (200)
Rubber Process (3)
Sintering Plant
Sludge Incinerator
Storage Tank (5) (Species only)
Sumps (6)
Valves (24,000)
Vapor Recovery Tank to Car (8)
Vapor Recovery Truck to Tank
Well heads (5)

In addition to direct source sampling, one attempt was made to characterize emissions from a refinery, a complex point source, by collecting and analyzing air samples taken upwind and downwind of the refinery. Diffusion

modeling techniques were used to predict emission factors from the refinery. The resulting emissions predicted by this indirect technique were lower than those determined by direct source methods by an order of magnitude. This was probably caused by vertical dispersion of the hydrocarbon emissions, which could not be adequately detected by fenceline measurements.

Test results were augmented by questionnaire responses and literature data to establish both emission factors and emission profiles (percent composition by weight). One hundred forty unique emission profiles for point and area sources were developed. These 140 profiles covered 740 different combinations of device category (SCC No.) and industry category (SIC No.). Where possible, emission factors, determined from field tests, were compared for validity with factors contained in AP-42, and those in the SCAQMD data base. No existing emission factors were found for oil production, IC engines, and landfills.

Coincident with this work, the South Coast Air Quality Management District (SCAQMD) (Los Angeles, Orange, Riverside, and San Bernardino Counties), and the Ventura and Santa Barbara County Air Pollution Control Districts (VAPCD and SBAPCD) were compiling new EIS files for their individual districts. These County EIS data files were provided to KVB, Inc. by the ARB, along with a breakdown of population data for the Basin in 1 Km grid squares.

The last step in the program was to generate a final inventory. The EIS data were the basis for this KVB final inventory. The emission factors used in the EIS files were reviewed by KVB and adjusted where necessary by applying correction factors determined from source tests to specific sources or to a group of sources identified with a certain Source Classification Code (SCC) number. The 140 emission profiles were also keyed to the sources. In addition, sources not contained in the EIS files, primarily area sources, were added to the data base.

The final inventory was delivered to the ARB under separate cover as computer printouts and magnetic tape files. The primary elements are as follows:

1. A Total Organic Emission Report by ARB Application Category
2. A Total Organic Emission Report by Ten-Km Grid Squares
3. An Emission Profile Listing

4. An Emission Summary Report for Each One Km Grid Square
5. An Individual Organic Specie Report by Application Category
6. A Point Source Emission File in EIS Format (Tape)
7. An Emission Profile File (Tape)
8. An Area Source File (Tape)
9. Miscellaneous Indexes, Listings and Files (Tapes) to Support the Items Above

The inventory which has a baseline of 1975-1976, shows total hydrocarbon emissions of 2200 ton/day of which one-half is methane. Point sources (major and minor) account for 350 ton/day and area sources account for 1850 ton/day total hydrocarbon emissions.

The petroleum industry accounts for 20% of the total emissions; 110 ton/day from production, 120 ton/day from refining and 190 ton/day from marketing. Solvent use accounts for another 10% of the organic emissions.

The largest source category is landfills, which account for over 40% of the total emissions, 930 tons/day, and are 99% methane, which is photochemically non-reactive. Natural terpene emissions from forest and scrub vegetation account for 15% of the total emissions, 300 ton/day. These emissions occur at the perimeter of the Basin and downwind of the central populated area, therefore, their contribution to smog formation in the metropolitan area is probably of much less significance than the anthropogenic emissions.

The primary organic species emitted are:

	Ton/Day (Avg.)
Methane	1100
Terpenes	300
Pentane	80
Butane	70
Hexane	60
Perchloroethylene	50
Ethane	50
Propane	40
Isopropyl Alcohol	30
Toluene	30

The emissions of compounds rated as Class 3, highest photochemical reactivity, account for 500 ton/day, of which 300 ton/day are natural terpenes. Other Class 3 emissions include:

	Ton/Day
Isopropyl Alcohol	30
Toluene	30
Ethylene	20
Ethyl Alcohol	20
Xylene	15
Pentene	10
Butyl Alcohol	6
Glycol Ether	6
Formaldehyde	6
Propylene	4

A breakdown of the sources of individual species emissions by 13 application categories (i.e., petroleum refinery, solvent use, combustion of fuel, etc.) is provided in Section 2.4.

In addition to the emission inventory, an investigation of control techniques for various application categories was performed. Control techniques described in this report include:

a. Activated carbon adsorption systems

b. Thermal and catalytic incinerators

c. Vapor condensation systems

d. Scrubbers (absorption systems)

e. Vapor space elimination (e.g., floating roof tanks)

f. Liquid/vapor exchange systems for fluid transfer

g. Enclosure (covering drains, sewers and separators)

h. Process and material changes (e.g., solvent substitutions, high solids coatings, etc.)

i. Improved maintenance.

Over 60 industrial and commercial processes are considered. For each process, applicable control techniques are identified. Finally, cost effectiveness data ($/unit weight of pollutant reduced) are developed for the techniques listed above.

With so many different processes and plant configurations involved, it is possible to determine most cost effective control technology only on a plant-by-plant basis. For the control of organic emissions from exhaust stacks, without a change in the basic process, activated carbon adsorbers and incinerators are the preferred add-on devices. For low hydrocarbon concentrations (around 100 ppm), carbon adsorption is more economical. For control of high concentrations (around 25% of the lower explosion limit, i.e., 12,000 ppm for hexane), carbon adsorption is both economical and can produce a profit if recovered solvents can be reused or sold. If the organic material cannot be reused, then for the high concentrations, incineration with primary heat recovery (using combustion gases to heat the incoming air/organic stream) is more economical than adsorption. Also, in general, it is more cost effective to control streams of high concentrations than of low concentrations. Between concentrations of 100 ppm and 10,000 ppm, the difference in cost effectiveness could be a factor of 10.

The conversion of architectural and industrial coatings to waterborne and solventless formulations should continue at the current rate over the next ten years. The pacing items are (1) necessary research to develop materials, (2) rate of facility obsolescence (i.e., replacing old facilities with ones incorporating provisions for low emission coatings), and (3) public resistance to change.

A ten-year forecast of organic emissions in the Basin indicates that the anthropogenic emissions will decline by 65% by 1986. Anthropogenic methane emissions will probably be reduced by 50% while non-methane emissions will be reduced by 70% since most control methods are less effective on methane than on non-methane emissions. A projection of natural emissions was beyond the program scope.

This report consists of four sections. Section 2.0 deals with the emission inventory describing the data sources and presents the detailed data used in its compilation. Various summary tables and plots are also

presented. Section 3.0 deals with the field test program presenting sampling and analysis methodology, test results and an assessment of data quality. Section 4.0 is a summary of control technology state-of-the-art. Of major interest is Section 4.4 which provides cost effectiveness data for using control techniques. Finally, a prediction of future emission trends is presented in Section 5.0 based on expected industrial and population growth, control technology implementation, and control legislation.

1.3 RECOMMENDATIONS FOR FURTHER RESEARCH

1.3.1 Standard Procedures for Organic Emission Measurement

The measurement techniques employed on this program met the objectives of characterizing typical emissions. The techniques were of necessity universal in application, covering emissions of pure hydrocarbons as well as organic compounds containing oxygen, nitrogen, halogens, etc. If future control strategy involves placing a limitation on organic emissons, then some measurement standards must be established similar to those now specified in the Federal Register for NOx, SOx, particulates, H_2S, etc.

It was observed on this program that the collection and recovery of certain species was dependent on the techniques employed. Some materials used in sampling trains like plastic tubing are known to adsorb certain compounds. These are avoided in the KVB sampling train. Heating the collector to release the sample is effective on certain compounds but causes others to undergo a chemical change. Some types of GC columns are more effective than others for separating certain compounds. Also, a GC will have different responses to various compounds. Certain oxygenated compounds such as aldehydes and carboxylic acids essentially fail to respond while esters, ketones, alcohols, ethers, and alicyclics behave as pur hydrocarbons. While the GC used on this program was calibrated for varying responses for known compounds, it is possible that certain unexpected compounds may have gone undetected. On certain solvent sources such as automobile painting, there seems to be a surprising lack of oxygenated compounds.

Therefore it is recommended that a research program be conducted to define specific equipment and procedures for measuring the various classes of organic compounds. The program must include sufficient evaluation testing of the selected techniques to establish values of accuracy and precision.

The EPA is aware of this need and is sponsoring some work in this area. They have divided the organic emissions into three categories: (1) synthetic organic compounds, (2) oxygenated solvents, and (3) pure hydrocarbon compounds. Procedure work books are being prepared for Category (1). Category (3) has not been handled yet but is admittedly routine. They are without a good answer on Category (2) which is the situation in which KVB has also found itself. One aspect that EPA is not addressing is speciation. They are only interested in measuring methane, ethane, and total organics. For use in the Basin, specific compound identification would be desirable.

1.3.2 Investigation of Organic Solvent Emissions from Paint Spray Booths

Emissions from paint spray booths have been estimated based on paint usage times the fraction of solvent in the paint. Attempts at a material balance in measuring actual emissions indicate that the calculation method may produce higher results. Many oxygenated solvents are water miscible and their vapors may be absorbed by water curtains used in spray booths to collect overspray. These oxygenated solvent vapors may also be missed by GC analysis.

Another interesting observation made on this program is that the emissions from water-based paint operations in an automobile assembly plant are similar in tonnage and reactivity to those from a similar solvent-based painting operation.

Therefore it is recommended that a research program be conducted to characterize the release of organic emissions from new automobile painting operations comparing those using water-based and solvent-based paints.

1.3.3 Development of Measuring Techniques for Evaporative Emissions from Petroleum Sources

Separators, ponds, cellars, sewers, and cooling towers appear to be significant sources of hydrocarbon emissions. Attempts to characterize emissions from these sources on this program met with varied results. Consultation with other investigators in the field revealed similar frustrations. Future control strategy may require establishment and enforcement of maximum emission level from evaporative sources.

Therefore, it is recommended that research be conducted to develop reliable measurement techniques for evaporative sources of hydrocarbon emissions.

1.3.4 Gasoline Marketing Data

Because gasoline marketing is one of the large sources of hydrocarbon emissions in the Basin, the control of these emissions with vapor recovery systems is an important part of any air quality improvement strategy. To handle the control of such a large number of sources, a computerized system would be a great convenience. A source of computerized information regarding gasoline station location, throughput rate, hours of operation, etc. exists in a private company, Lundberg Surveys, North Hollywood, California, who update the data regularly and sell this information to oil companies as printed reports. While their computer tapes are jealously guarded with regard to other private industries, it is possible that a magnetic tape version of this report could be obtained for government purposes.

Therefore, it is recommended that the Lundberg Survey tapes be secured to support the control of gasoline station hydrocarbon emissions.

1.3.5 Development of an Organic Compound Flux Gage

Because of the difficulties encountered in measuring organic emissions from large evaporative sources such as storage tanks as well as separators, cooling towers, etc. as mentioned above, an instrument which could measure the flow of hydrocarbon vapors would be useful. Devices exist to measure concentrations of organic vapors in the form of sniffers. The proposed device would measure the vapor flow in weight per unit area per unit time. KVB began the development of such a device under WOGA sponsorship at a low funding level, but the project was later terminated because it appeared that it would require some extensive development just to evaluate the proposed concept. The KVB instrument was based on using two cryogenically cooled quartz crystals to collect and weigh the organic vapor. Whether or not the quartz crystal microbalance approach is feasible, some method of measuring flux should be investigated and, if possible, developed.

Therefore, it is recommended that a laboratory research program be conducted to investigate the feasibility of developing an organic vapor flux-measuring instrument. The program should include the development of a prototype unit capable of being evaluated in the field.

1.3.6 Oil Field and Off-Shore Platform Emissions

KVB estimated oil production emissions based on emission factors developed from field tests at two oil fields. These factors were applied on a per-well basis using the California Divison of Oil and Gas information on the number and location of oil wells. This was the best estimate that could be made within the program budget limitations. Previous inventories had ignored this significant area source.

A more thorough program would involve an inventory of oil field equipment throughout the Basin and further testing to support component emission factors. The API is currently sponsoring a program to develop oil production emission factors. However, most of their testing will be in oil fields and off-shore platforms on the Gulf of Mexico coast. An equipment inventory for the Basin will still be required. The APCDs have performed only a limited amount of inventory work on oil field emissions.

Therefore, it is recommended that further research be conducted to characterize oil field emissions. The program should include an inventory of equipment and testing as necessary to develop or confirm emission factors for the equipment identified.

1.3.7 Emissions from Stationary IC Engines

The KVB inventory identifies IC engines greater than 30 HP because they require permits and are in the EIS file. Smaller engines are used throughout the Basin and do not require permits. Each oil well at the Huntington Beach field has a 60-HP engine. There was not enough time to conduct an inventory of these small engines.

The organic emission factors in AP-42 were based on engines much larger than those normally found in the Basin. KVB's limited testing showed little agreement with the AP-42 values.

Therefore, it is recommended that an inventory be made of IC engines in the Basin and that selected testing be performed to develop emission factors. In addition to organic emissions, NOx should be measured to check emission factors which were questioned in KVB's NOx inventory report to the ARB.

The SCAQMD is currently engaged in an effort to locate these engines. Depending on their success, this may fulfill the inventory need. A program to develop emission factors would still be appropriate.

1.3.8 Refinery Maintenance

As discussed in Section 4.0, the cost/benefits of a special emission-control maintenance program in a refinery are debatable. KVB could only afford a few exploratory tests which revealed some potential for significant benefits to be achieved by such a program.

Therefore it is recommended that a special research program be conducted to determine what the cost/benefit ratio would be for a program in which a maintenance crew were dispatched on a continuing basis to detect and correct any leaks that exist. The program should determine optimum crew size, frequency of surveillance, and recommendations for equipment and techniques to be employed. The feasibility of such a program would be determined based on estimates of costs and emission reduction tonnage.

SECTION 2.0

INVENTORY

2.1 DATA SOURCES

The data used in this organic emission inventory were obtained from the following sources:

1. Various government agency files
2. Field testing
3. Questionnaires
4. Literature
5. Engineering analyses
6. Personal contacts with government and industry personnel.

All county enforcement agencies were in the process of a total recompilation of their permit files using the EPA's EIS/P&R* (Ref. 2-1) format (referred to as EIS hereafter) during the period of this inventory. The computerized permit file from Los Angeles County and the permit files from the other counties were used to obtain data for the preliminary inventory. It was planned that the final inventory would be compiled using the new EIS data base for the major point sources as soon as data entry was completed and checked for all counties in the inventory. The following key data were contained in the EIS data base:

1. Plant name, address, ID No., etc.
2. Standard Industrial Code (SIC)
3. Source Classification Codes (SCC)
4. UTM Coordinates
5. Stack Height
6. Pollutant Identification
7. Emission Factor
8. Throughput Rates

*Emission Inventory Subsystems/Permit and Registration

9. Estimated emissions
10. Seasonal variations
11. Operating period (hr/day, day/week, week/yr)

For minor sources in LA County, the original permit file was used. Also a computer tape file of gasoline station locations in LA County was received from the SC AQMD. Both of these files had location coordinates on a one mile square grid basis. The ARB provided an algorithm for converting the one-mile grid to UTM coordinates (Ref. 2-2).

The ARB also provided a tape file of population by UTM coordinates which was used to distribute population related area source emissions.

Field test data were used to formulate emission profiles and to develop emission factors for new sources or check those factors on sources already characterized by the districts or the EPA in AP-42 (Ref. 2-3).

Questionnaires were received from approximately 100 industrial sources with comprehensive data on their solvent and fuel usage. Data received were used to develop emission profiles and to check values contained in the district files.

There was a great deal of activity in the area of organic emission assessment by other agencies and contractors. A list of those programs which provided valuable data for this inventory are summarized in Table 1. Excellent cooperation and data exchange were maintained with those contractors and agencies listed.

Other sources of information included personal contacts with various industry associations (dry cleaning, refinery, asphalt, printing, etc.) and government agencies (especially the ARB, California Division of Oil and Gas, EPA Office of Air Quality Planning and Standards in Durham, EPA Region 9, local air pollution districts and the Southern California Association of Governments, SCAG).

From data received from the above sources, comprehensive analyses were conducted to derive emission profiles in a form compatible with the inventory format. Analyses of test data from this and related programs listed in Table 2-1 were performed to create or evaluate existing emission factors.

TABLE 2-1. RELATED STUDIES ON ORGANIC COMPOUND EMISSIONS

Project Title	Scope	Sponsor*	Contractor	Status (as of Mid 1977)
Air Quality Impacts of Outer Continental Shelf Oil Development in the Santa Barbara Channel	Assess the impacts of OCS development on the environment	OPR	OPR Staff & ERT, Inc.	Final Report Draft issued March 1977
Fugitive Emissions from Oil Field Production Operations	Determine emission factors on a component basis for onshore and offshore facilities	API	Rockwell Air Monitoring Center	Work plan being developed
Assessment of the Environmental Effluents from Oil Refining	Determine validity of refinery emission factors currently used in AP-42	EPA	Radian, Inc.	Tests are currently being conducted in second refinery
Emissions from Ships and Shipping Operation including Transfer of Oil	Determine emissions from shipping operations in the SCAB	ARB	Scott Research Laboratory	Work plan being developed
Hydrocarbon Emissions from Floating Roof Petroleum Tanks	Determine validity of AP 2517	WOGA	Engineering Science, Inc.	Final Report released Jan. 1977
Hydrocarbon Emissions from Fixed Roof Tanks	Assess the validity of AP 2518	WOGA	Engineering Science, Inc.	Final Report released July, 1977
Hydrocarbon Emissions from Tanker Loading Operations	Determine HC emissions resulting from crude oil loading off Ventura and Santa Barbara counties	WOGA	Chevron Research, Inc.	Final Report originally scheduled for May 1977

TABLE 2-1 (Cont)

Project Title	Scope	Sponsor*	Contractor	Status (as of Mid 1977)
Floating Roof Tank Metallic Sealing Ring Emission Test Program	Determine effects of wind, ring quality, gap size and secondary seals on HC emissions	WOGA	Chicago Bridge and Iron	Final Report issued March 1977
Organic Compound Emissions From Natural Sources	Determine natural emission rates from forest vegetation	EPA	Washington State University	Final draft completed
Emission Factors from Burning Agricultural Wastes Collected in California	Determine emission factors from burning 31 field and orchard crops	ARB	UCR Statewide Air Pollution Research Center	Final Report, January 1977
ORGSOL Regulation Study Group Architectural Coatings Survey	Determine potential reduction of organic emission using H_2O borne paints	ARB	ARB Staff	Staff report issued June 1977
A Methodology for Reactive Organic Gas Emissions: Assessment of Pesticide Usage in California	Determine HC emissions from pesticide applications	ARB	ARB Staff	Report due August 1977
Gasoline Marketing Vapor Recovery System Development	Determine test procedures to assess the effectiveness of vapor recovery techniques applied to petroleum marketing	SDAPCD	SDAPCD	Test continuing

TABLE 2-1 (Cont)

Project Title	Scope	Sponsor*	Contractor	Status (as of Mid 1977)
Measurement of Atmospheric Organic Emission from Natural Sources	Determine HC emission factors from asphalt operations and landfills	EPA	Midwest Research Institute	Preliminary tests underway
Control of Volatile Organic Emissions for Existing Stationary Source	Preparation of documents for control of organic emissions	EPA	EPA Air Program Staff	Volume 1 issued November 1976. Future volumes to be released late 1977.

Abbreviation Code:

OPR - California Governor's Office of Planning and Research, Sacramento, Calif.

API - American Petroleum Institute, Washington, DC

EPA - U.S. Environmental Protection Agency, Research Triangle Park, North Carolina

ARB - Air Resources Board, Sacramento, Calif.

WOGA - Western Oil & Gas Association, Los Angeles, Calif.

SDAPCD - San Diego Air Pollution Control District, San Diego, Calif.

2.2 DATA MANAGEMENT

The data to be processed as part of the final organic emission included:

1. EIS data for major point sources for SCAQMD
2. Minor point source data from the SCAQMD (Metro Zone)
3. Gasoline station data for SCAQMD (Metro Zone)
4. EIS data for Ventura and Santa Barbara County (major and minor sources including gasoline stations)
5. Petroleum production field
6. Additional area data for sources such as forests, landfills, architectural coating, domestic solvent use, etc.
7. Emission profiles
8. Population distribution by one kilometer grid
9. Emission factor adjustments to EIS data

The available EIS data processing software was incorporated for processing the EIS data. In this system individual sources could be modified, added or deleted. KVB added a feature which also permitted the data to be modified by SCC number. For example, the emissions in the EIS data base from certain fixed roof tanks (identified by a specific SCC number) appeared to be too high based on recent test data. The emissions from those tanks were modified by one correction factor applied to all the emissions of that specific SCC number.

The profile data was organized with SCC number as the key. The specific organic specie emissions for any source were determined by factoring the total source emissions by the profile of specie weight percentages.

Area source emission rates were added to the EIS data file using the emission factor and inventories presented in Section 2.3.4. These sources, including natural emissions, architectural surface coatings, and gasoline marketing, constituted a large portion of the total emissions in the Basin. Since a standard format was not yet available for describing emissions not meeting the EIS point source criteria, KVB chose to develop an area source data base for this purpose based on general guidelines proposed by the ARB (Ref. 2-4). The format was designed to allow description of emissions by their one kilometer grid location and process (or activity).

Gasoline marketing data for this data base were acquired in three ways. In Los Angeles County, information concerning 10,000 stations in the Basin was computerized; however, individual station throughputs were missing. KVB chose to take the total sales for Los Angeles County and apportion the through-put by the total storage tank volume at each station. For Ventura County the gas station data were included in the EIS file. For consistency, KVB chose to take these EIS data and format them as the Los Angeles County data with the gas station locations and throughputs retained. KVB assigned new emission factors to the data. For the remaining counties the gas station emissions were apportioned by residential area based on the total county sales. These gas station data were formatted in the KVB area source format.

Since the EIS point source data base did not contain the organic emissions for minor point sources under permit in L.A. County (Metro Zone), these data were acquired from Metro Zone's permit files and formatted in the KVB area source format. Data on the emissions from minor point sources not under permit were also obtained and included in the KVB area source data base.

Finally the KVB area source data base contained data from all area sources identified by the KVB engineers. These emission sources included waste disposal, petroleum operations other than refining, domestic and agricultural sources, geogenic sources and natural emissions.

All point sources in the inventory were given an SCC number which was occasionally qualified by the SIC number. For area sources, process codes devised by the ARB Staff were used in lieu of SCC numbers. A file was created with all information relative to these SCC numbers (or process codes), the emission correction factors to be applied to all sources with the given SCC/SIC number; the profile key to identify the profile for this source type, the relevant ARB application category, and summer or winter differentials to be used to alter emissions seasonally if warranted by the source type. This SCC file was used as the major system link between sources and their profiles.

Within each ARB application category only unique profiles were identified. The profile records contained information concerning the method of determining the profile and estimated error. In addition, each profile contained the SAROAD code and percent by weight of each specie in the profile. Where the SAROAD coding was not comprehensive, KVB and their subcontractor, ARLI, added SAROAD codes in a logical manner. Since SAROAD codes were the only specie identifier in the profile data base, a separate tabular file was created to contain SAROAD codes, species name, molecular weights and ARB reactivity class.

From the data files used in this inventory, eight reports were produced. They included:

1. A Total Organic Emission Report containing:

   a. Source information (county, APCD Point ID No., SSC No., SIC No.)

   b. Total organic emissions, ton/year

   c. Summer emissions, ton/day, broken down into weekday emissions and weekend emissions

   d. Winter emissions, ton/day, broken down into weekday emissions and weekend emissions

   e. Emission profile key which will relate to an emissions species breakdown in Item 2 below.

   These data were reported in two sorted orders:

   a. According to the ARB application categories and including point and area sources (Report #1)

   b. According to location in 10 Km UTM grid squares and including point and area sources (Report #2)

   A plant identification index (Report #3)

2. An Emission Profile Listing which lists each organic specie (by name and code no.) emitted by a particular source or source type, the reactivity class (according to the ARB's 3-class system) of that specie, and the percent by weight of the total emitted hydrocarbons that the specie contributes (Report #4).

3. An Emission Summary consisting of the following data for each 1 Km grid square in the Basin (Report #5):

   a. Total organic emissions, ton/year

   b. Individual specie emissions by code no., lb/year

   c. Emissions for each reactivity class: I, II, and III, ton/year

4. An Individual Organic Specie Report showing the emission of each specie broken down by ARB Application Categories (Report #6).

5. An SCC report listing the profile keys, application and emission correction factors for all SCC codes encountered in the source files reported in two sorted orders:

   a. By SCC code (Report #7)

   b. By profile key in order to reference all SCC codes attributed to a given profile (Report #8).

A more detailed description of these reports is presented in Section 2.4.1.

In addition to these reports which were delivered to ARB under separate cover as computer printouts, the following data files were prepared and submitted to ARB on IBM compatible magnetic tape:

1. An updated (for hydrocarbon emission) point source emission file in EIS format (File #1) (KVB Label No. 7077 and 7078)
2. An organic specie profile file (File #2) (Label No. 113)
3. An area source data file (File #3) (Label No. 111)
4. A chemical species description file (File #4) (Label No. 114)
5. An SCC description file (File #5) (Label No. 112)

2.3 ENGINEERING ANALYSIS

2.3.1 Point Source Emission Factors

There has been considerable interest in the development of emission factors that can be employed to estimate emissions from specific sources based upon a knowledge of the pertinent operating characteristics of the source. Such procedures are in common use throughout the country by local control agencies to estimate air pollution emission rates for point and area sources. One of the primary objectives of the ARB organic compound emission study was to critically evaluate the emission factors for organic compound emissions used by the SCAQMD and local APCD's and to develop new emission factors for sources not contained in the EIS data system that were applicable to the South Coast Air Basin. The following discussion outlines the methodology employed during the analysis for point sources. Emission factors for area sources have been separated into a separate section (Section 2.3.4) as they required a significantly different approach.

Point source emission factors for industrial point sources in the Basin were divided into three groups. The first group included the combustion of fuels and evaporative emissions from petroleum operations. In general, emission rates from these sources had been calculated by the local control agencies using emission factors and the appropriate information on fuel usage, petroleum product throughput, etc. This group, especially petroleum storage and transfer operation represented a large part of the total hydrocarbon emissions in the Basin and therefore was given primary emphasis in the analysis of point source emission factors.

The second group of sources included solvent evaporation. Emissions from these sources were generally not calculated by local control agencies using emission factors but rather were determined from solvent use questionnaires since the organic compound emissions were essentially predetermined by the solvent content of the materials employed. Therefore, correction to the EIS data base were made through updates of the solvent use inventory rather than corrections to emission factors. A discussion of the questionnaires used to update the EIS is contained in Section 2.3.3.

The third category included much less significant industrial point sources of organic compounds in the Basin such as metallurgical, mineral and food processing operations. For these sources, data contained in the EIS data base were left intact and no corrections were attempted.

A. Approach--

A comprehensive listing of point source emission factors was found in the EPA publication, "Compilation of Air Pollution Emission Factors" (Ref. 2-4), hereafter referred to as "AP-42." The SCAQMD had its own emission factors which had been employed in the process of estimating emission rates for industrial point sources contained in the EIS data file. To a certain extent, these emission factors were the same, because frequently SCAQMD data were used as the basis for the development of AP-42 emission factors. In other instances the emission factors differed because the SCAQMD sometimes based its emission factors on its own test data in preference to using AP-42 values.

A specific objective of this study was to examine the point source emission factors used by the SCAQMD and AP-42. This was done for three reasons. First, much of the data used to generate emission factors for specific source types such as petroleum operations and the combustion of fuels stem from studies conducted as far back as the 1950's. Considerable debate had been raised about their continued applicability in view of improved technology, sampling procedures, etc. Second, certain emission factors listed in AP-42 intended for use nationally may not necessarily represent conditions in the Basin. Finally, it was necessary to generate entirely new emission factors where none had existed previously.

Field tests were conducted to provide data to assist in emission factor evaluation and development. In addition, data from several related projects Table 2-1, specifically oriented to improving AP-42 emission factors have been incorporated into this analysis. In most cases, these studies had been directed at conditions within the Basin making them directly applicable to the current study.

Comparisons have been made between the emission factors used by the SCAQMD, those contained in AP-42 and those generated in this and related studies. Where KVB felt that available data disagreed with the SCAQMD emission factors, correction factors were applied to the emission rates listed in the EIS data system to update these emission estimates. The intent was to have the EIS data file, delivered to the ARB, reflect the best and most recent information available. This was a vital part of the improvements incorporated into the final KVB data base.

B. Results--

Emission factors selected for evaluation in this study are discussed in the following sections. Sources have been divided into four groups: (1) fuel combustion, (2) petroleum transfer and storage, (3) refinery fugitive emissions, and (4) petroleum production operations. A table for each of these source categories presents a general description of the source, appropriate SCC codes, units employed, emission factor listed in AP-42, those used by the local control agencies, and those resulting from recent investigations including field tests from this study. The "best" emission is also given along with the correction factor used to update the EIS data files. A complete discussion of each table is also presented.

1. Fuel combustion--It was appropriate to investigate the organic compound emission factors for the combustion of fuels used in the Basin. Emission factors used by the SCAQMD stem from data generated in the 1950's (Ref. 2-5) and were currently under revision during the study using more up-to-date test data.

AP-42 emission factors represented data accumulated over the last several years and generally had an emission factor rating of A. These emission factors, however, are still subject to revisions for specific sources.

Emission factors developed during the current program were themselves subject to error due to the broad nature of the test program and the limited number of samples that could be obtained for any one source type. Sources tested were selected so that the tests would be representative of that general sources type. A thorough evaluation of the test data was made to assure its accuracy. Table 2-2 presents a summary of the sources and emission factors for fuel combustion evaluated during this program.

Among the most important of the emission factors investigated was that from the combustion of residual oil in utility boilers. This represented one of the largest uses of fossil fuels in the Basin. The emission factor used by the SCAQMD was 2.6 times greater than that listed in AP-42. For this source type, the results of the KVB test program conducted on a utility boiler firing low sulfur residual oil tended to support the lower figure. Consequently, a correction factor was incorporated into the data management program.

Similarly, the SCAQMD emission factor for natural gas combustion in utility boilers was nine times that of AP-42. However, in this case, since the quantity of natural gas used by utilities has decreased dramatically in recent years, a decision was made to forego emissions testing of this source type. Since this represented a relatively insignificant source of organic compounds, the SCAQMD emission factor was not changed.

Refinery gas combustion, on the other hand, represented an important industrial source of organic compounds. In this case, good agreement between the three emission factor sources was obtained and no correction factor was necessary.

TABLE 2-2. ANALYSIS OF EMISSION FACTORS

Combustion of Fuels

Description	Applicable SCC Codes	Units	Emission Factors					(Reference)	Emission Factor Used in the Current Study	EIS* Correction Factor
			AP-42	SCAQMD	VAPCD	SBAPCD	Others			
Residual Oil Combustion Power Plants	1-01-004-XX	lb TOC/10^3 Gal.	1.0	2.6	1.0	1.0	0.7	(KVB)	1.0	0.40
Natural Gas Combustion Power Plants	1-01-006-XX	lb TOC/10^6 ft^3	1.0	8.8	1.0	1.0	-		8.8	1.00
Refinery Gas Combustion	3-06-001-02 3-06-001-04	lb TOC/10^6 ft^3	30.0	21.9	-	-	20.0	(KVB)	21.9	1.00
Natural Gas Industrial	1-02-006-XX	lb TOC/10^6 ft^3	3.0	7.0	3.0	3.0	30.0	(KVB)	7.0	1.00
CO Boiler	3-06-002-01	lb/10^3 BBl Feed	200	1.6	-	-	1.13	(KVB)	1.6	1.00
Natural Gas IC Engines	2-02-002-02	lb TOC/10^6 ft^3	1400	-	1400	-	1850-11600	(KVB)	1400	NA

*EIS Correction Factor = Ratio of emission factor used in current study to the emission factor used by SCAQMD in their EIS file.

TOC = Total Organic Compounds

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Industrial natural gas consumption also represents an extremely large energy use in the Basin. As shown in Table 2-2, the emission factor used by the SCAQMD was between the AP-42 and KVB emission factors so that again no correction factor appeared to be warranted.

Emissions from CO boilers treating exhaust gases downstream of an FCC unit were also evaluated. Since the SCAQMD used test results from these units rather than emission factors, the comparison between SCAQMD values and those obtained in this program has been made for a particular unit tested. Again, the SCAQMD value appeared to be reasonably close to that obtained during this study and no correction factor was necessary.

Natural gas combustion in IC engines represented another somewhat unique case. At the time of the study, sources of this type were not included in the EIS data file although a preliminary inventory of IC engines in the Basin had been made (Ref. 2-6). This inventory was incorporated into the area source data base for this study. A decision on an appropriate emission factor was somewhat difficult to make. Data presented in AP-42 represented emission factors of 800 hp units which are much larger than those typically found in the Basin. The results of the tests conducted by KVB on IC engines also resulted in large emission rates; however insufficient data were obtained to generalize an emission factor. The AP-42 value was used as it was somewhat conservative, although it was fully recognized that the emission rates from these sources may be higher.

2. Petroleum storage--Table 2-3 presents a comparison of the emission factors used to estimate organic compounds emitted from petroleum storage operations. Perhaps no other source has received so much recent investigation and is under so much controversy as those sources listed in this group. Responding to this controversy both the Western Oil and Gas Association (WOGA) and the California Air Resources Board have initiated field test programs (Refs. 2-7, 2-8, and 2-9) to investigate emission from petroleum storage operations. The results of the WOGA programs as well as the revised AP-42 emission factors (Ref. 2-10) are listed in Table 2-3.

TABLE 2-3. ANALYSIS OF EMISSION FACTORS PETROLEUM STORAGE

Description	Applicable SCC Codes	Units	Emission Factors					(Reference)	Emission Factor Used in the Current Study	EIS Correction Factor *
			AP-42	SCAQMD	VAPCD	SBAPCD	Others			
Floating Roof Storage Tanks	4-03-002-XX	--	API Bulletin 2517	2517	2517	2517	50% of API 2517	(WOGA Report Ref. 2-7)	100% of API Bulletin 2517	1.00
Fixed Roof Storage	4-03-001-XX	--	API Bulletin 2518	2518	2518	2518	58% of API 2518	(WOGA Report Ref. 2-8)	60% of API Bulletin 2518	0.60

*EIS Correction Factor = Ratio of emission factor used in current study to the emission factor used by SCAQMD in their EIS file.

API Bulletins 2517 and 2518 are universally used to estimate emissions from floating roof and fixed storage tanks respectively. These formulas and their application to conditions in the Basin have resulted in two programs sponsored by WOGA.

Results of the first study on floating roof tanks (Ref. 2-7) are presented in Table 2-4. It has been widely published (Ref. 2-11) that the results of this program demonstrate that emission estimates using 2517 are twice those of actual test results. However, a statistical evaluation of the data does not seem to support any conclusions about the relationship of the API formula to actual test emissions. The correlation coefficient which relates the two sets of data in Table 2-4 was 0.489 and therefore not significant. Using Kendall's method of rank correlation yielded an even less significant correlation of 0.14. While a t-test on the API 2517 predictions versus the actual test results did tend to improve by factoring the API formulas by 0.60, it was felt that the floating roof data did not support any conclusions which attempted to relate the test results to the API predictions. When no correlations exist, attempts to state which set of data was more reliable could not be made. Therefore, it was considered inadvisable to use these data to make any estimate of a correction factor for API 2517. The final inventory used emission factors as calculated using API 2517.

TABLE 2-4. API 2517 CALCULATED VERSUS OBSERVED HYDROCARBON EMISSIONS

Tank	Hydrocarbon Emission Rate (bbls/year) API 2517 Calculated	Observed
A	510	55
B	30	87
C	131	0
D	128	175
E	49	60
F	237	55
G	237	57
H	362	445
I	35	56
J	34	33
K	145	43
L	132	84
M	433	286

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Data from the program on fixed roof tanks (Ref. 2-8), presented in Table 2-5, on the other hand, demonstrated that there was a correlation between the various sets of numbers. The correlation coefficient between the predicted and measured losses was calculated to be 0.749. This value was accepted as representative of a significant correlation suggesting that API Bulletin 2518 does predict the trends in emissions based on storage tank parameters. However, the API formula appeared to overestimate emissions.

In order to test the hypothesis that the emissions data calculated using the API formula represented the same data population as the actual measured emissions (i.e. the means of the differences of the pairs of data equal zero), the t-test was employed. For the API estimates versus the actual test results, the calculated value for t is 2.11 while the acceptance limit for t_o at 0.05% confidence and 20 degrees of freedom is 1.725. Therefore, the data did not seem to represent the same population.

To test the theory that the API formula was overestimating the fixed roof tank emissions, two numbers were chosen as factors for the API estimate. The actual ratio of the means of the two sets of data (0.58) was used as one factor and 0.60 was also tested. (The correlation coefficient was unaffected by changes in the estimated emissions factored by either 0.58 or 0.60.) Resulting t values were 0.631 and 0.119 for correction factors of 0.58 and 0.60, respectively, supporting the hypothesis that the corrected emission predictions from API 2518 were not significantly different from the test data. A correction factor of 0.60 was therefore applied to the EIS data base given in Table 2-3.

3. Refinery fugitive emissions--An analysis of the emission factors used to estimate fugitive emissions from valves and pumps in operation within petroleum refineries has been made. Emission estimates for both AP-42 and the SCAQMD generally stem from an extensive study conducted in 1958 of air pollution emissions from petroleum refining operations located in the Basin (Ref. 2-12). Considerable interest had been raised about the accuracy of these emission estimates in view of advances in technology in the form of better valve and pump packing materials and improved pump seal designs.

TABLE 2-5. MEASURED VERSUS API CALCULATED EMISSIONS FOR STANDING STORAGE FIXED-ROOF TANKS

Test No.	Measured Loss (bbls/yr)	API Calculated Breathing Loss (bbls/yr)
1	Negligible	17
2	< 1	51
3	Negligible	91
4	Negligible	10
5	1	101
6	Negligible	21
7	224	607
8	164	257
9	122	856
10	Negligible	44
11	< 1	26
12	6	74
13	240	167
14	3	17
15	84	138
16	339	490
17	1,086	783
18	Negligible	61
19	9	298
20	Negligible	2
21	20	38
TOTAL	2,400	4,149

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Table 2-6 presents a summary of the analysis of the emission factors from fugitive sources within petroleum refineries. Since the SCAQMD did not use emission factors to estimate emission rates from these sources but rather used actual test data on specific sources only the emission factors listed in AP-42 (Ref. 2-10) are given. However, since both the SCAQMD and the emission estimates are based on the same data from Reference 2-12, a comparison of test data from the KVB study with AP-42 values was made to indicate if any corrections to the EIS data were necessary.

A specific objective of the KVB field test program, therefore, was to evaluate these emission factors listed in AP-42. Of course, a test program comparable to that described in Reference 2-12 was beyond the scope of this study. Therefore, a brief evaluation (as described in Section 3.0) was conducted with the aim of assessing the relative magnitude of these emission rates. The results of these tests are presented in Table 2-7. Given is a description of the device and the product carried, the total number of devices inspected, the number and class of leakers identified with the average leak rate measured (shown in parentheses) and the total emissions from each device. The corresponding emission factor on a per device basis is also given. These test results involve the inspection of approximately 18,000 valves and other fittings and 80 pumps.

Several conclusions were apparent from the results of the tests conducted on valves and fittings. As shown in Table 2-7, there was a substantial difference between the average emission rate for valves and that for metal connections in both gas and liquid service. Based on these results, emissions from metal connections such as flanges, unions, ties, etc. were assumed to be negligible. Note that there also was a significant difference between emissions for valves in gas service as opposed to those carrying liquid products.

A composite emission factor for valves was determined by applying an appropriate weighting factor to each of the gas and liquid emission factors. Previous inventories (Ref. 2-12) had reported that the ratio of valves in liquid service to those in gas service in refinery operations was approximately 3 to 1. Applying this ratio to the emission factors listed in Table 2-7 resulted in a composite emission factor of 0.15 lb/day·valve. Using these

TABLE 2-6. EMISSION FACTORS, REFINERY FUGITIVE EMISSIONS

Description	Applicable SCC Codes	Units	AP-42	Others	(Reference)	Emission Factor Used in the Current Study	EIS Correction Factor*
Valves	3-06-008-01	lb/day-valve	0.15	0.15	(KVB)	0.15	1
Pumps	3-06-008-03	lb/day-seal	3-5	4	(KVB)	3	1
Cooling Towers	3-06-007-01	$lb/10^6$ gal	6	12	(KVB)	6	1
FCC Units	(See Figure 2-2, CO Boiler)						

*EIS Correction Factor = Ratio of emission factor used in current study to the emission factor used by SCAQMD in their EIS file.

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TABLE 2-7. KVB FUGITIVE EMISSION DATA FOR PETROLEUM REFINING OPERATIONS*

Device Type	Product	Total Inventory No.	No. of Leakers Identified (Average Leak Rate, lb/day·leak)† Large	Medium	Small	Total Emissions (lb/day)	Emission Factor (lb/day·device)
Valves & Fittings							
Valves	Gas	1698	29(18)	23(3)	100(0.3)	620	0.4
Metal Connections	Gas	3100	0	1(3)	17(0.3)	8	0.003
Valves	Liquid	2774	2(18)	4(3)	32(0.02)	49	0.02
Metal Connections	Liquid	5661	1(18)	0	2(0.02)	18	0.003
Pump Seals							
Mechanical	< 26 RVP	93	3(7)	4(1)	17(0.01)	25	0.3
Mechanical	> 26 RVP	19	2(70)	0	8(0.06)	140	7
Packed	< 26 RVP	12	1(4)	0	5(0.06)	5	0.4
Packed	> 26 RVP	4	1(170)	0	0	170	40

* Based on test data from Source #7 only.

† See Table 3-48 for determination of average leak rate.

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results, the AP-42 emission factor of 0.15 lb/day·valve appeared to be reasonable and no correction factor was applied to the EIS data.

A similar analysis for pumps was conducted. As shown in Table 2-7, the product transferred and the type of seal both had a significant effect on emission rates. Tests conducted on pumps servicing liquid with a Reid Vapor Pressure (RVP) less than 26 had a relative low emission rate as compared with pumps carrying more volatile materials. Similarly, for pumps with high volatile materials, packed seals leaked at a rate five times that of mechanical seals. In general, these results were consistent with values reported in Reference 2-12.

A composite emission factor for pumps was difficult to determine since no inventory of pumps comparable to valves was available. Therefore a composite emission factor was developed using both the inventory data and emission factor presented in Table 2-7. The emission factor for mechanical and packed seals were 1.5 and 11 lb/seal·day respectively with a composite emission factor for all pumps of 3 lb/seal·day. This result compared favorably with the values listed in AP-42 and no correction factor was deemed necessary.

Additional field test data on emission rates from oil/water separators, cooling towers and compressor seals were obtained during this study. However, insufficient data from the field test conducted as part of this program were available to perform a creditable analysis of the emission factors.

4. Petroleum production fugitive emissions--(Although these sources have been considered as area sources and are included in Section 2.3.4, a discussion of the methodology used in determining emission factors from these sources was felt appropriate due to the similarity with previous analyses.)

Table 2-8 presents the emission factors developed by KVB to estimate fugitive emissions in petroleum production operations. These represent new data since emission factors from these sources had not appeared previously in AP-42 or in the EIS data base.

TABLE 2-8. EMISSION FACTORS, PETROLEUM PRODUCTION FUGITIVE EMISSIONS

Description	Applicable SCC Codes	Units	AP-42	County Agencies	Others	(Reference)	Emission Factor Used in the Current Study	EIS Correction * Factor
Valves	3-06-008-01	lb/day-valve	--	--	0.10	(KVB)	0.10	NA §
Separators	3-06-005-XX †	lb/day-ft^2	--	--	0.1	(KVB)	0.1	NA §
Compressor Seals	3-06-008-04	lb/day-unit	--	--	28	(KVB)	28	NA §
Well Heads	3-06-008-01 †	lb/well-day	--	--	0.05	(KVB)	0.05	NA §
Cellars	3-06-005-XX †	lb/well-day	--	--	2.0	(KVB)	2.0	NA §

*EIS Correction Factor = Ratio of emission factor used in current study to the emission factor used by SCAQMD in their EIS file.

†Best fit

§Data entered into EIS data base by KVB using listed Emission Factors

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The emission factors for leaking valves and metal fittings were developed using the data in Table 2-9. The format for this table is similar to that used in Table 2-7. These data represent the results of the inspection of over 3000 possible leak sources.

As found in previous analysis for refinery operations, the emission rate from valves and fittings appeared to be highly dependent on both the type of device and the product involved. Again, (1) emission rates from metal fittings were much less than those from valves, and (2) valves in gas service had higher emission rates than those in liquid service. A composite emission factor developed using the emission rates and inventories presented in Table 2-9 was determined to be 0.10 lb/valve·day. This was comparable to that found for refining operations.

A similar procedure for fugitive emissions from compressor seals was used and the results are presented in Table 2-9. This represents data on only nine compressors (out of an estimated population of approximately 500) and therefore must have a lower level of confidence.

Another potential source of emissions was found to be the leakage from the stuffing box around the polish rod on the rod pumps used in production operations in the Basin. This was shown to be extremely small in comparison to other leak sources.

Techniques were also developed to estimate the evaporative loses from standing oil in pump cellars and oil/water separators. The emission factor presented in Table 2-8 for these sources represents composite data from eight cellars and seven separators evaluated during the current program.

TABLE 2- 9. FUGITIVE EMISSION FACTORS FOR PETROLEUM PRODUCTION OPERATIONS

Device Type	Product	Total Inventory	No. of Leakers Identified (Average Leak Rate, lb/day·leak) Large	Medium	Small	Total Emissions (lb/day)	Emission Factor (lb/day·device)
Valves & Fittings							
Valve	Gas	910	15(13.0)	20(1.3)	42(0.2)	229	0.25
Metal Connections	Gas	372	3(13.0)	6(1.3)	20(0.2)	50	0.11
Valve	Crude	1,192	0	2(0.5)	4(0.05)	1	< 0.01
Metal Connections	Crude	339	0	0	3(0.05)	Neg.	Neg.
Compressor Seals	Gas	9 units	8(31.2)	5(0.5)	2(0.1)	280	28.0

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2.3.2 Emission Profiles

A. Description--

A unique aspect of the current program was the development of emission profiles, the identification of the organic compound species represented by the total hydrocarbon emission rates currently given in emission measurements. Only one other study (Ref. 2-13) had previously attempted a breakdown into generic classes. That was done primarily for the purpose of dividing emissions into reactivity classes. The results of that previous study have been widely used in the Basin.

A primary objective of this program was to identify the organic compound emissions for each stationary source type in the Basin and develop a data management system capable of applying this information to the total hydrocarbon emissions in order to calculate the emissions of the individual organic compounds. Thus an emission profile was formulated for each Source Classification Code (SCC) emitting organic compound species in the Basin. Both point and area sources were included. In certain instances a further breakdown was made into individual industries identified by Standard Industrial Codes (SIC).

Another objective of this program was to predict future emission trends. Satisfying this objective required emission profiles based on SCC number rather than individual plant profiles based on individual plant characteristics. All plant devices identified by the same SCC and SIC number were given the same emission profile. Conversely, it was important that profiles be truly representative of the device in general. Additional advantages of developing aggregate profiles by SCC number were that: (1) estimations based on larger data samples were more statically reliable than single data samples, (2) the profiles were compatible with the EIS concept by describing devices by the SCC number system, and (3) the volume of profile data was reduced to a more manageable level.

The initial intent was to provide a profile for each SCC listed in the data base. In many instances, however, an individual profile was found to cover several SCC and SCC/SIC combinations. The profile data base was therefore formulated and indexed by a profile number. Separate profile numbers (with identical specie distributions) were given to specific SCC/SIC combinations to facilitate data management, specifically the segregation of emissions from devices with similar SCC codes in two different industry classes into the appropriate ARB Application Categories.

In each profile the organic species were identified by their appropriate SAROAD code, ARB reactivity classification (3 class) and molecular weight. Each profile was also "tagged" with other identifiers to assist those who may wish to use or evaluate these data. Associated with each emission profile was an estimate of its relative error. This "Error Estimate" was strictly subjective and has been included to give a relative level of confidence to the specific profile. No statistical significance have been or should be given to these error estimates.

Given in the Appendix is a listing of the emission profiles used in the current study. Two reports are used to relate the profiles to the devices in the inventory. The SCC report (sorted by SCC number and profile number) lists all devices in the inventory and gives the profile number of the profile that describes the emission breakdown for the particular device. The profile report lists the profiles by profile number.

A profile contains a subjective estimate of the probable error in the profile and also lists the SAROAD code, chemical name and percent contribution of each specie. The species are also summed by reactivity class. In all 270 profiles were identified as being unique by either the specie breakdown or application category.

Table 2-10 presents the emission profiles for some of the most significant source types in the Basin.

TABLE 2-10. EMISSION PROFILES

Chemical Name	Residual Oil Combustion	Refinery Gas Combustion	Fiberglass Mfg.	CO Boiler	Fugitive Emissions (Refinery)	Fugitive Emissions (Pet. Production)	Adhesives	Synthetic Dry Cleaning	Petroleum Solvent	Crude Oil Storage	Gasoline Marketing	Crude Tanker Loading	General Primer	General Enamel	General Flexographic	General Rotogravure	Architectural Surface Coating	Natural Forest	Landfills	Miscellaneous Petroleum Storage
	Profile (% Weight)																			
Methane	11.0	7.6		36.0	28.6	62.0				6.2		10.2			14.4				98.6	
Ethane		20.9			5.8	17.8	3.9			5.6		3.6			0.7				0.1	0.1
Ethylene																				0.2
Propane		18.9			11.5	11.1				17.6	1.8	23.4			0.2				0.1	1.0
Propylene		17.5			0.1															
Cyclopentane																			0.2	
N-Butane	14.0	23.1			18.3	4.4				27.1	19.8	26.5							0.2	1.4
Butene											1.8									
Iso-Butane		4.4			7.4	2.9				1.5	6.6	5.4			1.2				0.1	0.6
N-Pentane					7.7	0.7				14.6	10.6	7.3							0.1	1.4
Iso-Pentane					7.8	1.1				1.5	29.0	8.0								3.4
1-Pentene											6.2									
Hexane	5.0				3.4		59.0			7.9	2.5	5.6			0.7		20.7			8.9
Heptane					1.4					9.2	0.6	5.6								1.1
Octane					1.8					6.9	0.1	3.0								
Nonane					0.60							1.0								
Isomers of Hexane				13.0	1.6					0.3	8.9									0.9
Isomers of Heptane					0.8						2.0									1.0
N-Decane												0.3								0.1
Isomers of Octane					0.4				0.8		1.9									
Cyclohexane					0.1					0.1	2.1					10.0	20.7			
Undecane												0.1								
Isomers of Nonane					0.5				27.3		0.2									1.9
Isomers of Decane					0.3				69.3											4.9
Isomers of Undecane									2.6											0.2
C-7 Cyclo-paraffins					0.2					1.3	0.2									4.2
C-8 Cyclo-paraffins										0.5										
C-9 Cyclo-paraffins					0.1															
Terpenes																		100.0	0.1	
Mineral Spirits													41.0	67.6		51.0				

Continued

TABLE 2-10. (Continued).

Chemical Name	Residual Oil Combustion	Refinery Gas Combustion	Fiberglass Mfg.	CO Boiler	Fugitive Emissions (Refinery)	Fugitive Emissions (Pet. Production)	Adhesives	Synthetic Dry Cleaning	Petroleum Solvent	Crude Oil Storage	Gasoline Marketing	Crude Tanker Loading	General Primer	General Enamel	General Flexographic	General Rotogravure	Architectural Surface Coating	Natural Forest	Landfills	Miscellaneous Petroleum Storage
	Profile (% Weight)																			
Lactol Spirits															10.0					
Methyl Alcohol													1.0	0.7	3.6	6.0	3.9			
Ethyl Alcohol													0.8	0.5	2.4		0.6			2.6
Iso Propyl Alcohol													2.8	1.9	24.1	6.0	16.4			3.4
N-Butyl Alcohol													4.0	2.8		6.0	1.6			
Iso Butyl Alcohol																	0.6			2.6
Glycol Ether													11.5							
Propylene Glycol																	0.8			
Ethylene Glycol																	0.6			
Ethyl Acetate							4.1						0.9	0.3						4.4
Propyl Acetate															21.5					
N-Butyl Acetate													9.5	2.9		8.0	2.5			
Cellosolve Acetate																	1.3			
Isopropyl Acetate													0.8	0.3	9.5					
Isobutyl Acetate																	1.5			
Dimethyl Formamide																	0.5			
Isobutyl Iso-butyrate																	6.1			
Formaldehyde	42.0	7.6		51.0																0.4
Acetone	28.0						3.0						7.1	6.3	9.4		3.2			16.4
Methyl Ethyl Ketone													7.7	6.8	2.0		5.6			12.4
Methyl N-butyl Ketone																	0.7			
Methyl Isobutyl Ketone													3.1	2.7			0.6			6.7
Ethylene Dichloride																				0.4
Perchloro-ethylene							30.0	100.0											0.3	5.1

Continued

TABLE 2-10. (Continued).

Chemical Name	Residual Oil Combustion	Refinery Gas Combustion	Fiberglass Mfg.	CO Boiler	Fugitive Emissions (Refinery)	Fugitive Emissions (Pet. Production)	Adhesives	Synthetic Dry Cleaning	Petroleum Solvent	Crude Oil Storage	Gasoline Marketing	Crude Tanker Loading	General Primer	General Enamel	General Flexographic	General Rotogravure	Architectural Surface Coating	Natural Forest	Landfills	Miscellaneous Petroleum Storage
	Profile (% Weight)																			
Naphtha													1.0							
Benzene					0.1					0.1	1.1				0.1					
Toluene					0.5						2.1		3.9	3.2	0.2		5.2		0.1	8.6
Ethylbenzene																6.0	4.3			
Tri-methyl-benzene											0.3									
Ethyltoluene											0.5									
Iso Diethyl-benzene																7.0				
Styrene			100.0																	
Xylenes					0.2						1.6		4.9	4.0			2.6		0.1	5.7
Dimethylethyl-benzene											0.1									
TOTAL %	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

B. Methodology--

Two general approaches were used to formulate the emission profiles, one where only one data point was available to characterize many sources and another where multiple data points were available. In cases where a profile was available from only one source and that source was believed to be representative of all such source types in the Basin, then that particular source emission profile was used. An appropriate error estimate was given to reflect the relative confidence level of these data. It was anticipated early in the program that a significant number of source types would fall into this category due to the limited amount of field tests available. Therefore, test locations were carefully selected on the basis of the representative nature of their emissions to all other devices of that particular type. In this way, data from this source could be correctly applied to other non-tested sources. Test results are presented in Section 3.4. Similarly, questionnaires were submitted to and received from selected solvent users. Follow-ups were made to assure that the data from these large and representative sources were obtained.

Two examples of formulating profiles based on one data point from a selected source are the following. The first, concerned with the emission profile typical of residual oil fuel combustion, was obtained by (1) recognizing that 95% of all residual oil combustion in the Basin occurs in utility boilers, (2) selecting a boiler that was "typical" of such devices in the Basin and finally (3) conducting a test on this unit. Multiple samples were taken and the profile was based on an average composition.

The second example involved the use of data from questionnaires. One source in the Basin, according to the SCAQMD files, was responsible for 90% of the emissions from adhesive use. A questionnaire was mailed to this source and follow-up contacts were made to assure that information from this source was received. The questionnaire contained a comprehensive breakdown of the composition of the solvent composition and usage which formed the basis for the emission profile.

This approach of using one analysis to characterize a general source type also applied to profiles determined by inspection. For example, there were a few SCC's that specifically identify the solvent used in a coating operation or housed in a storage tank. In this case, a solvent identified by its SCC as toluene or xylene would be given an emission profile of 100% of that organic compound.

The second approach used was to develop emission profiles based on data from several sources within a particular source type. This involved (1) acquiring the data, (2) determining the relative magnitudes of each source compared to the total emissions from the source type, and (3) forming a composite profile by factoring the data from each source by an appropriate weighting factor. In this manner, emission profiles were developed for individual source types that in actuality represented the average emissions from sources of that category (SCC number).

An example of this approach was the formulation of a profile for "Miscellaneous Organic Storage" in the Basin. While SCC numbers had been assigned to storage tanks for gasoline, jet fuel, crude oil, various solvents, etc., the miscellaneous category covered all other petroleum products not listed. Table 2-11 presents a summary of the calculation procedures employed to determine this profile. Listed across the top are the various organic products identified and the fraction of the emissions from fixed roof tank storage for each based on information compiled from the SCAQMD file. Listed down the page are the various organic species that have been identified in the emissions from these products. The weight percentages of each specie associated with the product is listed in the appropriate column. The weight percentage for asphalt and Stoddard solvent were determined from KVB test data. The adhesive percentages came from questionnaire data. The remainder of the percentages were specified (e.g. 100% for acetone) or estimated based on contacts with industry (e.g. the breakdown of alcohols and ketone). The weight percent of each organic compound in the composite profile was determined by multiplying the weight percents by the appropriate fractions and are listed on the right hand side.

TABLE 2-11. COMPOSITE PROFILE FOR MISCELLANEOUS PETROLEUM STORAGE

(Fixed Roof Tanks)

Product Stored	Acetone	Adhesive	Alcohol	Asphalt	Perchloroethylene	Ethylene Dichloride	Formaldehyde	Ketone	Stoddard	Xylene	Others	Composite
Fraction of Emissions	0.163	0.022	0.084	0.078	0.051	0.004	0.004	0.191	0.071	0.057	0.275	
Organic Compounds												
Acetone	100.0	4.0										16.4
Perchloroethylene					100.0							5.1
Ethylene Dichloride						100.0						0.4
Formaldehyde							100.0					0.4
MEK								65.0				12.4
MIBK								35.0				6.7
Xylene										100.0		5.7
Toluene		5.6									31.0	8.6
Ethane				1.0								0.1
Ethylene				2.0								0.2
Propane				13.0								1.0
N-Butane				18.0								1.4
I-Butane				8.0								0.6
N-Pentane				18.0								1.4
I-Pentane											12.5	3.4
Hexane		84.6		2.0							25.0	8.9
I-Hexane				12.0								0.9
Heptane				14.0								1.1
I-Heptane				11.0								1.0
I-Octane				1.0					0.8			0.1
I-Nonane									27.3			1.9
I-Decane									69.4			4.9
I-Undecane									2.4			0.2
Ethyl Acetate		5.8									15.5	4.4
C-7 Cyclo-paraffins											15.5	4.2
Isopropyl Alcohol			40.0									3.4
Ethyl Alcohol			30.0									2.6
Isobutyl Alcohol			30.0									2.6

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C. Key Profiles--

Due to the magnitude of the sources which they represent several emission profiles were recognized to have a significant impact on the results of the final inventory. These include gasoline vapors emitted from storage facilities and marketing operations, crude oil vapors released from production and refining storage tanks, fugitive emissions from petroleum refining operations, architectural surface coatings, automotive spray painting, land fills and natural forest emissions. Detailed discussions of the development of these profiles are included in the following sections.

1. Gasoline storage and marketing--For the purpose of the ARB hydrocarbon inventory, a general emission profile suitable for use for both gasoline storage and marketing operations was desired. Such a profile was difficult to develop for several reasons. First there was the problem of determining a "typical" gasoline blend. There were eight major brands and numerous independent brands of gasoline marketed in the Basin (Ref. 2-14). Each of these brands generally had three grades of gasoline including regular, premium and unleaded. In addition, there were seasonal variations in the properties of each of these grades as reported in Ref. 2-15. Therefore, a composite gasoline blend properly accounting for each of these factors would have involved the incorporation of scores of gasoline samples. Furthermore, obtaining a representative sample from each stock required careful sample preparation with minimum vapor losses prior to analysis. The analysis of gasoline liquid and vapor constituents represented perhaps the most complex of GC/MS analytical procedures due to the large number of organic constituents (greater than 100) that were present. It was apparent, therefore, that such determinations of vapor constituent were beyond the budget of this study.

Data for the gasoline vapor emission profile were obtained primarily from 1974 ARB studies of gasoline compositions in the Basin (Ref. 2-14 and 15). The objective of that study was to investigate differences in composition of gasolines (liquid) that would influence emissions to the atmosphere both from

evaporative losses and engine exhaust. A blend of 55% leaded regular, 38% leaded premium and 7% unleaded was prepared. These three types of gasoline had each been blended from samples taken from large volume retailers of the eight major brands as shown below in Table 2-12.

TABLE 2-12. GASOLINE SALES: PERCENTAGE OF TOTAL FOR MAJOR CALIFORNIA BRANDS

ARCO	14.0
Exxon	12.1
Gulf	7.0
Mobil	10.1
Shell	14.4
Standard	20.0
Texaco	9.4
Union	13.0
Total	100.0

The composition of the liquid and the vapor at 70 °F were determined and are presented in Table 2-13 as the emission profiles used for this inventory.

In selecting and validating these data it was noted that the samples of gasoline blended and analyzed had been purchased in mid September 1974 (Ref. 2-14). This means that the blend should have been representative of the gasoline sold during 1975, the base year of the inventory. The validity of blending and measuring as compared with analyzing individual products and averaging the results was proved by the ARB (Ref. 2-15A) when they analyzed six samples individually and calculated an average composition which they compared with the analysis of a composite mixture of the six blends. The results agreed compound by compound within 5-15%.

In this same study the ARB (Ref. 2-14) presented their GC analyses results for the blends of leaded premium, leaded regular and unleaded. The results for the leaded premium and regular were compared with results published in 1968 by WOGA in a gasoline marketing emissions study (Ref. 2-16). The agreement in composition was found to be very close. To validate the unleaded gasoline composition a calculation was made of a gasoline vapor

TABLE 2-13. EMISSION PROFILE FOR THE COMPOSITE AVERAGE GASOLINE LIQUID AND VAPOR AT 70 °F IN THE SOUTH COAST AIR BASIN - 1975 (REF. 2-14 AND 2-15)

Compound	Weight % Liquid (Spills)	Weight % Vapor (Evap. Loss)
Propane	0.1	1.8
Isobutane	0.5	6.6
Butane	2.2	19.8
Butenes	0.4	1.8
Isopentane	8.0	29.0
Pentane	4.2	10.6
Pentenes	2.5	6.2
2-methylpentane	5.9	6.3
3-methylpentane	3.0	2.6
Hexane	3.8	2.5
Methylcyclopentane	3.6	2.1
Benzene	2.4	1.1
2,3-dimethylpentane	3.3	1.2
3-methylhexane	2.4	0.8
2,2,4-trimethylpentane	3.5	1.1
Heptane	2.5	0.6
Methylcyclohexane	1.1	0.2
Dimethylhexane	1.7	0.3
Toluene	9.7	2.1
Iso-octane	3.6	0.5
Octane	1.3	0.1
Isononane	1.2	0.2
m & p-Xylene	9.9	1.2
o-Xylene	3.6	0.4
Nonane	0.6	--
Propylbenzene	0.3	--
3-ehtyltoluene	6.5	0.5
1,2,4-trimethylbenzene	3.8	0.3
1,2,3-trimethylbenzene	1.4	0.1
Dimethylethylbenzene	2.7	0.1
Butylbenzene	1.7	--
$> C_{10}$	2.2	--

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composition based on the published composition of the unleaded gasoline liquid. This calculation involved the use of the laws of partial pressures and the gas law. The resulting vapor composition was compared with measurements of unleaded gasoline vapor made in early 1977 in San Diego during an investigation by KVB on gasoline marketing vapor recovery systems. Table 2-14 presents a comparison of the two compositions. The two are similar except that the ARB composition had approximately nine percent olefins and cycloparaffins which were not found in the San Diego test gasoline. It was suspected that the San Diego tests were conducted using straight-run gasoline. Straight-run gasoline means that the gasoline was merely fractionated from the crude oil and not formed by a cracking process which tends to form unsaturated and cyclic compounds. Since most gasoline in the Basin is a blend of the cracked and straight-run gasoline, it was felt that the use of the ARB composition was appropriate.

TABLE 2-14. COMPARISON OF UNLEADED GASOLINE VAPOR COMPOSITIONS
WEIGHT PERCENT

	Measured*	Calculated from Liquid†	
Propane	3.7	2.2	
N-Butane	26.1	31.3	
I-Butane	11.8	12.3	
N-Pentane	12.2	6.9	
I-Pentane	27.8	24.8	
N-Hexane	3.9	1.0	
I-Hexane	7.1	6.1	
I-Heptane	4.4	1.7	
I-Octane	1.5	0.7	
Other	1.5	13.0	(olefins, cyclo-paraffins and aromatics)
Total	100.0	100.0	

*Sample collected from automobile gas tank fill pipe during filling operation and analyzed by GC as described in Section 3.0

†Vapor composition calculated from liquid composition reported by ARB in Reference 2-14.

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2. Crude oil storage--Approximately 45% of the crude oil refined in the Basin is produced locally. The balance comes from several sources including domestic and foregin suppliers. There exist significant differences therefore between the crude oils stored in production and refining in the Basin and that involved in marketing operations. The following discussion is therefore divided into the three general areas of production, marketing and refinery operations.

a. Production operations--Results from the current inventory show that the organic compound emissions from crude oil storage at petroleum production operation account for 35 tons per day or approximately 5% of all anthroprogenic sources. The emission profiles for the vapors released from these sources were developed using data from the field tests conducted on this program and the results of a recently completed study on fixed roof tank emissions sponsored by WOGA (Ref. 2-8).

A summary of the data used to determine this profile is included in Table 2-15. Since data from Reference 2-8 did not identify "normal" and "isomer" compounds, the organic compounds for these tests have been identified as "normal". The layout of this table is similar to previous tables with the identification of the crude oils across the top and the organic compounds listed vertically. The numbers in each column represent the weight percent of that specie in the associated crude oil vapors.

As seen in Table 2-15, there was a wide variation in the organic constituents of the crude oil vapors within the study area. The composite emission profile was developed using the weighting factor listed with each crude oil which represents roughly the fraction of the total crude oil produced within the Basin according to the California Division of Oil and Gas (Ref. 2-17).

b. Refining operations--A similar procedure was used to develop an emission profile for crude oil storage associated with refining operations. A summary of the data used to calculate a composite profile is included in Table 2-16. The crude oil stored in refineries showd a much larger variation in vapor compositions reflecting the diverse origins in the crude oil.

TABLE 2-15. CRUDE OIL STORAGE, PETROLEUM PRODUCTION OPERATIONS

	Production Field										
	† Huntington Beach	† Saticoy	§ Rosecrans	§ Wilmington	§ Seal Beach	§ Ventura	§ Santa Fe Springs	§ Brea Olinda	§ South Mountain	§ Ojai	Composite
Fraction of Production	0.13	0.01	0.10	0.45	0.05	0.12	0.02	0.08	0.05	0.01	1.0
Organic Compound (wt. %)											
Methane	3.0	7.1	1.0	10.8	2.0	1.2	5.3	1.4	7.9	0.2	6.2
Ethane	6.7	17.6	1.9	6.7	1.9	2.6	15.4	2.0	9.2	2.1	5.6
Propane	20.2	30.8	12.6	18.1	12.5	19.6	19.7	9.5	25.5	8.4	17.6
N-Butane	19.9	19.5	24.7	27.4	25.6	34.5	26.2	30.7	26.5	30.9	27.1
I-Butane	11.0	9.9									1.5
N-Pentane	8.0	5.1	19.3	13.1	30.7	14.7	13.0	23.5	10.5	25.6	14.6
I-Pentane	11.1	5.8									1.5
Hexane	5.0	2.1	12.9	6.8	12.3	9.4	5.8	11.3	5.8	11.3	7.9
I-Hexane	0.8										--
Heptane			17.2	9.3	9.2	10.7	6.2	13.7	7.5	11.8	9.2
Octane*			10.4	7.8	5.8	7.3	8.4	7.9	7.1	9.7	6.9
C-7 Cycloparaffins	9.9	0.6									1.3
C-8 Cycloparaffins	3.5										0.5
Benzene	1.0	0.1									0.1
Cyclohexane											--
3-Methyl Pentane		1.4									--
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* C_8 +

† Tests conducted during the current project

§ Ref. 2-8

Data in Table 2-16 represented vapors collected from both fixed and floating roof tanks. However, insufficient data were available to allow a differentiation between vapors emitted from each tank type. Regulations by the SCAQMD require storage of petroleum liquids with a vapor pressure greater than 1.5 psia in floating roof tanks. Therefore, it would seem reasonable to assume that differences between the vapor composition for crude oils above and below this limit would exist.

c. Crude oil storage and transfer operations--Table 2-17 presents the data employed to determine a composite emission profile for crude oil storage and transfer operations primarily at marine terminals. Significant variations in the crude oil vapors were observed between the various samples analyzed. The data shown were taken from the WOGA Fixed Roof Tank Study (Ref. 2-8).

3. Refinery fugitive emissions--A significant portion of the field test program involved the measurement and evaluation of fugitive emissions from leaking valves and pumps in refineries. This was done both to assess the accuracy of emission factors (discussed in Section 2.3.1) but also to develop emission profiles "typical" of refinery operations. Recognizing that such an undertaking was subject to numerous complications including variations among crude oils and resulting products, differences between various refineries and the extremely complex nature of refinery processes in general, an attempt was made to meet this objective.

As discussed in Section 2.3.1, tests were conducted to characterize the emission rate from valve and pumps within petroleum refineries. To complement these efforts, numerous samples of leaking vapors were collected and analyzed. These analyses were believed to be as representative of leaks in refinery processing as is reasonably possible. As in the previous analyses, the problem became one of apportioning the leaks from various product lines to form a composite leak emission profile "typical" of all leaks from valves within a refinery.

Figure 2-1 presents a schematic view of a simplified refining process. Basically three types of products result from crude processing: gases, low-viscosity liquids, and high-viscosity liquids.

TABLE 2-16. CRUDE OIL STORAGE, PETROLEUM REFINING OPERATIONS

Organic Compound (wt. %)	Crude Sources					
	Foreign*	Domestic*	Domestic*	Domestic*	Unknown†	Composite
Methane	5.3	9.0	0.1	2.7	26.8	8.8
Ethane	4.5	6.0	2.1		0.9	2.7
Propane	17.1	26.0	20.6	7.3	9.7	16.1
N-Butane	18.6	26.0	22.7	15.4	21.7	20.8
I-Butane	10.7	11.0	15.5	9.5		9.3
N-Pentane	15.0	8.0	8.0		19.4	10.1
I-Pentane	13.4	8.0	12.3	22.2		11.2
Hexane	7.3	3.0	0.2		12.8	4.7
I-Hexane	5.2	2.0	1.0	17.1		5.1
Heptane	0.9		0.2		8.7	2.0
I-Heptane	2.0	1.0	8.1	14.0		5.0
I-Octane			1.9			0.4
Benzene			4.3	7.9		2.4
Toluene			3.0	3.9		1.4
	100.0	100.0	100.0	100.0	100.0	100.0

* Tests conducted for the program

† Ref. 2-8

TABLE 2-17. CRUDE OIL STORAGE, PETROLEUM MARKETING OPERATIONS

Organic Compound (wt. %)	Crude Source			
	Foreign	Foreign	Domestic	Composite
Methane	6.0	0.4	1.5	2.6
Ethane	8.1	1.1	2.0	3.7
Propane	15.0	19.3	13.0	15.8
Butane	31.1	33.7	25.7	30.2
Pentane	12.8	22.7	20.1	18.5
Hexane	7.4	9.7	9.3	8.8
Heptane	8.8	8.5	15.0	10.8
Octane +	10.8	4.6	13.4	9.6
	100.0	100.0	100.0	100.0

Ref. 2-8

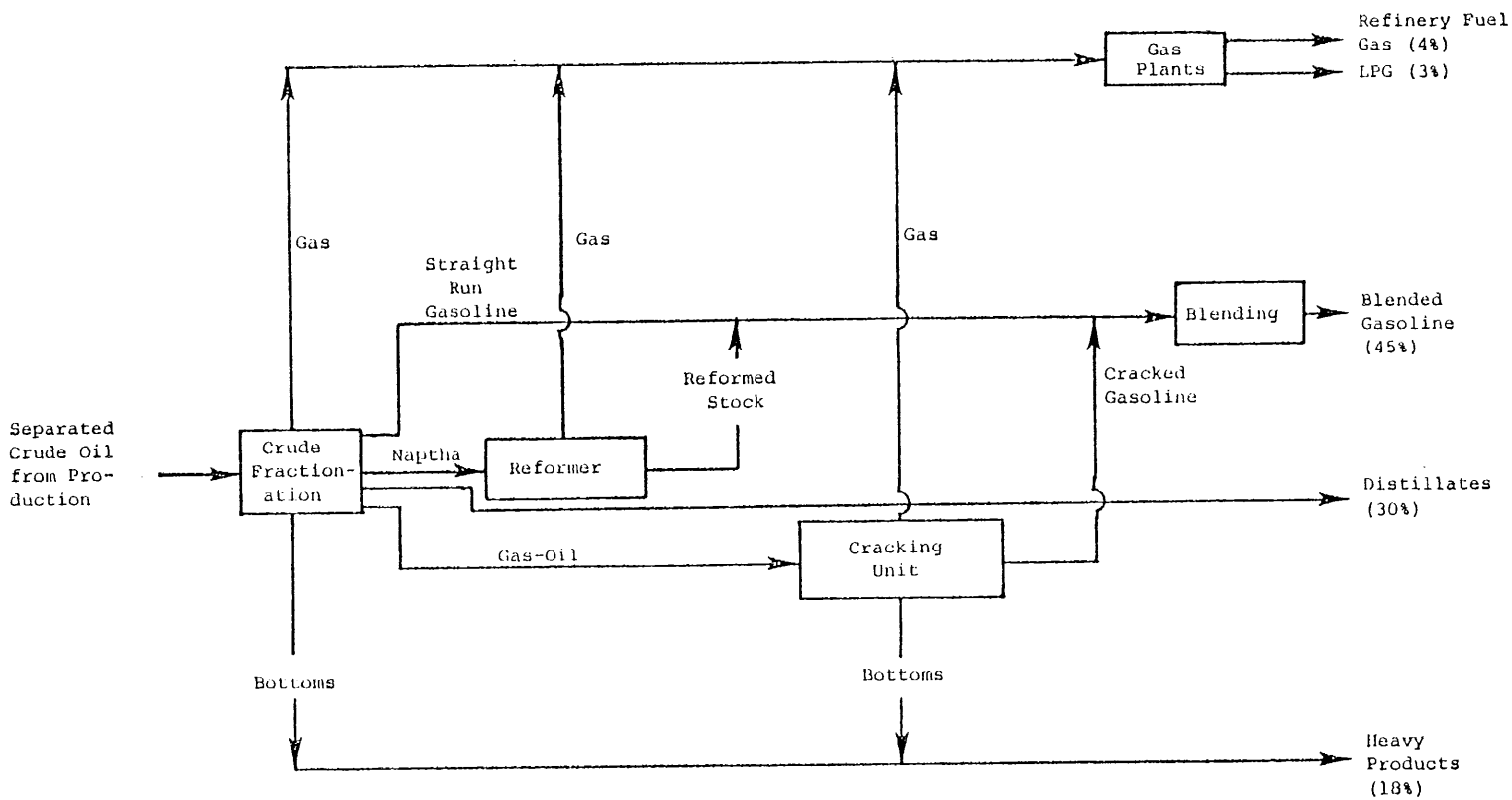

Figure 2-1. Refining process schematic.

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The primary source of gaseous leaks was fuel gas lines. According to data issued by the SCAQMD, approximately 25% of the gas used in refineries is purchased natural gas. The balance is the refinery generated gas which varies from methane to butane.

Heavy liquids called "bottoms" were removed and used to form heavy fuel oils, coke and asphalt. For the purpose of this analysis and the subsequent analysis on fugitive emissions from pumps, it was assumed that the losses from product lines carrying heavy liquids were negligible. This assumption was verified by field tests conducted during this program and was thought to be due to either the leaks being self sealing or being so visible that maintenance is performed within a short time period.

The intermediate stream was composed of liquids that flow through various paths and ultimately ended up as gasoline and other petroleum distillates. There were interactions between these three product streams through the use of coking operations and vapor recovery which were intended to produce a higher fraction of gasoline and distillate products. Approximately 50% of the original crude oil (Ref. 2-18) that entered a refinery ultimately ended up as blended gasoline. As shown in Figure 2-1, this could have been through paths generating straight run gasoline, reformed stock or cracked gasoline to form the final gasoline products. Approximately 30% of the original crude became other distillate products.

a. Valves--As discussed in Section 2.3.1, the leak rate for valves in gaseous products was 0.424 lb/valve-day whereas the comparable leak rate for valves in liquid service was 0.022 lb/valve-day. Estimates (Ref. 2-13) of the total valves in gaseous and liquid service in refineries located in the Basin were 23.6% and 76.4% respectively. By applying these percentages to the associated leak rates it was determined that approximately 85% of leaks from valves result from those handling gaseous products.

Using the above information, a "typical" fugitive emission profile for valves was generated. Table 2-18 gives a summary of the calculation procedure. Listed are the analyzed emission profiles for leaks in various

TABLE 2-18. COMPOSITE PROFILE FOR REFINERY FUGITIVE EMISSIONS FROM VALVES

	Refinery Gas	Natural Gas	Straight Run Gasoline	Naphtha	Reformate Stock	Gas-Oil Stock	Cracked Gasoline	Distillate	Composite
Fraction of Emissions	0.64	0.21	0.015	0.015	0.015	0.03	0.03	0.045	
Organic Compounds (wt. percent)									
Methane	16.4	84.5				10.0		4.2	28.6
Ethane	5.1	11.0			0.9	3.8		1.0	5.8
Propane	15.9	3.6	0.2	0.6	13.9	3.3		5.3	11.5
Propylene		0.4							0.1
N-Butane	26.8	0.5	0.7	0.6	24.7	6.5	1.1	12.7	18.3
I-Butane	11.3		0.1					2.5	7.4
Butene							1.1		--
N-Pentane	9.4		1.3	1.3	21.5	7.4	19.7	11.0	7.7
I-Pentane	10.7			0.4		3.8	21.4	5.0	7.8
N-Hexane	2.8		3.2	6.2	19.3	11.8	15.4	9.0	3.4
I-Hexane	1.3		1.1	6.6		6.0	12.8	3.0	1.6
N-Heptane	0.1		1.4	1.8	10.0	8.3	14.9	8.6	1.4
I-Heptane	0.2		3.4			16.0		2.0	0.8
N-Octane			58.1	6.4	9.7	7.9		9.9	1.8
I-Octane			4.7	5.6			4.1	3.0	0.4
N-Nonane			2.8	8.3		4.4		6.5	0.6
I-Nonane			8.5	20.6			0.2	0.5	0.5
N-Decane						3.5		14.8*	0.8
I-Decane			2.6	16.6					0.3
C-7 Cycloparaffins			1.0	2.4			3.9		0.2
C-8 Cycloparaffins			0.2	0.6					--
C-9 Cycloparaffins			2.6	4.8			0.3		0.1
Toluene			3.2	6.2		7.3	3.0		0.5
Xylene			2.6	7.0			1.6		0.2
Benzene			1.4	2.5			0.5		0.1
Cyclohexane			0.9	1.5				1.0	0.1
	100	100	100	100	100	100	100	100	100

* C_{10}^{+}

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product streams along with the estimated contribution from each to the total. For the purpose of this analysis it was assumed that the percentage of valves in liquid service are as follows:

Straight Run Gasoline	10%
Naphtha	10%
Reformate Stock	10%
Gas-Oil Stock	20%
Cracked Gasoline	20%
Distillate	25%

For this analysis, the distribution was not critical since the leaks from valves in liquid service constitute only 15% of the total emissions.

Because 85% of the emissions are from valves in gas service, the composition of the natural gas and refinery fuel gas had a very significant influence on the composite emission profile. A much more detailed analysis would have also incorporated leaks from other gaseous lines within the refinery however data on these internal gaseous stock transfer were not available.

b. Pumps--Tests were also conducted on 80 pumps to characterize emission rates from these fugitive sources. For the purposes of this analysis it has been assumed that leaks from pumps occur only from the liquid product lines as previously described. A summary of the calculation procedure is given in Table 2-19. As with valves, a much more complex analysis was possible; however, existing data are only sufficient to make a cursory estimate.

4. Architectural surface coatings--As described in Section 2.3.4, architectural surface coatings represented a significant source of organic compound emissions. These are comprised of the contribution of solvent from countless applications of surface coatings supplied by literally hundreds of paint manufacturers.

The approach used to establish a composite profile was to use the results of data generated by the AQMD and APCD's in the area. These agencies

TABLE 2-19. COMPOSITE PROFILE FOR REFINERY FUGITIVE EMISSIONS FROM PUMPS

	Straight Run Gasoline	Naphtha	Reformate Stock	Gas-Oil Stock	Cracked Gasoline	Distillate	Composite
Fraction of Emissions	0.10	0.10	0.10	0.20	0.20	0.30	
Organic Compounds (wt. percent)							
Methane				10.0		4.2	3.3
Ethane			0.9	3.8		1.0	1.2
Propane	0.2	0.6	13.9	3.3		5.3	3.7
N-Butane	0.7	0.6	24.7	6.5	1.1	12.7	7.9
I-Butane	0.1					2.5	0.8
Butene					1.1		0.2
N-Pentane	1.3	1.3	21.5	7.4	19.7	11.0	11.1
I-Pentane		0.4		3.8	21.4	5.0	6.6
N-Hexane	3.2	6.2	19.3	11.8	15.4	9.0	11.0
I-Hexane	1.1	6.6		6.0	12.8	3.0	5.5
N-Heptane	1.4	1.8	10.0	8.3	14.9	8.6	8.5
I-Heptane	3.4			16.0		2.0	4.1
N-Octane	58.1	6.4	9.7	7.9		9.9	12.0
I-Octane	4.7	5.6			4.1	3.0	2.8
N-Nonane	2.8	8.3		4.4		6.5	3.9
I-Nonane	8.5	20.6			0.2	0.5	3.1
N-Decane				3.5		14.8 *	5.1
I-Decane	2.6	16.6					1.9
C-7 Cycloparaffins	1.0	2.4			3.9		1.1
C-8 Cycloparaffins	0.2	0.6					0.1
C-9 Cycloparaffins	2.6	4.8			0.3		0.8
Toluene	3.2	6.2		7.3	3.0		3.0
Xylene	2.6	7.0			1.6		1.3
Benzene	1.4	2.5			0.5		0.5
Cyclohexane	0.9	1.5				1.0	0.5
	100	100	100	100	100	100	100

* C_{10}^{+}

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had in their files all of the paint formulations and information on product sales within their jurisdiction. This information had been obtained directly from manufacturers and suppliers. Such an inventory was well beyond the scope of this study.

The most comprehensive architectural coating study was conducted by the San Diego APCD as described in the Appendix. The results of the SDAPCD study are summarized in Table 2-20. This table gives the total solvents that were contained in the architectural surface coatings marketed in San Diego County in 1974-75. This represented the most complete accounting of solvents used in this manner and was used to formulate the composite emission profiles for this inventory.

5. Automotive surface coatings--One of the largest sources of industrial solvent used in the Basin was surface coating operations associated with automotive assembly operations. Auto painting operations in the Basin include both water-based and oil-based formulations. An important aspect of the current test program was to document emissions from each of these sources to establish emission rates, compositions, and the effects of the water-based reformulation on possible control strategies.

Presented in Table 2-21 are the results of the test program conducted on the body priming and top coat operations for each of the coating types. The objective was to generate a composite emission profile representative of both water based and oil based coatings. Given also in Table 2-21 are the fractions of total emissions from each of the coating types. The composite emission profiles have been determined and are presented in Table 2-21.

6. Landfills--Table 2-22 presents the results of the samples of landfill gases collected during the current program. As expected, these gases were primarily methane with trace quantities of various other materials. Considering that there were approximately 1000 tons per day of total emissions from these sources (see Section 2.3.4) these trace quantities represented significant sources of each of the organic compounds to the atmosphere in excess of one ton per day.

TABLE 2-20. SOLVENTS USED IN ARCHITECTURAL COATINGS IN SAN DIEGO COUNTY (1974-75)

Solvent	lbs.	Solvent	lbs.
Acetone	324,315	Kerosene	554
Benzene	4,234	Methyl Amyl Ketone	681
iso-Butane	60	Methyl iso-Amyl Ketone	12,912
Butanol	158,340	Methyl Amyl Acetate	3,739
Butyl Acetate	257,417	Methyl Ethyl Ketone	571,769
iso-Butyl Acetate	130,443	Methyl n-Butyl Ketone	66,455
iso-Butyl Alcohol	60,985	Methyl iso-Butyl Ketone	59,043
Butyl Cellosolve	5,636	Methyl Heptyl Ketone	15,900
Butyl Cellosolve Acetate	25,881	Methylene Chloride	29,299
Butyl Lactate	129	Methanol	393,512
iso-Butyl iso-Butyrate	619,674	Monochlorobenzene	207
C_8+Aromatics	372,752	Monoethanolamine	2,870
Cellosolve Acetate	52,040	1 & 2 Nitro-propane	2,575
Cellosolve Solvent	75,212	Olefins	416
Cyclohexane	4,021	Paraffins & Naphthenes	4,169,717
Diacetone Alcohol	2,437	Pentoxone	3,876
Ortho-Dichlorobezene	1,309	n-Propanol	3,357
Diethylene Glycol	1,543	iso-Propanol	1,673,935
Dimethyl Formamide	51,529	n-Propyl Acetate	2,478
Dipentane	181	iso-Propyl Acetate	1,483
Ethanol	59,804	Propylene Carbonate	610
Ethyl Acetate	11,140	Propylene Glycol	74,462
Ethyl Amyl Ketone	663	Tetrahydrofuran	24
Ethyl Benzene	63,868	Triethanolamine	2,068
Ethylene Dichloride	1,144	Triethylene Glycol	1,323
Ethylene Glycol	62,513	Trichloroethylene	24
Hexane	303	Toluene	534,229
		Turpentine	6,088
		Xylene	269,177

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TABLE 2-21. AUTOMOTIVE SPRAY BOOTH EMISSION PROFILE

	Type of Coating					
	Primer			Top Coat		
	Water-borne	Oil-borne	Composite	Water-borne	Oil-borne	Composite
Fraction of Emissions	0.3	0.7	1.0	0.1	0.9	1.0
Organic Compounds % wt						
Acetone	68.9		20.7	9.9		0.9
Benzene	22.2		6.6	16.0		1.6
Toluene	8.9		2.6	8.6		9.0
N-Heptane					0.4	0.4
I-Heptane					5.8	5.2
N-Octane		19.6	13.7		25.4	22.8
I-Octane		22.2	15.5		23.8	21.4
I-Nonane		37.1	26.0		16.4	14.8
Cyclohexane		2.2	1.5		7.4	6.7
C-7 Cycloparaffins		0	--		7.4	6.7
C-8 Cycloparaffins		8.0	5.6		10.9	9.8
C-9 Cycloparaffins		1.6	1.1		2.0	1.8
2 Methyl Pentane		8.7	6.1		0.5	0.5
3 Methyl Pentane		0.8	0.6			
Methane				39.6		3.9
Ethane				4.9		0.5
Ethyl Acetate				21.0		2.1

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TABLE 2-22. CLASS II LANDFILL SITE

	% by Wt.
Methane	98.6
Ethane	0.1
Propane	0.1
Cyclopentane	0.2
N-Butane	0.2
Iso-Butane	0.1
N-Pentane	0.1
Terpenes	0.1
Perchloroethylene	0.3
Toluene	0.1
Xylene	0.1
	100.0

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7. Natural forest emissions--As discussed in Section 2.3.4, emissions from the natural interaction between forest vegetation and the atmosphere represented the largest source of organic compound emissions to the atmosphere, equaling approximately 1200 tons per day. These emissions had been identified by Rasmussen (Ref. 2-19) as consisting of terpenes. Specifically α pinene emissions had been associated with emissions from soft woods whereas hard wood tended to emit isoprene. However, since the identification and characterization of these emissions was far from complete a detailed profile development for the various forest types did not appear warranted. Therefore in this study, emissions from forest vegetation were identified simply as terpenes. Continued interest in those emission generated by additional verification of these emission rates and more complete identification of the organic compounds considered will no doubt result ultimately in a more detailed emission profile.

2.3.3 Solvent Use Questionnaires

Solvent use questionnaires were processed primarily to obtain information on the quantities and specific types of solvents used in the Basin during 1975 for use in developing emission profiles and factors. Other information on process equipment, control devices, future plans for modifications or expansion were also requested for checking the EIS data and forecasting emission trends.

KVB prepared the questionnaires using modified formats from Reference 2-20. Sections were specifically directed to the following solvent users:

- Degreasing Operations
- Dry Cleaning Operations
- Protective and Decorative Coatings
- Fabric and Rubberized Coatings
- Miscellaneous Coatings
- Ovens
- Printing Operations

Data were requested on an individual device basis using actual process records or best estimates from total plant consumption. Provisions for confidential or proprietary information were made. A copy of the organic solvent use questionnaire is presented in the Appendix.

Individual questionnaires were mailed to approximately 200 plants within the Basin with reported total organic compound emissions from solvent use in excess of 25 tons per year. Only the questionnaire forms that would pertain to the individual source operation were included. The response to these questionnaires was only 25% despite follow-up by telephone.

Of those returned, the quality and completeness of the information was excellent providing detailed information on solvent composition and operating parameters previously not available. Data were obtained from a wide cross section of industries which added depth to the data base. These data, along with updated solvent use patterns for those firms visited during the field test program have been incorporated into the final emission inventory.

2.3.4 Area Sources

An important aspect of the KVB organic compound inventory was the identification of sources of organic compound emissions not under permit and generally not included or adequately characterized in previous inventories. These sources were grouped as waste disposal, petroleum operations other than refining, domestic and agricultural sources, geogenic sources and natural emissions. Because these were diffuse sources not concentrated like industrial point sources, they are referred to as area sources. Emission factors for these sources were therefore based on land area, population, land use or other criteria characteristic of the area source.

Table 2-23 presents a summary of total hydrocarbon emission estimates from each of the area sources considered. Precise emission rates were difficult if not impossible to estimate due to the complex nature of each source type. A discussion of realistic limits to these values is presented in subsequent sections.

A second objective of the current project was to locate these area sources geographically in the Basin. To this end, information was secured from various governmental agencies on population distribution, land use, petroleum production operations, etc. Maps corresponding to the approximate location of each source were developed for each source. Area sources based on population were distributed on a per capita basis based on information received from the ARB.

The following sections present a discussion of the methodologies and references used in making these estimates. In general, the procedure involved the establishment of two factors, (1) an emission factor coupled with (2) an appropriate inventory. Using this procedure, improvements to either factor can be readily employed to improve future estimates.

It must be pointed out that the emission factors and inventories presented were developed for use in this study of the California South Coast Air Basin and are not necessarily appropriate or applicable to other study areas. Caution must be exercised in their application to other study areas.

A. Waste Disposal--

1. Agricultural burning--The organic compound emissions from the burning of agricultural wastes in California have been recognized for several years (Ref. 2-21). The ARB and the EPA have sponsored several on-going studies (Refs. 2-22, 2-23, 2-24) with the intent of developing emission factors for such operations.

TABLE 2-23. EMISSION ESTIMATES FOR AREA SOURCES (STATIONARY SOURCES ONLY)

	Tons/Day
Waste Disposal	
Agricultural Burning	2
Sanitary Landfills	900
Petroleum Operations	
Production Operations	70
Marine Terminals	3
Gasoline Marketing	80
Natural Gas Transmission	80
Domestic and Commercial Sources	
Architectural Surface Coatings	100
Solvent Use	30
Fuel Consumption	5
Agricultural	
Natural Emissions	15
Orchard Heaters	3
Animal Wastes	80
Pesticides	15
Geogenic Sources	
Natural Seeps	10
Forest Emissions	
Natural Emissions	300*
Forest Fires	40
Other Sources	
Dry Cleaning	25
Asphalt Paving Operations	1

*An additional 200 tons/day is released above the inversion layers at altitudes above 3500 ft.

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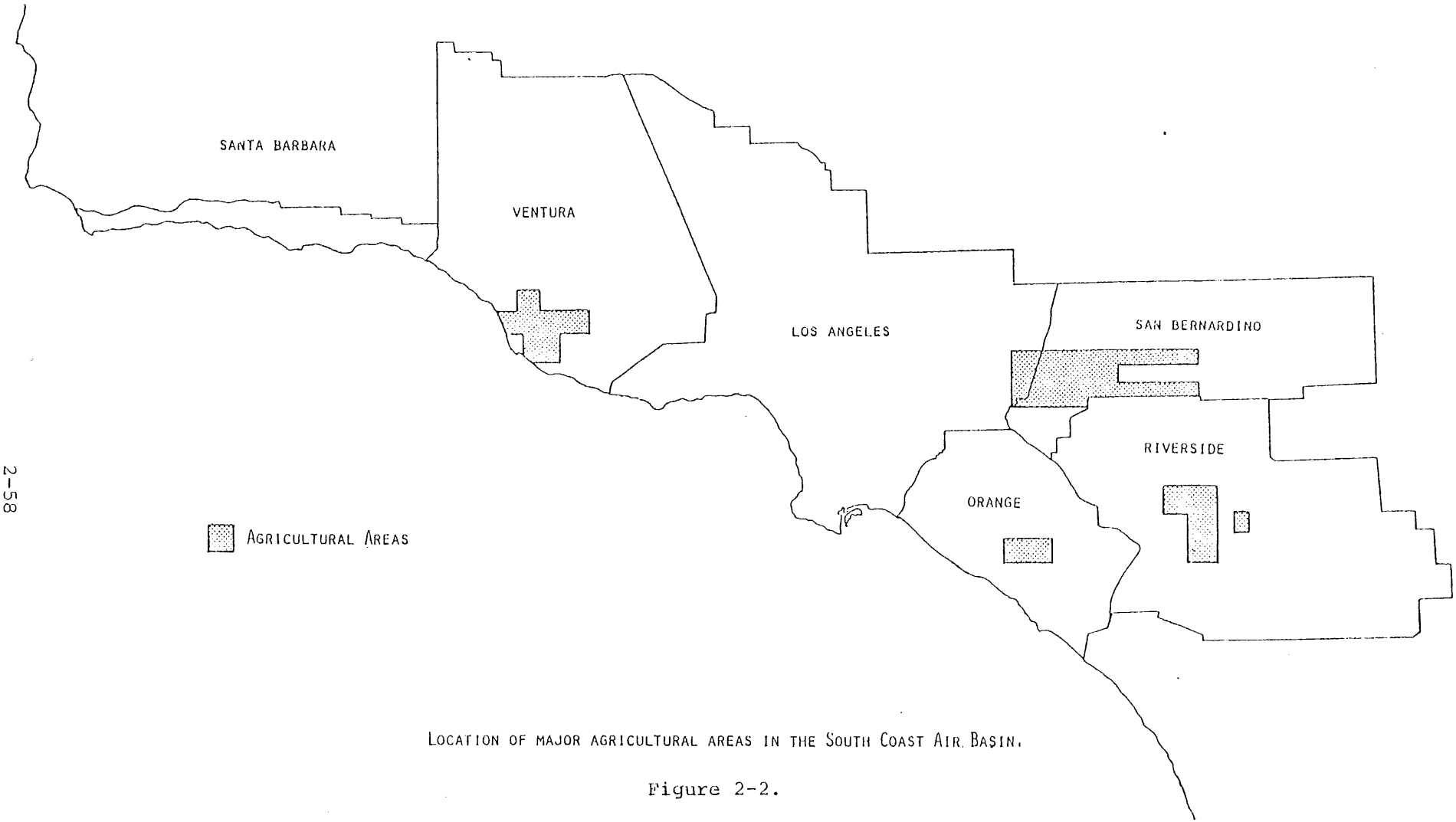
The ARB and local districts have also implemented regulations that severely restrict the open burning of waste materials. Existing regulations (Ref. 2-25) require burn permits to be issued by local government control agencies prior to the burning of farm wastes, burns conducted for range improvement, forest management, pest control or the improvement of wildlife or game habitats. Such burns can only be conducted during "permissive burn" days as determined by local meteorological conditions. Burn permits recorded the location and quantity of material to be burned.

Annual reports by the ARB were issued with estimates of the air pollution impact of these burns utilizing this inventory and the emission factors referred to above. It was estimated by the ARB that 550 tons of organic compound vapors were emitted in 1975 due to agricultural burning in the South Coast Air Basin. These emissions were distributed into the agricultural regions shown in Figure 2-2. The apportionment of these emissions were made based on the data on agricultural waste generation reported in the various county solid waste management plans and presented in Table 2-24.

2. Sanitary landfills--As shown in Table 2-25, over 15 million tons of liquid and solid wastes were disposed annually in the 45 major landfill sites distributed within the Basin as shown in Figure 2-3. Several studies (Refs. 2-26, 2-27) indicated that appreciable amounts of methane rich gas are generated due to the biological anerobic decomposition of these wastes. The production rate of this gas appeared to be highly dependent on the type, liquid content, soil composition and age of the particular site. These gases represent not only a potential source of useful energy but a large, currently uncontrolled source of organic compounds to the atmosphere.

No precise estimate of the emissions from landfill operations for the study area existed. Results from the above mentioned references and field tests during the current program were used to estimate the emissions from these sources. Three approaches were available. The first was to use the results from a recent study (Ref. 2-28) concerned with recovering these gases. Generally it was assumed that 3-6 cubic feet of methane gas are generated over the total period of decomposition for each pound of refuse.



LOCATION OF MAJOR AGRICULTURAL AREAS IN THE SOUTH COAST AIR BASIN.

Figure 2-2.

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TABLE 2-24. AGRICULTURAL WASTE PRODUCTION IN THE SOUTH COAST AIR BASIN AND VENTURA COUNTY

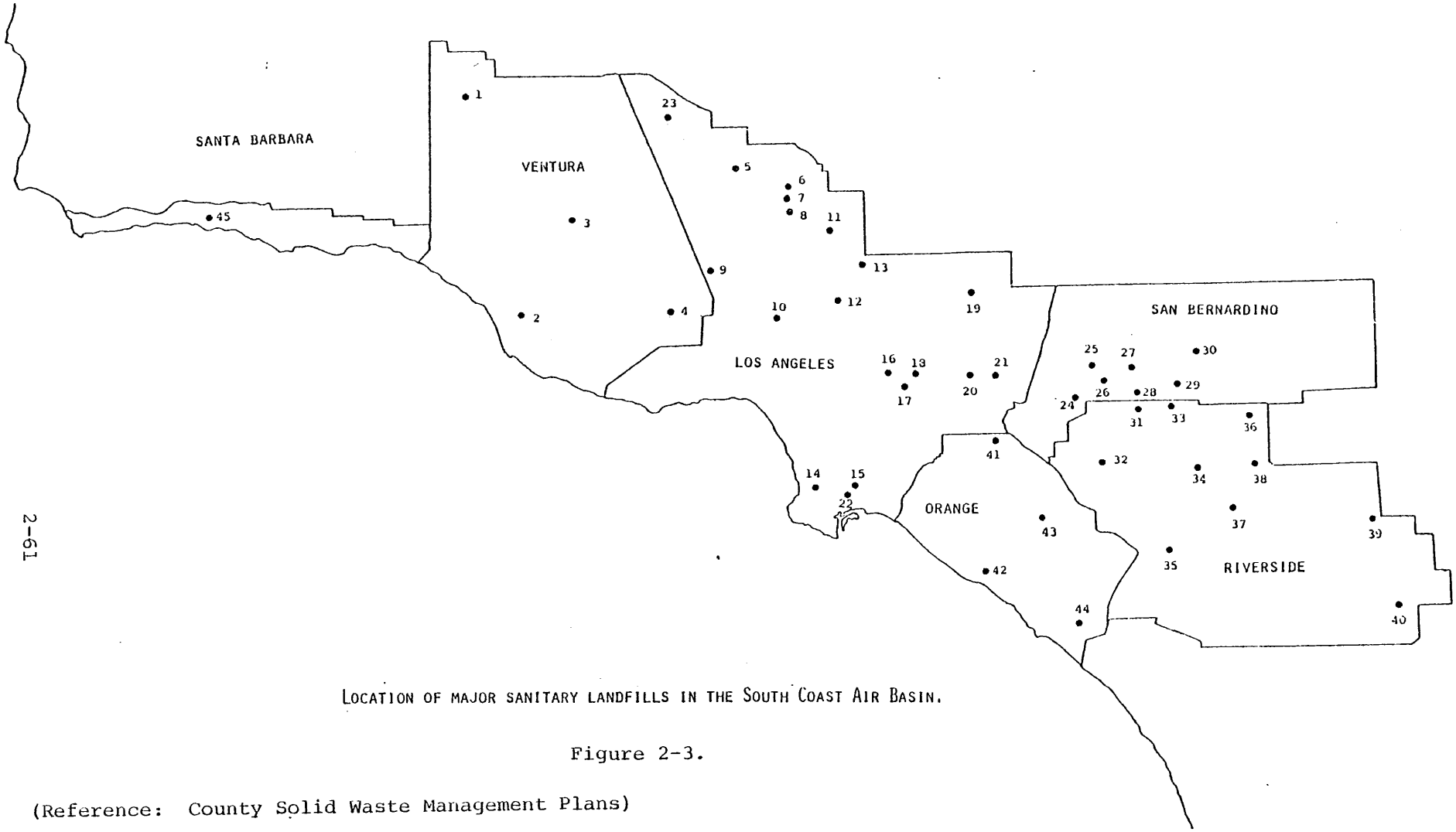
Agricultural Wastes* (Tons/Year)	County				
	Ventura	Los Angeles	Orange	Riverside†	San Bernardino†
Fruit & Nut Crops	107,644	--	--	139,800	87,400
Field & Row Crops	30,900	60,000	112,000	765,000	9,800
Vegetable	481,800	--	--	--	--
Total	620,344	60,000	112,000	904,800	97,200

*Data from the county solid waste management plans.
†Totals only available for counties as a whole.

TABLE 2-25. EXISTING MAJOR CLASS I AND II SANITARY LANDFILL SITES IN THE SOUTH COAST AIR BASIN

(Reference - County Solid Waste Management Plans)

Quantity of Waste Received	Class	Reported Acreage	Tons/Year Liquid	Solid	Total
Ventura County, 1975					
1. Ozeha	II		- 1,086 -		1,086
2. Santa Clara	II	47	- 434,400 -		434,400
3. Toland Road	II	120	- 36,200 -		36,200
4. Simi	I	230	- 144,800 -		144,800
All Other Class II Sites		~60	- 167,400 -		167,400
Total		457			783,886
Los Angeles County, 1974					
5. N. Valley Refuse Center	II	230	-	550,000	550,000
6. Bradley Avenue Dump	II	63	-	332,000	332,000
7. Penrose Pit	II	73	-	398,000	398,000
8. Hewitt Pit	II	117	-	436,000	436,000
9. Calabasas Land Fill	I	416	36,000	320,000	356,000
10. Mission Canyon Land Fill	II	1,491	-	1,394,000	1,394,000
11. Burbank City Land Fill	II	133	-	75,000	75,000
12. Toyon Canyon Land Fill	II	40	-	795,000	795,000
13. Scholl Canyon Land Fill	II	484	-	450,000	450,000
14. Palos Verdes Land Fill	I	295	280,000	1,300,000	1,580,000
15. Ascon	II	65	85,000	422,000	507,000
16. Operating Industries	II	190	177,000	589,000	766,000
17. City of Whittier Land Fill	II	117	-	107,000	107,000
18. Puente Hills Land Fill	II	1,214	17,000	1,165,000	1,182,000
19. Azusa Western	II	307	-	271,000	271,000
20. B.K.K. Land Fill	I	583	254,000	352,000	606,000
21. Spadra Land Fill	II	199	13,000	192,000	205,000
22. Harbor Dump	II	25	-	160,000	160,000
23. Chiquita Canyon Land Fill	II	40	-	33,000	33,000
All Other Minor Class II Sites		N.R.		56,050	56,050
Total		6,082	862,000	9,341,000	10,203,000
San Bernardino County, 1974					
24. Milliken	II	106	-	215,500	215,500
25. Cajon	II-2	106	- 117,500 -		117,500
26. Fontana	II	82	-	64,000	64,000
27. Heaps Peak	II	63	-	16,600	16,600
28. Colton	II	94	-	93,700	93,700
29. Yucaipa	II	560	-	34,600	34,600
30. Big Bear	II	70	-	11,600	11,600
Total		1,081			553,500
Riverside County, June 1975					
31. West Riverside	II-2	63	- - 52,700 -		52,700
32. Corona	II-2	101	- 88,350 -		88,350
33. Highgrove	II-2	280	-	8,100	8,100
34. Mead Valley	II-2	240	-	8,100	8,100
35. Elsinore	II-2	44	-	12,400	12,400
36. Badlands	II-2	904	-	15,500	15,500
37. Double Butte	II-2	580	-	61,380	61,380
38. Lanb Canyon	II-2	788	- 48,050 -		48,050
39. Idyllwild	II-2	30	- - 3,010 -		3,010
40. Anza	II-2	10	-	1,550	1,550
Total		3,040			299,140
Orange County, December 1975					
41. Olinda	II	235	-	758,000	758,000
42. Coyote Canyon	II	593	-	2,130,000	2,130,000
43. Santiago Canyon	II	160	-	374,000	374,000
44. Prina DeSchecha	II	945	-	478,000	478,000
Total		1,933		3,740,000	3,740,000
Santa Barbara, 1975					
45. Tajiguas	II	130	-	302,900	302,900
GRAND TOTAL		11,580			15,782,426



LOCATION OF MAJOR SANITARY LANDFILLS IN THE SOUTH COAST AIR BASIN.

Figure 2-3.

(Reference: County Solid Waste Management Plans)

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Assuming the lower figure, this represents a 13% conversion by weight of waste to generated organic vapors. For the 15 million tons of refuse deposited annually, this represented 2 million tons of methane gas or nearly 5500 tons per day, assuming that the decomposition period was one year.

The second approach used estimates of the rates of carbon escape over the "life" of the fill presented in a study by the California State Water Quality Control Board (Ref. 2-29). Using this study, it was found that

$$r = \frac{177}{3.75 + 1.95t}$$

where r = rate of carbon escape (lb/ton refuse·year)

t = age of refuse (years)

Note that carbon is released as both methane and carbon dioxide gas. To use this relation, a gross estimate of the total quantity and age of wastes presently "alive" in the Basin was needed. It was assumed for the purpose of this estimate that the quantity of materials disposed in landfills over the last 75 years was constant and therefore proportional to the total population with the Basin. A summary of the resulting computation using the above relation and the assumed age and quantity of refuse alive in the Basin is given in Table 2-26. As shown in Table 2-26, 90% of the carbon emission result from deposits made in the last 25 years. Assuming 15% by weight of the total carbon emitted is transformed to methane (Ref. 2-29), this would represent 340,000 tons per year or approximately 930 tons per day of methane emissions.

The third approach employed test data generated by KVB during the current test program. Utilizing techniques described in Section 3.0, it was estimated that 1500 lb/acre·yr of gas were evolved from landfills. This represented 240 tons/day from the 46 sites in the Basin. This however represents the results from only two tests on relatively small landfill surface areas of indeterminable composition and history.

TABLE 2-26. SUMMARY OF COMPUTATION OF TOTAL CARBON RELEASE FROM ACTIVE LANDFILL SITES DURING 1975*

Period	t (yr)	r (lb c/ton refuse)	% of 1975 Refuse (based on population)	Refuse Quantity for Period (10^6 tons)	Total Carbon Emissions in 1975 (10^6 lb)
1970-75	2.5	20.52	98	76.3	1566.49
1965-70	7.5	9.63	92	71.7	690.14
1960-65	12.5	6.29	83	64.7	406.68
1955-60	17.5	4.67	70	54.5	254.65
1950-55	22.5	3.72	55	42.8	159.38
1945-50	27.5	3.08	44	34.3	105.57
1940-45	32.5	2.64	35	27.3	71.98
1935-40	37.5	2.30	28	21.8	50.17
1930-35	42.5	2.04	23	17.9	36.55
1925-30	47.5	1.84	18	14.0	25.80
1920-25	52.5	1.67	13	10.1	16.91
1915-20	57.5	1.53	8	6.2	9.53
1910-15	62.5	1.41	4	3.1	4.39
1905-10	67.5	1.31	2	1.6	2.04
1900-05	72.5	1.22	1	0.8	0.95
Total				447.1	3401.23

*(Ref. 2-29)

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For the final organic inventory, the second approach was selected because it appeared to have the most data to substantiate the emission factors. It was evident, however, that regardless of the approach used, the organic compound emissions from these sources were appreciable.

B. Petroleum Operations--

1. Production operations--As shown in Table 2-27, extensive petroleum production operations were underway in the Basin. Nearly 150 million barrels of crude oil and 116 billion cu.ft. of natural gas were produced in 1975 (Ref. 2-17). For this inventory only onshore production operations were considered. These production facilities were distributed throughout the study area as shown in Figure 2-4.

Prior to this ARB study, the magnitude and composition of organic compound emissions from production operations other than tank storage were essentially unknown. Tests were conducted at two locations recommended by the Western Oil and Gas Association as typical of such operations in the Basin. Since only brief test programs were possible during the current program, the emission factors developed should be considered as representative and useful for estimating purposes only. Discussion of the test procedures employed and the emission factors developed is included in Sections 2.3 and 3.0.

A summary of the emission factors and inventories used in the current study are given in Table 2-28. These inventories were made based on data from the California Department of Oil and Gas (Ref. 2-17), data from SCAQMD (Ref. 2-6) and numerous discussions with representatives of the major petroleum production companies operating in the Basin. It must be emphasized that these represented data for the study area only and should not be applied arbitrarily to any other situation. Confidence factors on a scale of A to E (A-high, E-poor) were also assigned to assist in the evaluation of these data.

TABLE 2-27. PETROLEUM PRODUCTION FIELDS IN THE SOUTH COAST AIR BASIN (1975)

(Reference: California Division of Oil and Gas)

	Average Number of Producing Wells	Oil Production 10^3 Bbl/yr	Gas Production 10^6 ft^3/yr
1. Aliso Canyon	90	670	38,413
2. Bandini	32	141	207
3. Bardsdale	93	154	616
4. Beverly Hills	179	5,141	7,168
5. Brea-Olinda	736	3,185	4,136
6. Carpenteria	61	1,452	1,730
7. Casataic Hills	27	44	85
8. Casataic Junction	27	473	1,806
9. Chino-Sequel	8	5	-
10. Delle Valley	33	99	1
11. Dominques	132	1,035	503
12. East Coyote	152	721	342
13. El Sequndo	6	37	19
14. Esperanza	13	23	-
15. Eureka	14	32	1
16. Honor Ranch	15	140	328
17. Hopper Canyon	9	96	109
18. Huntington Beach	1,108	17,167	3,999
19. Inglewood	441	3,580	1,788
20. Kraemer	79	1,686	14
21. Long Beach	623	2,594	1,562
22. Los Angeles	46	52	858
23. Mohala	34	143	47
24. Montalvo	51	587	1,311
25. Montebello	216	675	522
26. Newhall	42	39	9
27. Newhall-Potrero	80	444	7,699
28. Newport	239	1,425	40
29. Oak Canyon	19	185	293
30. Oak Park	15	82	12
31. Oakridge	20	207	81
32. Ojai	138	1,127	1,814
33. Olive	8	56	22
34. Oxnard	92	368	281
35. Piru	7	3	-
36. Placentia	169	296	-
37. Playa Del Rey	52	70	15
38. Potrera	18	129	150
39. Prado-Covona	13	69	32
40. Ramona	101	179	384
41. Richfield	257	1,666	138
42. Rincon	311	2,919	3,729
43. Rosecrans	115	503	589
44. Salt Lake	57	1,019	761
45. San Miguleto	62	1,794	882
46. Sansinena	116	736	1,151
47. Santa Fe Springs	216	709	688
48. Santa Paula	17	10	2
49. Santa Suzana	13	151	1,826
50. Saticoy	33	200	150
51. Seal Beach	173	1,205	855
52. Sespi	182	1,085	1,380
53. Shields	77	350	93
54. Simi	39	42	17
55. South Mountain	437	1,548	2,663
56. Summerland Off Shore	22	259	1,328
57. Sunset Beach	5	12	-
58. Tapia	12	20	-
59. Tapo	25	54	6
60. Temescal	16	67	11
61. Timber Canyon	25	90	260
62. Torrence	388	2,859	1,421
63. Torrey Canyon	41	207	2,659
64. West Coyote	144	2,039	184
65. West Mountain	23	50	77
66. Whittier	208	693	669
67. Wilmington	2,285	65,595	11,808
68. Ventura	787	10,943	6,776
69. Yorba Linda	486	3,726	11
TOTALS	11,810	145,162	116,031

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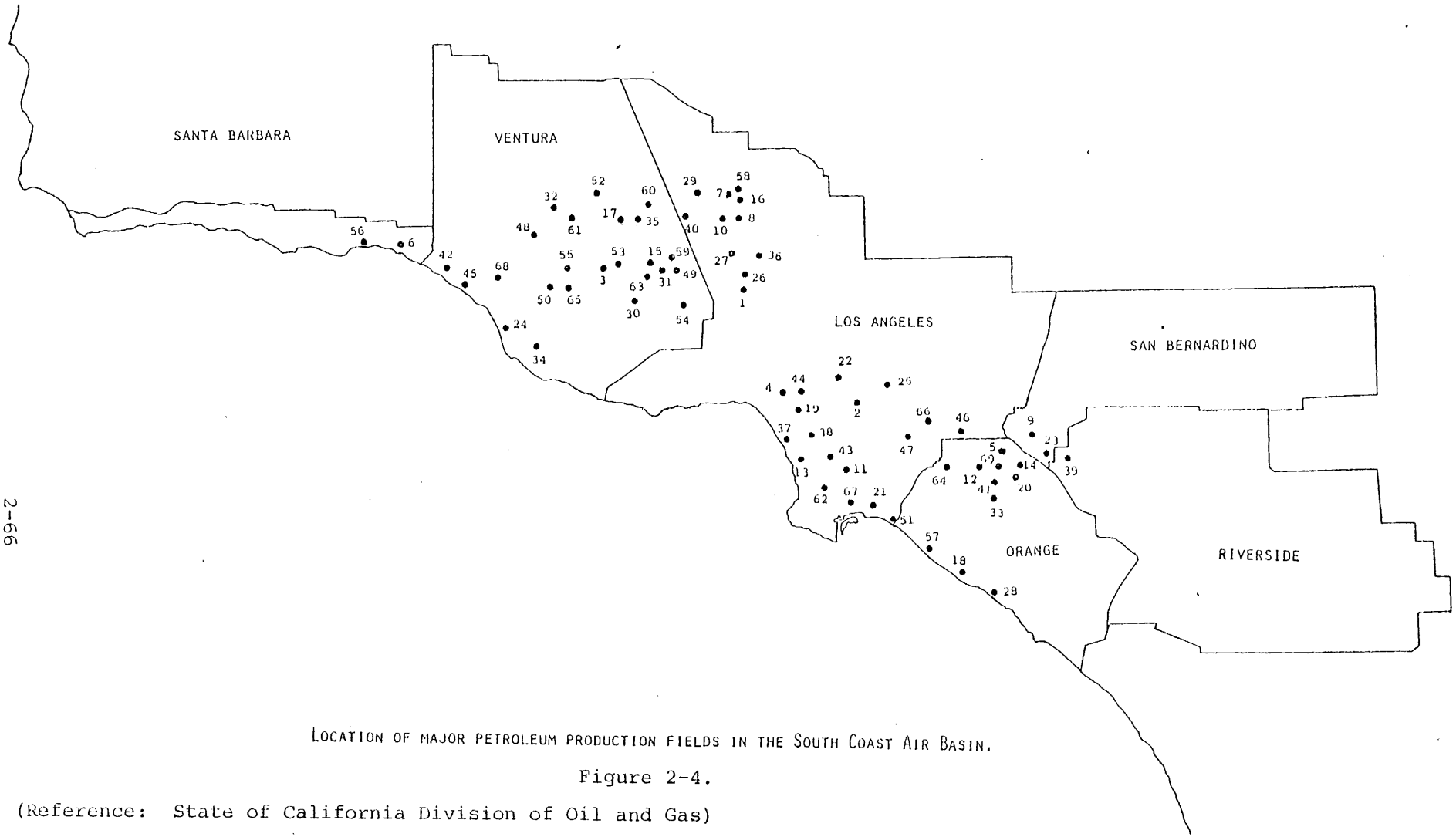

LOCATION OF MAJOR PETROLEUM PRODUCTION FIELDS IN THE SOUTH COAST AIR BASIN.

Figure 2-4.

(Reference: State of California Division of Oil and Gas)

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TABLE 2-28. PETROLEUM PRODUCTION EMISSION FACTORS AND INVENTORIES

Source	Units	Emission Factor	Inventory	Emission Estimate† (tons per day)	Confidence Level
Crude Oil Storage Tanks	--	*	1650 tanks	34	B
Process Drains	lb TOC/rod pump well-day	2.0	8000 rod pump wells	8	D
Oil/Water Separators	lb TOC/ft^2-day	0.1	184,000 ft^2	9	C
Fugitive Leaks from Valves	lb TOC/valve-day	0.10	150,000 valves	8	B
Pump Engine Exhausts	lb TOC/10^6 ft^3	1400	4250×10^6 ft^3/yr	8	C
Heaters and Boiler Exhausts	lb TOC/10^6 ft^3	30.0	5100×10^6 ft^3/yr	0	C
TOTAL				67	

* Emissions estimated by local control agenices using API 2518, adjusted to 60% of this using the analysis contained in Section 2.3.1.

† Emissions have been rounded to the nearest ton per day.

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As shown in Table 2-28, petroleum production operations represented approximately 68 tons per day of which 50% were from storage tanks. The balance were primarily fugitive emissions from leaking valves and metal connections and evaporation from standing oil.

2. Marine terminals--As shown in Table 2-29, significant quantities of petroleum products were transferred through marine terminals in the Basin. These generally represented (1) crude oil loading off the Santa Barbara and Ventura coasts, (2) crude oil delivery to refineries in Los Angeles County and (3) refined product loaded at the Los Angeles and Long Beach Harbors and the El Segundo Marine Terminal as illustrated in Figure 2-5. A description of the various marine facilities within the study area can be found in Reference 2-30.

TABLE 2-29. MARINE TRANSFER OPERATIONS IN THE SOUTH COAST AIR BASIN

	Quantity (10^6 gal)	Emission Factor (lb/10^3 gal)	Emission Rate (Ton/Yr)
Loaded			
Fuel Oils	1304	0.0002	0.1
Gasolines	384	2.5	480.0
Distillates	881	0.005	2.2
Crude Oils	754	1.20	452.4
Lube Oils	29	< 0.001	0.0
Petrochemicals	57	0.56	16.0
			950.7
Unloaded			
Fuel Oil	951	--	--
Gasolines	627	-- (Not determined	--
Distillates	433	-- - mobile	--
Crude Oils	7724	-- sources)	--
Lube Oils	86	--	--
Petrochemicals	17	--	--

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Considerable interest was raised concerning the magnitude of these emissions. Several studies directly applicable to this program were initiated. These involved a WOGA/Chevron crude oil loading program in Santa Barbara and Ventura Counties (Ref. 2-31) and a SOHIO product transfer program in the Los Angeles/Long Beach Harbor area (Refs. 2-32, 2-33).

Emission factors for crude oil loading ranged from 0.5 to 2.0 $lb/10^3$ gal (Ref. 2-10) and appeared to be a function of the condition and cleanliness of the tanker prior to loading as well as the properties of the crude being loaded. For the purpose of this inventory, an emission factor of 1.2 $lb/10^3$ gal proposed by Laird (Ref. 2-34) and used by both the Santa Barbara and Ventura APCD's has been employed. Total organic compound emission rates based on this emission factor are presented in Table 2-29.

The loading of refined petroleum products had received much less recent investigation. Estimates of loading loses were made using a formula developed by API (Ref. 2-35):

$$L = 0.3\ PW$$

where

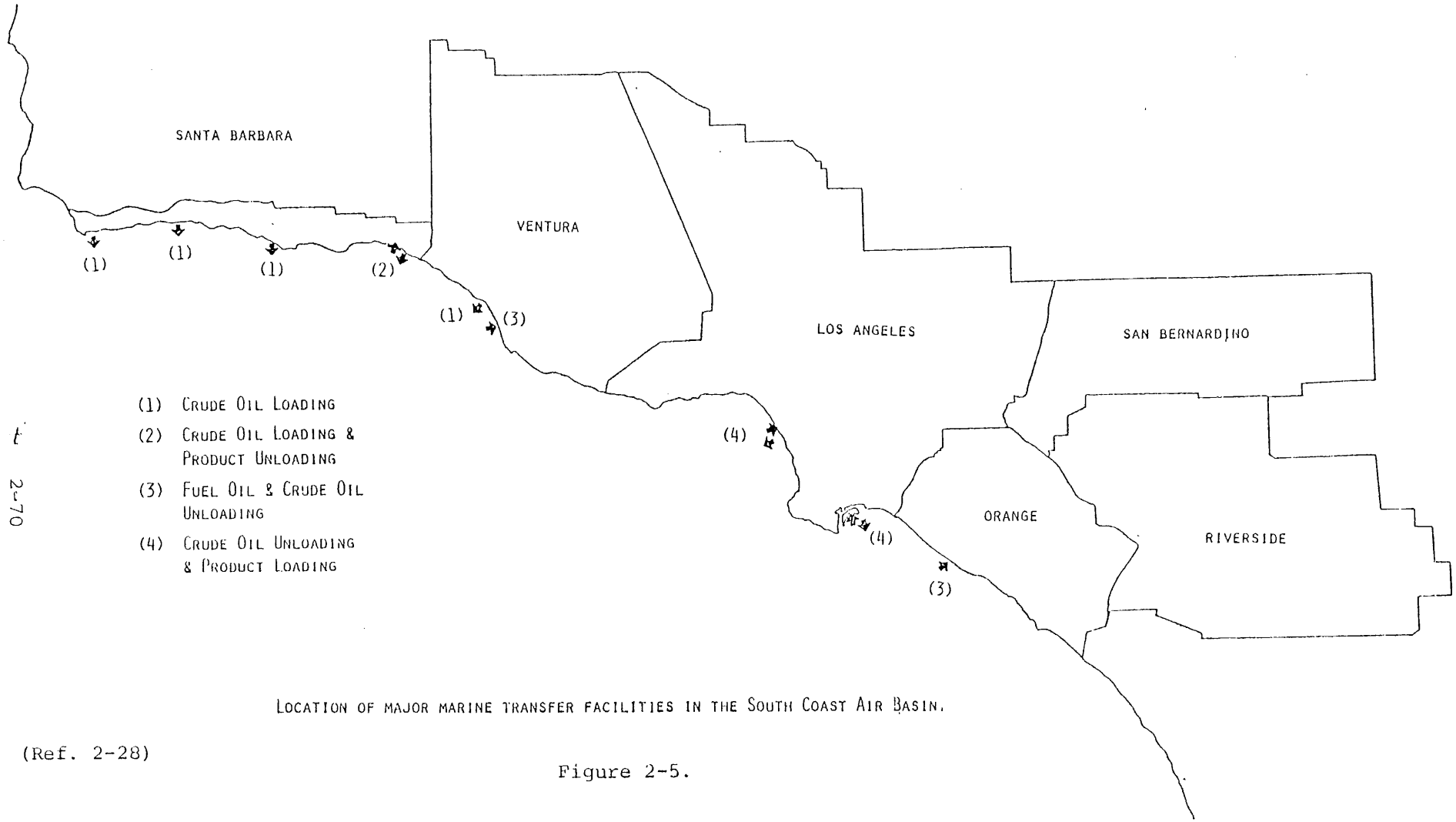
L = loading loss $lb/10^3$ gal of load

P = true vapor pressure at storage temperature, psia

W = density of liquid at storage temperature, lb/gal

Inventories of the total product throughput in the harbors were obtained from the Corps of Engineers (Ref. 2-36). These inventories together with the above emission factor were employed to generate the emission rates given in Table 2-29.

Additional emissions resulting from what is generally termed "unloading losses" were considered and discarded. The great majority of these losses resulted from shipboard operations including bilging and venting which take place at sea as well as within the harbor area. Since these operations are small and more appropriately considered as "mobile sources," they are not included in the current inventory.



LOCATION OF MAJOR MARINE TRANSFER FACILITIES IN THE SOUTH COAST AIR BASIN.

(Ref. 2-28)

Figure 2-5.

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3. Gasoline marketing--Organic compound emissions from the transfer of gasoline to automobile tanks has been recognized as a major source of emissions to the atmosphere and has been studied extensively. Control measures were being implemented in counties in Southern California to reduce these emissions through vapor recovery techniques at both the tanker truck to storage tank transfer (Phase I) and the nozzle to vehicle tank transfer operations (Phase II). Phase I had been essentially completed within the Basin whereas Phase II operations had yet to be started at the time of this study. A description of both Phase I and II operations is presented in Section 4.0.

Emission factors have been recently revised (Ref. 2-10) to reflect additional test data on gasoline marketing operations and the effectiveness of these control measures. The emission factors used in this study (given in Table 2-30) represent not only information from Reference 2-10, but also discussions with representatives of the EPA and the San Diego County APCD, one of the most active of the local control agencies in assessing the validity of these emission rates and effectiveness of Phases I and II control measures. Note that the emission factor for submerged filling of underground tank (controlled) is 0.7 lb/10^3 gal. throughput which represents a 90% control efficiency, rather than the AP-42 (Ref. 2-3) value of 0.3 lb/10^3 gal. throughput which would represent a control efficiency of 95%. The 95% control efficiency is believed to be too high.

TABLE 2-30. GASOLINE MARKETING EMISSION FACTOR

Emission Source	lb/10^3 Gal Throughput
Submerged Filling of Underground Tank (Controlled)	0.7
Underground Tank Breathing	1.0
Vehicle Refueling Displacement Loss (Uncontrolled)	9.0
Vehicle Refueling Spillage Loss	0.7

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These emission factors have been incorporated with an estimate of gasoline sales in the Basin generated for this program. Estimates by the California Board of Equalization (Ref. 2-37) indicated that 52% of the total gasoline sales in the state occurred in the six counties comprising the study area. This amount was corrected to account for the population of those counties which have areas outside the Basin. A summary of this calculation is presented in Table 2-31. This procedure resulted in an estimate of 5.3 billion gallons of gasoline sold annually in the Basin. Applying the appropriate emission factors from Table 2-30 resulted in an average daily emission rate of organic compounds from this source of 83 tons per day.

These emissions have been distributed by estimated sales and location of service stations as described in Section 2.2.2. Information on the sales from individual stations was available for Ventura and Santa Barbara Counties generated by surveys conducted by the local APCD's. Additional information on gasoline sales for specific service stations in Los Angeles County was available in Reference 2-39, however not in a form suitable for processing.

4. Natural gas distribution--The average daily consumption of natural gas by all sources in the South Coast Air Basin is in excess of 1.5 billion cubic feet. Although precise measurements are not available, the Southern California Gas Company (Ref. 2-40) estimated that of this total, 3.7 million cubic feet (0.25%) or 83 tons per day were lost to the atmosphere as fugitive emissions from valves, flanges and other metal connections as well as pipe failures or required maintenance works.

This estimate was made by SCGC by taking the difference between purchased gas that enters the system and the total sales volume from all users less internal SCGC usage. Of the remainder, 25% were assumed lost as fugitive emissions and the balance as metering inaccuracies.

These emissions have been distributed throughout the Basin on the basis of population. This generally reflects the location of transfer facilities and especially meters and their metal connections which have been shown to be the most prevalent source of fugitive emissions.

TABLE 2-31. COUNTY GASOLINE SALES

1976 Total State Sales - 10,756,387,557 Gallons of Gasoline*

County	% of Total State Sales*	Annual Sales gallons x 10^6	Total Population	Population in SCAB †	% of Population in SCAB	Total Sales in SCAB x 10^6 gal/yr
Los Angeles	34.25	3,684.063	6,963,604	6,884,933	98.87	3,642.284
Orange	7.64	821.788	1,722,042	1,722,042	100	821.788
Ventura	1.79	192.539	442,060	422,060	100	192.539
San Bernardino	3.92	421.650	701,220	578,409	82.49	347.803
Riverside	2.86	307.633	534,726	383,945	71.80	220.887
Santa Barbara	1.41	151.665	281,294	162,294	57.70	81.504
						5,312.805

* Ref. 2-37.

† Ref. 2-38.

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C. Domestic and Commercial Sources--

Over 10 million people reside in the Basin. Therefore sources of organic compound such as domestic fuel burning, solvent use, dry cleaning and surface coatings which may appear to be small for each individual, can collectively represent large sources of organic emissions. Emission factors were developed on this program on a per capita basis and were distributed by population.

1. Architectural surface coatings--Estimates of the total volume of coatings applied to the surface of stationary structure and marketed within the Basin was difficult to make due to the large number of manufacturers and suppliers involved. The most effective approach was to use marketing questionnaires. This proved to be very time consuming and costly operation without the legal authority to require responses by those questioned.

Surveys that were performed by the local control agencies in California showed that emissions of organic compounds from architectural surface coating applications were from 3.4 to 3.7 tons/1000 people/year (Ref. 2-41). The ARB estimated that 93 tons per day of emissions result from architectural coating within the Basin (Ref. 2-42) for annual emission factor of 3.3 tons per 1000 people. In the same study it was estimated that total emissions from architectural coating for the entire state amounted to 193.7 tons per day or an annual emission factor for the state of 3.3 tons per 1000 people consistent with the estimate for the South Coast Air Basin. Thus 3.3 tons/1000 people/year was used in this inventory resulting in total emissions within the study area of 97.6 tons per day.

2. Domestic solvent use--Numerous products used in residences, commercial establishments and industrial plants contain organic solvent materials. Such products included cleaning compounds, floor waxes, cosmetics, and health and beauty aids used in homes and commercial establishments (barber and beauty shops, shoe repair shops, etc.) and institutions (schools, hospitals, churches, etc.). The total contribution of solvent evaporation from these products had not heretofore been attempted. Due to the large potential for organic emissions, it was felt necessary to determine its magnitude.

Two approaches were used. The first consisted of obtaining information on product sales from a limited number of retail establishments in Orange County. These sales data were divided by the approximate consumer population for that establishment and an emission factor on a per capita basis was obtained.

The second approach used data from the Department of Commerce (Ref. 2-43) on the total value of these products manufactured nationally. A national use factor was then determined by dividing the total value by wholesale prices for each product. These wholesale prices were determined by KVB through a limited survey of local retail establishments and contacts with major manufacturing sales representatives. No itemized wholesale price information was available. A summary of the estimated national sales and solvent composition is presented in Table 2-32.

Both approaches yielded an annual emission factor for all products of approximately 1.1 tons per 1000 people. This corresponds to an emission rate of 31 tons of total organic vapors per day released within the Basin.

3. Domestic and commercial natural gas fuel consumption--Over 410 billion cubic feet of natural gas were consumed annually by domestic and commercial users within the study area (Refs. 2-40, 2-44). An emission factor of 8 lb per million cubic feet (Ref. 2-4) was used which corresponded to an emission rate of 4.5 tons per day and an annual emission factor of 0.16 tons per 1000 people.

D. Agricultural Sources--

1. Natural citrus emissions--Studies have shown that significant quantities of terpenes are emitted as part of the natural biological cycle of citrus trees. An emission factor of 0.06 tons per year per acre of citrus trees was proposed by Zimmerman (Ref. 2-45).

There were approximately 85,000 acres of citrus trees in the Basin which were distributed by specific type and county as shown in Table 2-33 (Ref. 2-46). Using this inventory and the emission factor it was estimated that 13.9 tons per day of organic compounds were emitted to the atmosphere each year by this source.

These emissions were distributed into approximate areas of major citrus growing activity as shown in Figure 2-6 based upon information obtained from Citrus Industry representatives (Ref. 2-47).

TABLE 2-32. NATIONAL DOMESTIC AND COMMERCIAL SOLVENT SALES
Based on Department of Commerce Data

Product	Estimated National Sales (10^6 lbs)	Solvents (wt. %)	Total Weight of Solvents (10^6 lbs)
Furniture Polish	53	40	21
Floor Polish	87	40	35
Shoe Polish	3	40	1
Metal Polish	8	40	3
Shaving Soap	56	5	3
After Shave	49	20	10
Perfumes, Toiletries & Cosmetics	17	39	7
Shampoo	152	10	15
Hair Tonics	5	5	0
Hair Spray	210	59	124
Hair Rinses	23	5	1
Mouthwash	119	14	17
Creams	74	30	22
Suntan Oil	9	50	5
Hand Lotion	51	20	10
Cleaning Lotions	23	60	14
Rubbing Alcohol	153	100	153
Deodorant	148	14	21
Nail Polish	1	50	1
Nail Polish Remover	8	90	7
TOTAL			469

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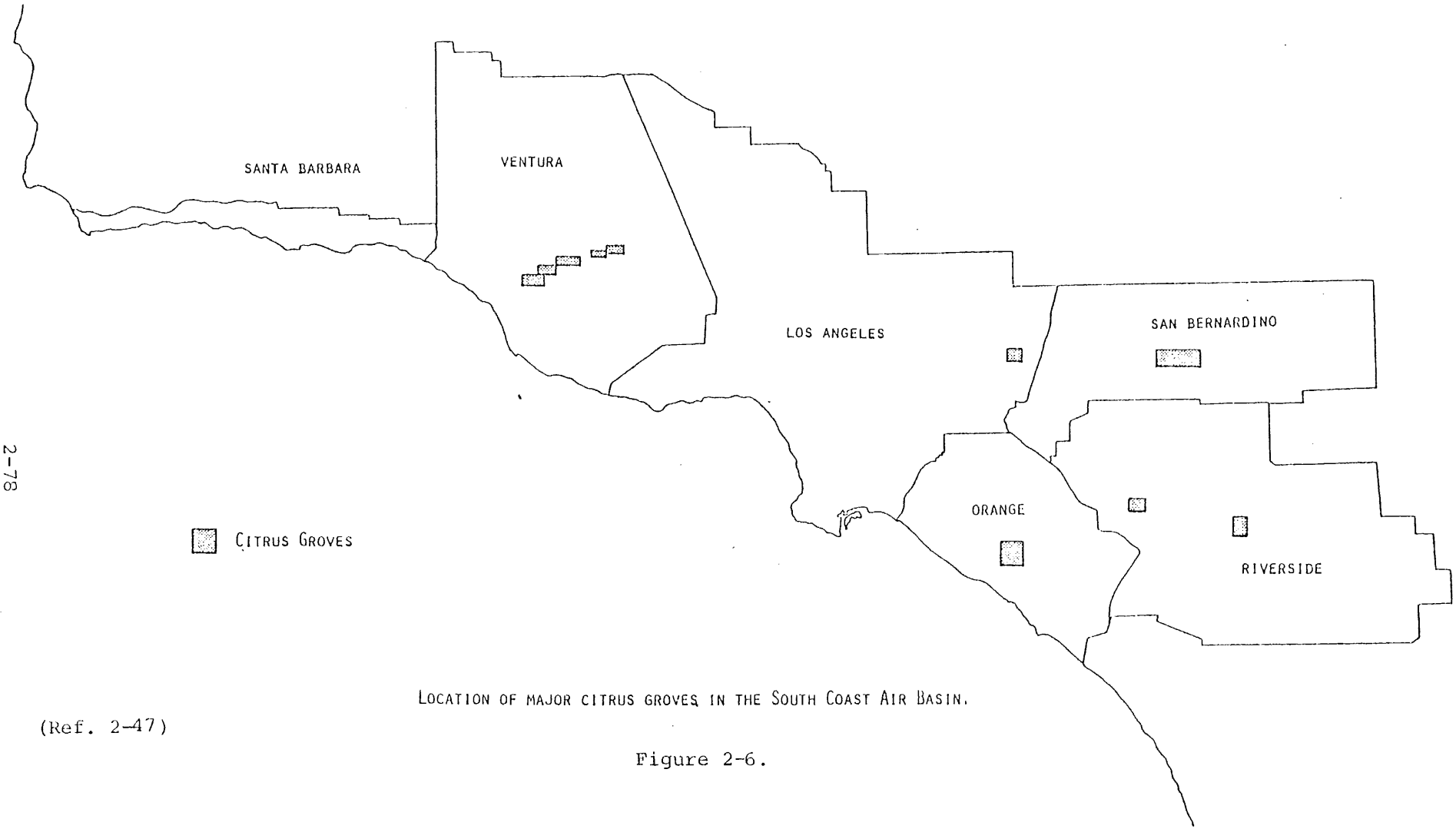
TABLE 2-33. CITRUS GROVE ACREAGE (1975)

Citrus Crop	Ventura	Orange	Los Angeles	Riverside	San Bernardino
Grapefruit	838	431	14	2,500	1,532
Lemons	23,098	1,148	953	5,300	2,220
Navel Oranges	1,427	102	283	8,400	6,782
Valencia Oranges	15,879	10,754	201	8,400	4,277
TOTAL	41,242	12,435	1,451	24,600	14,811

Reference 2-43.



LOCATION OF MAJOR CITRUS GROVES IN THE SOUTH COAST AIR BASIN.

(Ref. 2-47)

Figure 2-6.

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2. Orchard heaters--Orchard heaters were in common use in Ventura, San Bernardino and Riverside Counties to protect the citrus orchards from frost damage. It was estimated by the Ventura APCD (Ref. 2-48) that there were approximately 22 heaters per acre in citrus growth in that county.

Organic compound emissions resulted primarily from the evaporation of fuel oil and not as a result of the combustion process (Ref. 2-4). Therefore, even if the orchard heaters were used relatively infrequently, organic compound emissions were still present any time there was standing fuel exposed to the atmosphere. Emission estimates have been made in Reference 2-48A. The summer evaporation (March through November) averaged 2 gal./heater while the winter evaporation averaged 0.25 gal./heater, for a total of 2.25 gal./heater-year.

Emission estimates for the current program were based on published figures by the local control agencies. Total emissions from these sources were estimated to be 1200 tons per year.

3. Animal wastes--The existence of methane and other components in the gas generated by the biological decomposition of animal wastes had been extensively studied. These investigations had been aimed both at the potential for energy recovery (Ref. 2-49) as was the case with landfill gases and also to assess the harmful effects of these gases on livestock production in confined areas (Ref. 2-50).

Results from a recent study (Ref. 2-51) were employed to estimate the emission rates from these sources. A summary of the calculations is presented in Table 2-34. Inventories of the livestock population for each county were obtained from the County Agricultural Reports (Ref. 2-46). For these data, it was estimated that 77 tons per day of gases from animal wastes were generated in the agricultural areas shown in Figure 2-2.

TABLE 2-34. ORGANIC COMPOUND EMISSIONS FROM ANIMAL WASTES

	Total Inventory (10^3 Head)	Emission Factor (lb TOC/10^3 head·day)	Emissions (tons/day)
Cattle	147	440.5	32.4
Chickens	9992	7.0	35.0
Pigs	5	160.0	0.4
Horses	73	229.3	8.4
Sheep	87	33.2	1.4
Total			77.6

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4. Pesticides--Application of pesticides for agricultural and domestic use have been included in previous inventories of hydrocarbon emissions conducted by the local control agencies. These inventories have generally been based on county reports in the State Pesticide Use Report (Ref. 2-51A).

This procedure has also been used in the study. It was learned that the data base for the State Pesticide Use Report had been computerized by the University of California-Davis (Ref. 2-51B). Arrangements were made with the University to have the data reported for each pesticide on a township basis (to allow geographic distribution) and for the Basin as a whole. It was estimated from these data that the total emissions of pesticides in the study area were 5000 tons per year of which approximately 40% was nonsynthetic and 60% synthetic organic materials.

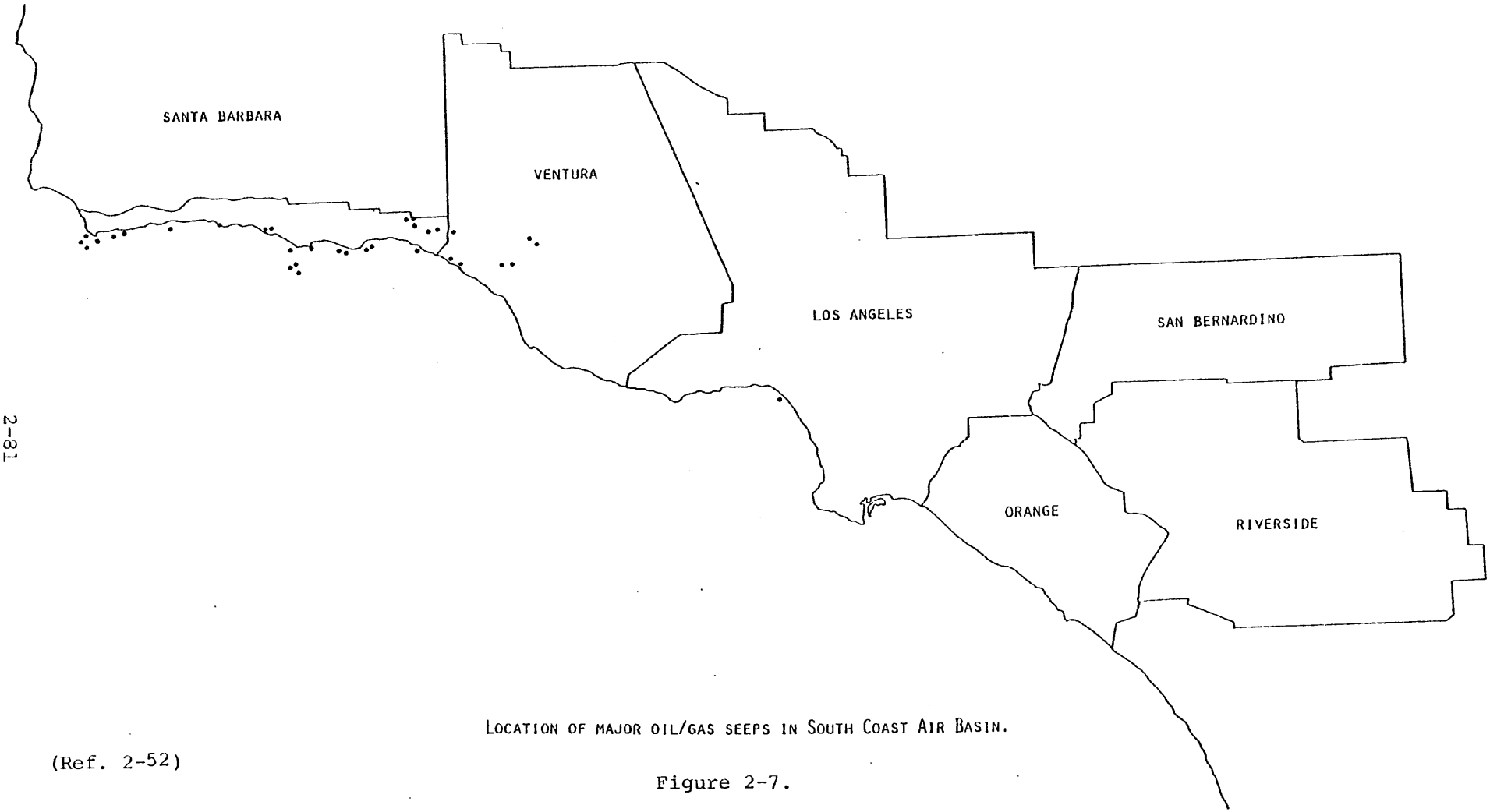
An estimate of the pesticide emissions due to domestic and commercial use has been made based on information from the Reference 2-51B for general pesticide use in the Basin. An emission factor of 9 tons/100,000 people·yr was developed from this data.

Recent more comprehensive examinations by CARB (Ref. 2-51C) have shown that the pesticide use reports under estimate the emissions from this source by factors of six and two for nonsynthetic and synthetic organic materials, respectively. Based on these estimates, the total emissions from these sources would be 17,000 tons per year. The quantification of these estimates was a complex problem as discussed in Reference 2-51B, and therefore the more conservative estimate, described above, was used in the inventory.

E. Geogenic Sources--

1. Natural seeps--Figure 2-7 (Ref. 2-52) shows the location of the major petroleum seeps within the study area. The presence of these seeps had created significant local pollution problems due to "petroleum odors" and evolution of heavy oil and tar.

Studies had been conducted to quantify the emission rates from two large offshore seeps in Santa Barbara County (Ref. 2-53). The largest of these was estimated to have organic compound emissions of approximately 6 tons per day. The California Division of Oil and Gas was in the process of mapping all existing oil seeps within the study area however no data on seepage or emission rates are expected (Ref. 2-54).



LOCATION OF MAJOR OIL/GAS SEEPS IN SOUTH COAST AIR BASIN.

(Ref. 2-52)

Figure 2-7.

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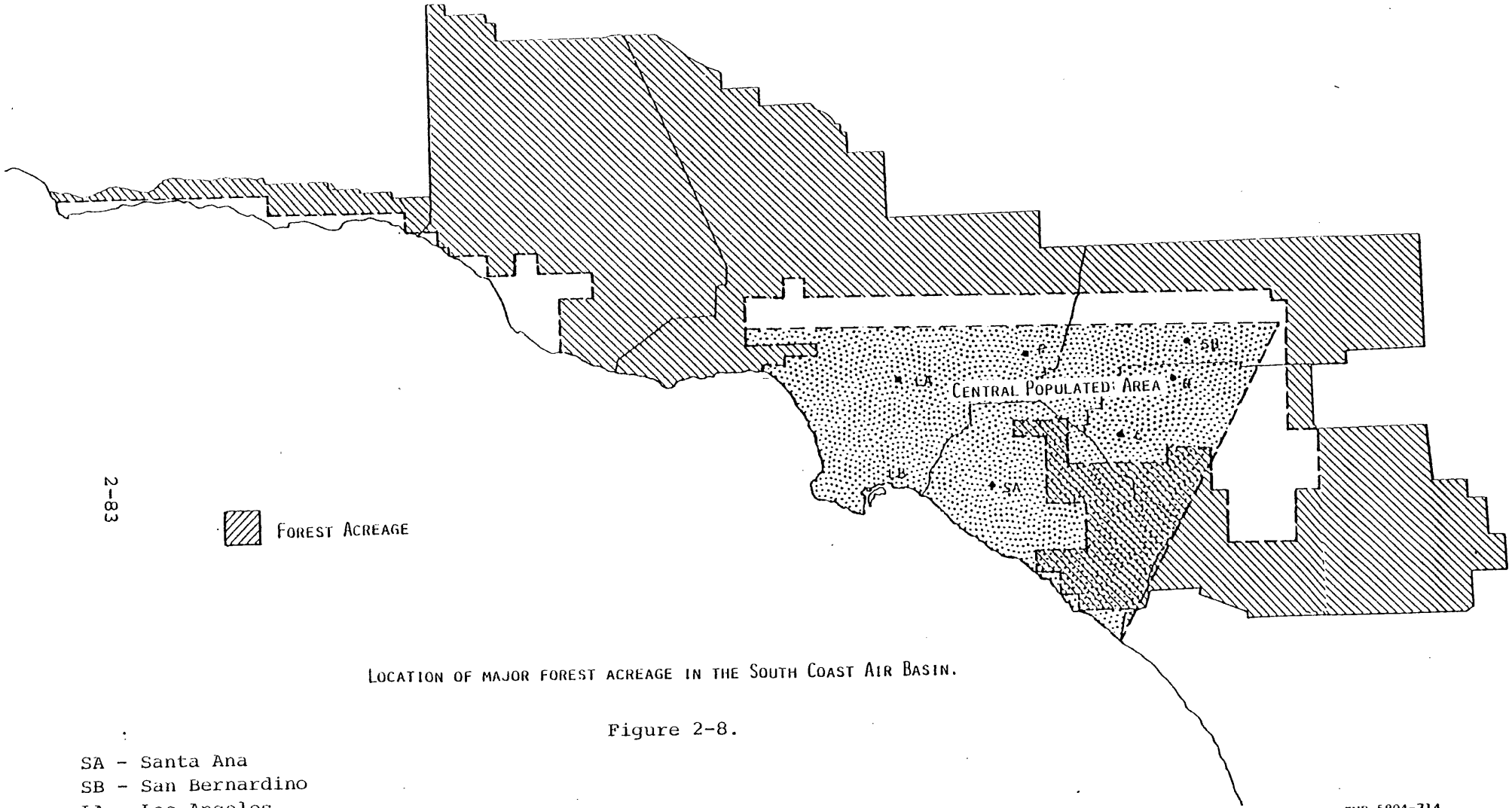
It was estimated by the Santa Barbara and Ventura County APCD's that the total emissions from these sources are approximately 4000 tons per year. These estimates were used for the final inventory.

F. Forest Emissions--

As illustrated in Figure 2-8, approximately 3.6 million acres of forest, located in the northern, eastern, and southern areas of the South Coast Air Basin, constitute nearly 2/3 of the total area. While the emissions from these forest areas may be significant, they probably have a lesser impact on the smog problem in the central population area shown on Figure 2-8 than the equivalent anthropogenic emissions because of their downwind location and the elevation at which they occur. Approximately 40% of the forest area lies above 3,500 ft elevation which is the normal maximum altitude of the inversion layer. While the forests are a source of natural terpenes and combustion products from forest fires, they also serve as a sink for the anthropogenic emissions generated in the Basin which cause damage to the plant life (Ref. 2-55). The forest areas referred to in this report comprise all of the open land in the Basin which are primarily of scrub forest type. Natural emissions from residential and commercial landscaping were ignored because preliminary measurements indicate that the emissions from this vegetation is one or two orders of magnitude lower than forest emissions for comparable acreage.

1. Natural emissions--Field investigations (Ref. 2-19 and 2-56) indicate that there are considerable α-pinene, β-pinene, and isoprene emissions from plant life found in the Southern California forests. The primary source of data on natural emission factors was Zimmerman, Washington State University (Ref. 2-56). Some of these data were unpublished at the time of this study. Information on the type and distribution of vegetation was obtained from the National Forest Service (Ref. 2-57).

The emission rate data provided by Zimmerman are presented in Table 2-35 along with the emission factors computed from these data. Table 2-36 presents a summary of the forest area by county and the type of vegetation found in each area. The National Forest Service provided data on the federal



LOCATION OF MAJOR FOREST ACREAGE IN THE SOUTH COAST AIR BASIN.

Figure 2-8.

SA - Santa Ana
SB - San Bernardino
LA - Los Angeles
LB - Long Beach
P - Pomona
R - Riverside
C - Corona

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TABLE 2-35. FOREST NATURAL EMISSION RATES BASED ON LEAF BIOMASS

Forest Type (% Composition)	Active Emission Rate µg/g·hr	Dormant Emission Rate µg/g·hr	Leaf Biomass 10^5 kg/km^2	Annual Emission Factor ton/acre·yr
Hardwoods	-	-	-	0.02
(60%) Oak	4	0	3	-
(40%) Maple	1	0	3	-
Douglas Fir	1	0	11	0.02
Mixed Conifer	-	-	-	0.08
(60%) Ponderosa Pine	3	1.5	11	-
(40%) Douglas Fir	1	0	11	-
Pines	3	1.5	11	0.1
Pinjon Juniper	3	3	3	0.04
Brush	-	-	-	0.08
(85%) Sagebrush*	12	4	3	-
(10%) Scrub Oak	4	0	3	-
(5%) Juniper	3	3	3	-

(Ref. 2-56)

*Sagebrush equivalent to mesquite and chaparrel in emissions.

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TABLE 2-36. FOREST AREA SUMMARY (10^3 ACRES)

Forest Type	County						
	Los Angeles	Ventura	Orange	Santa Barbara	San Bernardino	Riverside	Total
Hardwoods	161	370	59	27	48	6	671
Douglas Fir	195	146	2	8	20	1	372
Mixed Conifer	14	6	0	0	81	6	107
Pines	4	21	2	0	87	16	130
Pinjon Juniper	40	116	0	6	4	0	166
Brush	418	691	529	36	330	143	2,147
Total	832	1,350	592	77	570	172	3,593

Reference 2-55 and KVB estimates.

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land and assisted KVB on estimating the location and vegetation for privately owned lands. It must be emphasized that both the emission factors, acreages and compositions are estimates and more specific information on the composition, emission rates, and acreage would improve the natural emission calculations used in this inventory.

It was apparent from the vegetation composition and the emission factors presented in these tables that the primary concern was with the category of "brush". In the Basin, the primary types of brush found are mesquite and chaparral. These are believed to have similar emission rates to sagebrush. The degree of uncertainty regarding this similarity is probably the same as the uncertainty in the basic emission rate levels for sagebrush itself.

Zimmerman, in support of a national emission assessment, generated emission rate and biomass data based on tests performed in the northwest and east coast areas of the U.S. For sagebrush, he reported emission rates of 17 μg/g·hr for both active and dormant periods with a leaf biomass of 3×10^5 kg/km^2. However, recent measurements of Southern California vegetation have shown emission rates that are lower, especially during the dormant period. In Southern California, there are two dormant periods which occur during the dry summer months of July, August, and September, and during the winter months of December, January, and February. Zimmerman measured emissions rates of 4 μg/g·hr for the dry dormant period which is usually the worst period for ambient air quality. Based on an assumption by Zimmerman that the sagebrush active emission factor for Southern California was lower than the 17 μg/g·hr found in areas of year-around precipitation, a value of 12 μg/g·hr was estimated for this study, making the average annual emission rate 8 μg/g·hr.

The leaf biomass estimate of 3×10^5 kg/km^2 for brush is on the low side of a world-wide inventory of leaf biomasses which (according to Ref. 2-56) vary only by a factor of eight from the most dense tropical jungle to a scrub desert like the Mojave in Southern California. Thus the leaf biomass value of 3×10^5 kg/km^2 shown in Table 2-35 could be as low as 2×10^5 kg/km^2, while the value of 11×10^5 kg/km^2 also found in the table for pine and fir forests could be as high as 16×10^5 kg/km^2.

Applying the emission factors presented in Table 2-35 to the inventory in Table 2-36 results in a total emission rate estimate of 600 tons/day. Considering that 40% of these emissions are released above the inversion layer, only 300 to 400 ton/day are emitted into the mixing layer. A value of 300 ton/day was used in Table 2-23.

The EPA intends to sponsor further emission rate measurements in an attempt to improve the emission factors for vegetation types found in Southern California (Ref. 2-58). These experiments should assist in further clarifying the extent of natural emissions in the Basin.

2. Forest fires--Forest fires consumed over 80,000 acres of National Forest and private lands in the South Coast Air Basin in 1975 (Ref. 2-59). These fires burned over 2 million tons of forest material. Studies (Ref. 2-23) had estimated that 14 pounds of organic compounds were released per ton of forest material consumed. Therefore it was estimated that there were approximately 13,700 tons of emission in 1975. Since these fires generally occurred during relatively short periods, they constituted a significant source of organic vapor emission to the atmosphere.

G. Other Area Sources--

1. Dry cleaning--For the purposes of this inventory, dry cleaning operation associated with residential customers were considered as an area source distributed on the basis of population. Those establishments previously listed in the EIS data base with total emissions less than 10 tons per year were removed from the EIS data file. This categorization was required due to the fact that these small dry cleaning establishments were identified in the EIS data base for Ventura and Los Angeles Counties only. For the remaining four counties, the EIS data base for these sources were incomplete. Large dry cleaning establishments (with emissions greater than 10 tons per year) that generally use Stoddard solvents were retained as part of the EIS data base.

An analysis of the Los Angeles County permit files conducted for the preliminary inventory resulted in a total emissions of 3800 tons per year for these small dry cleaning establishments, of which 90% were synthetic solvents (perchlorethylene) and 10% Stoddard solvents. This corresponded to an annual emission factor of 0.93 tons per 1000 people. Reports from the National Fabricare Institute (Ref. 2-60) listed the annual per capita consumption of perchloroethylene dry cleaning solvent in California as 1.75 to 2.0 pounds, or an annual emission factor of 0.9 tons per 1000 people, which showed excellent agreement. Total emissions from this source were therefore estimated to be 25.9 tons per day.

2. Asphalt paving--The Asphalt Institute reports that 24 million tons of road paving were laid in 1975 (Ref. 2-61). Data from the current program showed that approximately 1×10^{-6} pounds of total hydrocarbons were released per pound of asphalt concrete laid. The emissions in the South Coast Air Basin were therefore estimated to be approximately 0.1 tons per day.

2.4 INVENTORY RESULTS

The final organic emission inventory was produced in April 1978 using EIS data tapes received from the ARB. The tape from SCAQMD was produced in February 1978 and the tape from Ventura APCD was produced in December 1977. Placing a baseline date on the inventory is difficult. The EIS efforts at SCAQMD and VAPCD were initiated in 1975 but data processing, correcting and updating contined from that time until the tapes used on this inventory were finally produced. Considering the span time involved in incorporating new source data into the EIS system, the most appropriate time base to assign to the inventory is 1975-76.

An attempt to run a final inventory was made in August 1977 using the first EIS tapes produced by the SCAQMD and VAPCD. During the initial data validation step in the inventory processing, a large number of data records were found to be incomplete and in error with respect to data needed for this inventory. Error messages were provided to the two control districts, who

completed or corrected the data entires. In April 1978, when the inventory was finally produced, only a negligible number of records were rejected for incomplete or inaccurate data. A check of the data records was made to attempt to locate any major point sources that had been omitted. None were found.

The area source data and emission profiles used in the inventory are discussed in the previous sections. In this section, the results of the inventory will be discussed.

2.4.1 Physical Description and Use Instructions

The inventory was delivered to the ARB in the form of three bound volumes of computer printouts plus four reels of computer tape as mentioned in Section 2.2. The following is a more detailed description of these reports to help facilitate their use.

A. Volume I--

Volume I of the printed reports contains a plant index, an inventory by application category and an inventory by 10 kilometer grid squares.

The plant index is aranged by counties and plant I.D. number. Five-hundred and thirty one plants are identified. For each plant, the following information is listed: County, Plant ID, Plant Name and Address and UTM Grid Coordinates. The other inventory reports identify the plants using the ID number. Therefore, the user must refer to the index to learn the plant name if he locates an entry in the inventory that he wishes to check. If the user wishes to look up a specific source, he must scan the index observing first the county (all plants are grouped by county [4200 is Los Angeles, 5440 is Orange, 6420 is Riverside, 6700 is San Bernardino and 8500 is Orange]), then the plant name. The plant names could not be sorted into correct alphabetical order because of a software problem on the EIS system. Fortunately, the Los Angeles County listing (by far the largest) is almost in alphabetical order. The first 228 entires are in alphatical order. The remaining 125 plants in LA County and those in the other counties will require individual

scanning. Once the plant has been located in the index, the complete emission record can be found in the 10-Km grid file by noting the UTM coordinates and the Plant ID Number.

The Application Category Report contains the sources grouped by application categories (i.e., Petroleum Production, Petroleum Refining, Organic Solvent Use, Combustion of Fuel, etc.). The information listed for each line item record is: County, Plant ID, Point ID, SCC No., SIC No., Summer and and Winter Emissions (ton/day), each broken down into Weekday and Weekend emissions, Annual Emission (ton/year), Profile Key and UTM Coordinates. The Profile Key is a reference to Volume III which lists emission profiles, a breakdown of the chemical elements comprising the total hydrocarbon emissions. For small sources, the inventory may indicate 0.00 tons/day emissions. This means that the daily emission is less than 0.005 ton/day or 10 lb/day. These small sources were included because they are in a plant producing 25 ton/year or more. At the end of each application category listing, a summary is provided for Major, Minor and Area Sources. The Major sources are those listed. The Minor sources are point sources not listed because they have less than 25 ton/year emission and are not part of a plant with 25 ton/year emissions. Area sources are as discussed in Section 2.3.4.

The 10-Km Grid Report contains the same information as the Application Category Report but the sources are grouped by their location in UTM Coordinate grids. For each grid, the population and major city (if appropriate) is listed. After the point sources are listed for each grid, a summary of minor point and area source emissions is indicated by Application Category. (The printout only indicates "Area Sources" but the data include minor point sources.

B. Volume II--

Volume II of the inventory report contains the One-Kilometer-Grid, Emission Summary and an Individual Species Report.

The One-Kilometer Report lists for each set of UTM X and Y coordinates the total organic emission (ton/year), the total emission by reactivity class,

I, II, III. (Refer to Table 3-32) and the emission of individual species (lb/year) by SAROAD Code. The code numbers listed are the last four digits of the SAROAD Code. In all cases the first number is "4" and therefore is not listed. The emissions are given in four digits (except for the last column "OTH"). In all cases the first three (two) digits are significant and the last digit indicates the decimal point location in places to the right of the left-hand side of the number (e.g., 0670 = .067, 5385 = 53,800).

The Individual Species Report lists each species in order of SAROAD Code and provides a listing of emissions broken down into Application Categories. One hundred and one species are included.

C. Volume III--

Volume III contains a SCC Description Report and the Emission Profiles. The SCC Description lists 739 source categories by SCC and SIC number, the emission profile key (which indicates the applicable profile), the ARB application category equivalent to that source, any emission factor correction (see Section 2.3.1). The last two columns are of no significance. The SCC Report is presented in two orders, the first by profile key and the other by SCC number.

The emission profiles contain the Profile Key, an estimate of error in the profile for any species, the reactivity class, SAROAD Code, chemical name, molecular weight and weight % for each species. Also included is a summary of the emissions for the three ARB emission reactivity classes.

2.4.2 Total Organic Emissions

The total organic emissions in the Basin plus Ventura County are 810,000 tons per year (2200 tons per day) of which 16% (350 ton/day) are from point sources. Over 5000 individual point sources are identified. A breakdown of these emissions according to application categories is presented in Table 2-37. Also presented in that table are the data from 1975 inventories conducted by KVB (the preliminary inventory on this program published in the Interim Report, November 1976) and a combined SCAQMD/Ventura APCD inventory for 1975 (Refs. 2-5, 4-48).

TABLE 2-37. COMPARISON OF EIS/KVB AND AQMD/VCAPCA EMISSION INVENTORIES

			EMISSION TONS/YEAR									
			EIS/KVB FILE				PRELIMINARY INVENTORY			AQMD/VCAPCA (1975)		
Application Cat.	Device Type	(No. of Major Sources)	Major Point	Minor Point	Area	Total	Point	Area	Total	Point	Area	Total
Petroleum Prod.		390	7900	970	30,000	39,000	12,400	--	12,400	7860[1]	14,600[2]	22,000
	Tanks				15,000		11,700	--		4700	14,700	19,300
	Other				15,000		700	--		3100	--	3,100
Petroleum Refining		1700	40,000	500	1900	42,000	30,000	--	30,000	15,600	--	15,600
	Tanks				--		21,900	--		3300	--	8,300
	Other				1,900		8,400	--		7300	--	7,300
Petroleum Mktg.		220	3700	200	64,000	68,000	22,000	57,000	79,000	14,000	33,000	47,000
	Tanks				--		9,500	--		11,700	--	11,600
	Gasoline Mktg.				30,000		12,400	57,000		1,180	33,000	34,000
	Mar. Loading				950		--	--		1,100	--	1,100
	NG Trans.				33,000		--	--		--	--	--
Solvent-Surface Coat		1600	31,000	5000	9000	45,000	39,000		39,000	45,000	--	45,000
- Dry Cleaning		80	2700	2100	9700	14,000	24,000	8,900	11,300	3,700	6,100	9,800
	Petroleum						2,400	--	2,400	3,700	--	3,700
	Synthetic						--	8,900		--	6,100	6,100
- Degreasing		310	9000	1100	2000	12,000	11,700	--	11,700	11,300	--	11,300
- Other		100	6400	150	200	6,800	9,100	--	9,100	13,000	--	13,000
	Printing						9,100		9,100	10,300	--	10,300
	Misc.						--		--	2,600	--	2,600
Chemical		30	1000	50	250	1,300	4,400	--	4,400	1,300	--	1,300
Metallurgical		45	950	50	50	1,050	--	--	--	200	--	200
Mineral		4	50	50	150	250	400	--	400	--	--	--
Waste Burning		5	0	0	550	550	--	--	--	--	140[1]	140[1]
Comb. of Fuel		400	5300	400	200	5,900	6,100	--	6,100	1,400	--	1,400
Food & Agriculture		10	200	150	50	400	--	40	40	300	--	300
Pesticides		0			5500		--	--	--	--	2,800	2,800
Misc. Inc.		90	3900	200	150	4,300	--	--	--	--	--	--

Continued

TABLE 2-37. Continued

		EMISSION TONS/YEAR									
		EIS/KVB FILE				PRELIMINARY INVENTORY			AQMD/VCAPCA (1975)		
		Major Point	Minor Point	Area	Total	Point	Area	Total	Point	Area	Total
Unclassified	90	3900	200	570,000	570,000	--	39,000	39,000	--	78,000	78,000
Domestic Comb.				1,600		--	1,200	1,200	--	50[1]	50[1]
Domestic Solvent				11,000		--	--	--	--	--	--
Structure Fires				10,000		--	--	--	--	450[1]	450[1]
Arch. Surf. Coat				33,000		--	38,000	38,000	--	77,000	77,000
Forest Natural				124,000		--	--	--	--	--	--
Forest Fires				13,700		--	--	--	--	--	--
Animal Waste				28,000		--	--	--	--	--	--
Landfills				340,000		--	--	--	--	--	--
Seeps				4,000		--	--	--	--	--	--
Citrus Trees				5,600		--	--	--	--	--	--
Orchard Heaters				1,200		--	--	--	--	2,300	2,300
Total (tons/day)	5200 Sources	116,000	11,100	680,000	810,000	138,000	105,000	121,000	114,000	135,000	250,000
(tons/day)		(320)	(30)	(1,850)	(2,200)	(380)	(300)		(310)	(370)	(680)

(1) Ventura only

(2) SCAQMD only

The total emissions from the EIS/KVB inventory are greater than the respective totals of the other two inventories. However, the EIS/KVB inventory accounts for a greater number of source types than the other two inventories. The sources seem to be consistent. The major and minor point source emissions were calculated directly from the SCAQMD and VAPCD EIS data files. Adjustments were made to the emission factors of certain source types (see Section 2.3.1); but, essentially, the inventory results reflect the basic EIS inventory data. Since the EIS data base was built from the previous permit files used to compute the other two comparison inventories, it is encouraging to note the similarity in this area.

Seventy percent of the emissions are from area sources essentially unaccounted for in previous inventories. The largest of these are from landfills (which produce over 900 tons/day of 99% methane gas) and from trees and brush (which emit approximately 300 tons/day of terpenes.)

The refinery emissions in the EIS/KVB inventory are higher than those in the previous inventories. This is due exclusively to the EIS data. KVB made no adjustments in this area. Petroleum industry emissions account for over 50% of the point source emissions and 18% of the total emissions.

2.4.3 Emission by Species

A breakdown of the total organic emissions by species is presented in Table 3-38, which is arranged in order of SAROAD Code and includes the reactivity class designation for each compound. Table 2-38 is a summary of Table 2-39 which is an application category report for each of the species accounting for 1000 tons/year or greater.

Methane accounts for half of the total emissions and is considered relatively unreactive. The methane listing in Table 2-39 can be used to determine non-methane hydrocarbons from each application category as presented in Table 2-40.

2.4.4 Spatial Distribution

A map showing the spatial distribution of the emissions is shown in Figure 2-9. Table 2-41 identifies the grids with emissions of over 20 tons/day.

TABLE 2-38. SOUTH COAST AIR BASIN
ORGANIC SPECIES INVENTORY
EMISSIONS BY SPECIES

Chemical Name	SAROAD Code	React Class	Tons/Year
Methane	43201	1	415,000
Ethane	43202	1	17,000
Ethylene	43203	3	6,400
Propane	43204	2	14,000
Propylene	43205	3	1,600
Acetylene	43206	1	2,500
Cyclopentane	43210	2	700
N-Butane	43212	2	25,000
Butene	43213	3	900
I-Butane	43214	2	7,500
N-Pentane	43220	2	11,000
Pentene	43224	3	2,800
Hexane	43231	2	14,000
Heptane	43232	2	4,400
Octane	43233	2	3,500
I-Hexane	43236	2	6,700
I-Heptane	43237	2	2,100
I-Octane	43239	2	1,300
Cyclohexane	43240	2	8,600
I-Nonane	43242	2	1,100
I-Decane	43243	2	2,500
C-7 Cycloparaffin	43253	2	3,000
C-8 "	43254	2	400
Terpenes	43256	3	124,000
Mineral Spirits (C-4 to 8)	43263	2	10,000
I-Pentane	43268	2	17,000
Methyl Alcohol	43301	1	2,000
Ethyl Alcohol	43302	3	6,000
N-Propyl Alcohol	43303	3	500
I-Propyl Alcohol	43304	3	12,000
N-Butyl Alcohol	43305	3	2,000
I-Butyl Alcohol	43306	3	200
Cellosolves	43308 & 43309	3	300
Glycol Ether	43367	3	2,300
Glycol	43368	3	800
Propylene Glycol	43369	3	600
Ethylene Glycol	43370	3	200
Ethyl Acetate	43433	2	500
Propyl Acetate	43434	2	700
N-Butyl Acetate	43435	2	4,600
Cellosolve Acetate	43443	3	600
Isopropyl Acetate	43444	3	600
Isobutyl Acetate	43446	3	500
Dimethyl Formamide	43450	2	200
Isobutyl Isobutgrate	43451	2	2,000
Formaldehyde	43502	3	2,400
Acetone	43551	1	7,100
Methyl Ethyl Ketone	43552	2	8,100
Methyl N-Butyl Ketone	43559	2	200
Methyl-Isobutyl Ketone	43560	2	2,000
Ethylamine	43721	1	300
Trimethylamine	43740	1	300
Freon 11	43811	1	900
1.1.1-Trichloroethane	43815	1	2,600
Perchloroethylene	43817	1	20,000
Methylbromide	43819	1	500
1.1.2-Trichloroethane	43820	1	2,700
Naphtha	45101	2	1,700
Benzene	45201	1	3,400
Toluene	45202	3	12,000
Ethyl Benzene	45203	3	1,600
Isomers of Xylene	45222	3	5,200
Isomers of Ethyltoluene	45227	3	300
Isomers of Diethylbenzene	45229	3	200
Isomers of Trimethyl-benzene	45230	3	200
			810,000

TABLE 2-39. SPECIES BY APPLICATION CATEGORIES

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43201	METHANE	16.04	1

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	13770.02	3.32
PETROLEUM REFINING	3479.49	0.84
PETROLEUM MARKETING	28715.86	6.92
ORG SOL SURFACE COAT	2957.05	0.71
ORG SOL OTHER	168.28	0.04
CHEMICAL	16.63	0.00
METALLURGICAL	547.89	0.13
MINERAL	35.96	0.01
WASTE BURNING	45.92	0.01
COMBUSTION OF FUELS	1494.59	0.36
FOOD AND AGRICULTURAL	147.85	0.04
UNCLASSIFIED	359638.09	86.67
MISCELLANEOUS INDUSTR	3938.61	0.95
TOTAL	414956.24	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43202	ETHANE	30.07	1

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	2662.80	15.40
PETROLEUM REFINING	1165.97	6.75
PETROLEUM MARKETING	3786.97	21.91
ORG SOL SURFACE COAT	222.46	1.29
ORG SOL OTHER	19.73	0.11
CHEMICAL	3.57	0.02
METALLURGICAL	41.92	0.24
MINERAL	10.01	0.06
WASTE BURNING	0.80	0.00
COMBUSTION OF FUELS	81.50	0.47
UNCLASSIFIED	9289.98	53.74
MISCELLANEOUS INDUSTR	0.20	0.00
TOTAL	17285.91	99.99

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43203	ETHYLENE	28.05	3

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	681.01	10.59
PETROLEUM REFINING	100.40	1.56
PETROLEUM MARKETING	10.76	0.17
ORG SOL SURFACE COAT	88.92	1.38
ORG SOL OTHER	1.57	0.02
CHEMICAL	222.97	3.47
METALLURGICAL	143.99	2.24
MINERAL	4.65	0.07
WASTE BURNING	108.08	1.68
COMBUSTION OF FUELS	19.02	0.30
FOOD AND AGRICULTURAL	2.03	0.03
UNCLASSIFIED	5050.29	78.50
TOTAL	6433.69	100.01

TABLE 2-39. (Continued).

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43204	PROPANE	44.09	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	3962.49	28.72
PETROLEUM REFINING	4281.79	31.03
PETROLEUM MARKETING	2204.83	15.98
ORG SOL SURFACE COAT	136.06	1.00
ORG SOL OTHER	6.58	0.05
CHEMICAL	0.01	0.00
METALLURGICAL	11.41	0.08
MINERAL	14.67	0.11
WASTE BURNING	10.70	0.08
COMBUSTION OF FUELS	176.08	1.28
FOOD AND AGRICULTURAL	0.20	0.00
UNCLASSIFIED	2890.20	20.95
PESTICIDE USE	98.61	0.71
MISCELLANEOUS INDUSTR	2.55	0.02
TOTAL	13798.18	100.01

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43205	PROPYLENE	42.08	3

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	37.32	2.33
PETROLEUM REFINING	282.75	17.64
ORG SOL OTHER	23.67	1.48
CHEMICAL	92.90	5.80
METALLURGICAL	10.55	0.66
MINERAL	8.25	0.51
WASTE BURNING	33.31	2.08
COMBUSTION OF FUELS	36.62	2.28
FOOD AND AGRICULTURAL	0.62	0.04
UNCLASSIFIED	1053.85	65.74
MISCELLANEOUS INDUSTR	23.11	1.44
TOTAL	1602.95	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43206	ACETYLENE	26.04	1

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	195.91	7.99
PETROLEUM REFINING	3.65	0.15
CHEMICAL	10.32	0.42
METALLURGICAL	10.03	0.41
WASTE BURNING	11.75	0.48
COMBUSTION OF FUELS	0.85	0.03
FOOD AND AGRICULTURAL	0.20	0.01
UNCLASSIFIED	2217.20	90.39
MISCELLANEOUS INDUSTR	2.94	0.12
TOTAL	2452.85	100.00

TABLE 2-39. (Continued).

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43212	N-BUTANE	58.12	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	5113.24	20.82
PETROLEUM REFINING	7464.08	30.39
PETROLEUM MARKETING	7070.71	28.79
ORG SOL SURFACE COAT	1040.33	4.24
ORG SOL OTHER	15.06	0.06
CHEMICAL	0.02	0.00
METALLURGICAL	12.78	0.05
MINERAL	25.52	0.10
WASTE BURNING	11.21	0.05
COMBUSTION OF FUELS	607.63	2.47
FOOD AND AGRICULTURAL	0.20	0.00
UNCLASSIFIED	2954.49	12.03
PESTICIDE USE	241.05	0.98
MISCELLANEOUS INDUSTR	1.37	0.01
TOTAL	24557.69	99.99

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43214	ISO-BUTANE	58.12	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	676.87	9.06
PETROLEUM REFINING	2968.55	39.75
PETROLEUM MARKETING	2521.57	33.77
ORG SOL SURFACE COAT	1.66	0.02
ORG SOL OTHER	11.15	0.15
CHEMICAL	0.01	0.00
MINERAL	25.35	0.34
WASTE BURNING	10.50	0.14
COMBUSTION OF FUELS	129.36	1.73
FOOD AND AGRICULTURAL	0.20	0.00
UNCLASSIFIED	1045.37	14.00
PESTICIDE USE	76.70	1.03
MISCELLANEOUS INDUSTR	0.20	0.00
TOTAL	7467.49	99.99

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43220	N-PENTANE	72.15	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	2692.53	25.55
PETROLEUM REFINING	3486.59	33.08
PETROLEUM MARKETING	3546.53	33.65
CHEMICAL	0.02	0.00
METALLURGICAL	8.52	0.08
MINERAL	15.28	0.15
WASTE BURNING	10.43	0.10
COMBUSTION OF FUELS	236.40	2.24
FOOD AND AGRICULTURAL	0.20	0.00
UNCLASSIFIED	361.93	3.43
PESTICIDE USE	175.31	1.66
MISCELLANEOUS INDUSTR	5.68	0.05
TOTAL	10539.42	99.99

TABLE 2-39. (Continued).

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43224	1-PENTENE	70.13	3

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM REFINING	739.79	26.79
PETROLEUM MARKETING	1960.43	70.98
ORG SOL OTHER	5.14	0.19
MINERAL	0.06	0.00
WASTE BURNING	32.21	1.17
FOOD AND AGRICULTURAL	0.62	0.02
MISCELLANEOUS INDUSTR	23.50	0.85
TOTAL	2761.75	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43231	HEXANE	86.17	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	1648.37	11.61
PETROLEUM REFINING	1665.26	11.73
PETROLEUM MARKETING	1231.20	8.67
ORG SOL SURFACE COAT	0.72	0.01
ORG SOL OTHER	15.99	0.11
CHEMICAL	54.03	0.38
METALLURGICAL	10.29	0.07
MINERAL	19.06	0.13
WASTE BURNING	75.90	0.53
COMBUSTION OF FUELS	332.52	2.34
FOOD AND AGRICULTURAL	26.58	0.19
UNCLASSIFIED	8914.03	62.79
PESTICIDE USE	202.70	1.43
TOTAL	14196.65	99.99

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43232	HEPTANE	100.20	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	1411.83	31.84
PETROLEUM REFINING	513.22	11.57
PETROLEUM MARKETING	329.47	7.43
ORG SOL OTHER	5.45	0.12
METALLURGICAL	66.07	1.49
MINERAL	3.11	0.07
WASTE BURNING	75.88	1.71
COMBUSTION OF FUELS	8.62	0.19
FOOD AND AGRICULTURAL	1.45	0.03
UNCLASSIFIED	2018.80	45.53
TOTAL	4433.90	99.98

TABLE 2-39. (Continued).

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43233	OCTANE	114.23	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	1058.47	29.99
PETROLEUM REFINING	146.74	4.16
PETROLEUM MARKETING	91.22	2.58
ORG SOL SURFACE COAT	136.07	3.86
ORG SOL OTHER	0.86	0.02
METALLURGICAL	0.41	0.01
MINERAL	0.05	0.00
WASTE BURNING	75.33	2.13
FOOD AND AGRICULTURAL	1.44	0.04
UNCLASSIFIED	2018.80	57.20
TOTAL	3529.39	99.99

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43236	#ISOMERS OF HEXANE	86.17	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	810.74	12.19
PETROLEUM REFINING	2277.16	34.24
PETROLEUM MARKETING	2931.47	44.08
CHEMICAL	0.04	0.00
METALLURGICAL	1.42	0.02
MINERAL	19.76	0.30
WASTE BURNING	0.01	0.00
COMBUSTION OF FUELS	166.27	2.50
PESTICIDE USE	443.75	6.67
TOTAL	6650.62	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43237	#ISOMERS OF HEPTANE	100.20	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	3.71	0.18
PETROLEUM REFINING	1259.19	60.25
PETROLEUM MARKETING	734.39	35.14
ORG SOL OTHER	15.48	0.74
METALLURGICAL	0.01	0.00
MINERAL	2.41	0.12
COMBUSTION OF FUELS	74.69	3.57
TOTAL	2089.88	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43239	#ISOMERS OF OCTANE	114.23	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	12.16	0.90
PETROLEUM REFINING	410.44	30.41
PETROLEUM MARKETING	767.33	56.85
ORG SOL SURFACE COAT	6.91	0.51
ORG SOL DRY CLEANING	14.52	1.08
ORG SOL DEGREASING	1.33	0.10
ORG SOL OTHER	1.73	0.13
METALLURGICAL	0.01	0.00
MINERAL	0.37	0.03
COMBUSTION OF FUELS	135.01	10.00
TOTAL	1349.81	100.01

TABLE 2-39. (Continued)

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43240	#CYCLOHEXANE	84.16	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	0.17	0.00
PETROLEUM REFINING	309.67	3.61
PETROLEUM MARKETING	753.46	8.79
ORG SOL SURFACE COAT	227.15	2.65
ORG SOL OTHER	312.78	3.65
CHEMICAL	18.63	0.22
METALLURGICAL	1.42	0.02
MINERAL	0.01	0.00
WASTE BURNING	0.01	0.00
COMBUSTION OF FUELS	16.90	0.20
FOOD AND AGRICULTURAL	38.19	0.45
UNCLASSIFIED	6895.23	80.42
TOTAL	8573.62	100.01

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43242	#ISOMERS OF NONANE	128.25	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	0.01	0.00
PETROLEUM REFINING	266.05	23.59
PETROLEUM MARKETING	123.84	10.98
ORG SOL SURFACE COAT	188.71	16.74
ORG SOL DRY CLEANING	495.53	43.94
ORG SOL DEGREASING	45.31	4.02
ORG SOL OTHER	8.05	0.71
METALLURGICAL	0.09	0.01
MINERAL	0.05	0.00
TOTAL	1127.64	99.99

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43243	#ISOMERS OF DECANE	142.28	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM REFINING	539.67	21.51
PETROLEUM MARKETING	94.20	3.76
ORG SOL SURFACE COAT	481.29	19.19
ORG SOL DRY CLEANING	1257.88	50.14
ORG SOL DEGREASING	115.01	4.58
ORG SOL OTHER	20.53	0.82
TOTAL	2508.58	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43253	#C-7 CYCLOPARAFFINS	98.19	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	1816.23	59.92
PETROLEUM REFINING	142.37	4.70
PETROLEUM MARKETING	81.17	2.68
ORG SOL OTHER	139.62	4.61
CHEMICAL	0.08	0.00
METALLURGICAL	0.01	0.00
MINERAL	7.85	0.26
PESTICIDE USE	843.67	27.83
TOTAL	3031.00	100.00

TABLE 2-39. (Continued).

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43256	#TERPENES	136.24	3

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
UNCLASSIFIED	205887.04	100.00
TOTAL	205887.04	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43263	#MINERAL SPIRITS	114.00	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
ORG SOL SURFACE COAT	8410.35	80.45
ORG SOL OTHER	1212.86	11.60
CHEMICAL	9.71	0.09
PESTICIDE USE	821.76	7.86
TOTAL	10454.68	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43268	#ISOMERS OF PENTANE	72.15	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	727.91	4.35
PETROLEUM REFINING	6005.69	35.87
PETROLEUM MARKETING	9477.45	56.60
CHEMICAL	0.02	0.00
METALLURGICAL	12.78	0.08
MINERAL	12.10	0.07
WASTE BURNING	0.09	0.00
COMBUSTION OF FUELS	310.07	1.85
UNCLASSIFIED	29.22	0.17
PESTICIDE USE	169.83	1.01
TOTAL	16745.16	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43301	METHYL ALCOHOL	32.04	1

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM REFINING	74.11	3.73
PETROLEUM MARKETING	18.96	0.95
ORG SOL SURFACE COAT	363.47	18.28
ORG SOL OTHER	169.65	8.53
CHEMICAL	56.16	2.83
UNCLASSIFIED	1299.10	65.35
MISCELLANEOUS INDUSTR	6.56	0.33
TOTAL	1988.01	100.00

TABLE 2-39. (Continued).

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43302	ETHYL ALCOHOL	46.07	3

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM REFINING	116.49	1.95
PETROLEUM MARKETING	18.97	0.32
ORG SOL SURFACE COAT	324.18	5.43
ORG SOL OTHER	627.29	10.51
CHEMICAL	14.77	0.25
UNCLASSIFIED	4863.15	81.46
MISCELLANEOUS INDUSTR	5.27	0.09
TOTAL	5970.12	100.01

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43304	ISO-PROPYL ALCOHOL	60.09	3

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM REFINING	131.41	1.06
PETROLEUM MARKETING	19.32	0.16
ORG SOL SURFACE COAT	1162.31	9.36
ORG SOL OTHER	750.43	6.05
CHEMICAL	27.23	0.22
UNCLASSIFIED	10303.82	83.00
MISCELLANEOUS INDUSTR	19.22	0.15
TOTAL	12413.74	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43305	N-BUTYL ALCOHOL	74.12	3

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
ORG SOL SURFACE COAT	1258.06	63.87
ORG SOL OTHER	144.41	7.33
CHEMICAL	6.67	0.34
UNCLASSIFIED	532.96	27.06
MISCELLANEOUS INDUSTR	27.54	1.40
TOTAL	1969.64	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43367	#GLYCOL ETHER	62.07	3

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
ORG SOL SURFACE COAT	1374.64	59.50
ORG SOL OTHER	11.39	0.49
CHEMICAL	2.81	0.12
UNCLASSIFIED	921.58	39.89
TOTAL	2310.42	100.00

TABLE 2-39. (Continued).

KVB = ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43435	N-BUTYL ACETATE	116.16	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
ORG SOL SURFACE COAT	3407.40	74.48
ORG SOL OTHER	188.92	4.13
CHEMICAL	1.22	0.03
UNCLASSIFIED	977.10	21.36
TOTAL	4574.64	100.00

KVB = ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43451	ISOBUTYL ISOBUTYRATE	144.21	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
UNCLASSIFIED	2031.93	100.00
TOTAL	2031.93	100.00

KVB = ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43502	FORMALDEHYDE	30.03	3

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	0.02	0.00
PETROLEUM REFINING	490.03	20.20
PETROLEUM MARKETING	10.76	0.44
ORG SOL OTHER	9.41	0.39
CHEMICAL	17.55	0.72
METALLURGICAL	11.36	0.47
MINERAL	0.07	0.00
WASTE BURNING	0.25	0.01
COMBUSTION OF FUELS	1787.34	73.67
UNCLASSIFIED	66.62	2.75
MISCELLANEOUS INDUSTR	32.71	1.35
TOTAL	2426.12	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43551	ACETONE	58.08	1

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM REFINING	460.20	6.48
PETROLEUM MARKETING	33.94	0.48
ORG SOL SURFACE COAT	4352.21	61.25
ORG SOL OTHER	256.60	3.61
CHEMICAL	9.64	0.14
MINERAL	0.06	0.00
WASTE BURNING	2.81	0.04
COMBUSTION OF FUELS	124.74	1.76
UNCLASSIFIED	1787.50	25.16
MISCELLANEOUS INDUSTR	77.49	1.09
TOTAL	7105.19	100.01

TABLE 2-39. (Continued).

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43552	METHYL ETHYL KETONE	72.10	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM REFINING	335.86	4.14
PETROLEUM MARKETING	33.92	0.42
ORG SOL SURFACE COAT	5762.77	70.95
ORG SOL OTHER	34.35	0.42
CHEMICAL	7.39	0.09
MINERAL	5.56	0.07
UNCLASSIFIED	1865.37	22.97
MISCELLANEOUS INDUSTR	77.08	0.95
TOTAL	8122.30	100.01

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43560	METHYL ISOBUTYL KETONE	100.16	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM REFINING	177.33	9.17
PETROLEUM MARKETING	16.96	0.88
ORG SOL SURFACE COAT	1498.23	77.44
ORG SOL OTHER	8.62	0.45
CHEMICAL	2.94	0.15
UNCLASSIFIED	199.86	10.33
MISCELLANEOUS INDUSTR	30.64	1.58
TOTAL	1934.58	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43814	1.1.1-TRICHLOROETHANE	133.42	1

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
ORG SOL DEGREASING	2594.58	100.00
TOTAL	2594.58	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARGAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43817	PERCHLOROETHYLENE	165.83	1

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM REFINING	216.31	1.09
PETROLEUM MARKETING	33.89	0.17
ORG SOL SURFACE COAT	177.91	0.90
ORG SOL DRY CLEANING	12835.18	64.77
ORG SOL DEGREASING	5497.11	27.74
ORG SOL OTHER	7.39	0.04
CHEMICAL	27.46	0.14
UNCLASSIFIED	1020.07	5.15
TOTAL	19815.32	100.00

TABLE 2-39. (Continued).

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
43820	1.1.2-TRICHLOROETHANE	131.66	1

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
ORG SOL DEGREASING	2737.39	100.00
TOTAL	2737.39	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
45101	NAPTHA	114.00	2

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
ORG SOL SURFACE COAT	1115.50	65.25
ORG SOL OTHER	8.33	0.49
CHEMICAL	82.07	4.80
WOOD PROCESSING	4.00	0.23
UNCLASSIFIED	499.65	29.23
TOTAL	1709.55	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
45201	BENZENE	78.11	1

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	1247.87	36.94
PETROLEUM REFINING	666.48	19.73
PETROLEUM MARKETING	382.24	11.32
ORG SOL SURFACE COAT	53.89	1.60
ORG SOL OTHER	10.01	0.30
CHEMICAL	103.43	3.06
METALLURGICAL	90.31	2.67
MINERAL	20.05	0.59
WASTE BURNING	1.97	0.06
COMBUSTION OF FUELS	124.41	3.68
FOOD AND AGRICULTURAL	3.20	0.09
PESTICIDE USE	673.84	19.95
TOTAL	3377.70	99.99

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAD CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
45202	TOLUENE	92.13	3

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	502.45	4.29
PETROLEUM REFINING	815.19	6.96
PETROLEUM MARKETING	833.69	7.11
ORG SOL SURFACE COAT	5788.21	49.40
ORG SOL OTHER	1285.32	10.97
CHEMICAL	49.43	0.42
METALLURGICAL	8.06	0.07
MINERAL	0.06	0.00
WASTE BURNING	0.02	0.00
COMBUSTION OF FUELS	33.80	0.29
FOOD AND AGRICULTURAL	55.20	0.47
UNCLASSIFIED	2072.16	17.68
PESTICIDE USE	273.92	2.34
TOTAL	11717.51	100.00

TABLE 2-39. (Continued).

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAQ CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
45203	ETHYLBENZENE	106.16	3

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
ORG SOL OTHER	137.61	8.65
CHEMICAL	0.03	0.00
FOOD AND AGRICULTURAL	20.94	1.32
UNCLASSIFIED	1432.34	90.03
TOTAL	1590.92	100.00

KVB - ORGANIC COMPOUNDS EMISSIONS REPORT - INDIVIDUAL SPECIES REPORT

SARDAQ CODE	CHEMICAL NAME	MOLEC. WEIGHT	REACTIVITY CLASS
45222	#ISOMERS OF XYLENE	106.16	3

APPLICATION CATEGORY	EMISSIONS (TONS/YEAR)	% OF TOTAL
PETROLEUM PRODUCTION	0.38	0.01
PETROLEUM REFINING	413.20	7.92
PETROLEUM MARKETING	745.67	14.29
ORG SOL SURFACE COAT	1933.91	37.05
ORG SOL OTHER	16.55	0.32
CHEMICAL	16.44	0.32
METALLURGICAL	0.01	0.00
FOOD AND AGRICULTURAL	65.55	1.26
UNCLASSIFIED	1206.09	23.11
PESTICIDE USE	821.76	15.74
TOTAL	5219.56	100.02

TABLE 2-40. METHANE/NONMETHANE ORGANIC EMISSIONS

Application Category	Emissions Ton/Year Total Organic	Methane	Nonmethane	% of Total Nonmethane
Petroleum Production	39,000	14,000	25,000	6
Petroleum Refining	42,000	3,500	38,000	10
Petroleum Marketing	68,000	29,000	39,000	10
Solvent Use - Surface Coating	45,000	3,000	42,000	11
Solvent Use - Other	33,000	170	33,000	8
Chemical	1,300	17	1,300	< 1
Metallurigcal	1,000	500	500	< 1
Mineral	250	40	200	< 1
Waste Burning	550	50	500	< 1
Combustion of Fuel	5,900	1,500	4,400	1
Food & Agriculture	400	150	200	< 1
Unclassified (natural)	570,000	360,000	210,000	53
Misc. Industrial	4,300	3,900	400	< 1
Total	810,000	410,000	400,000	100
(Ton/Day)	(2,200)	(1,100)	(1,100)	

KVB 5804-714

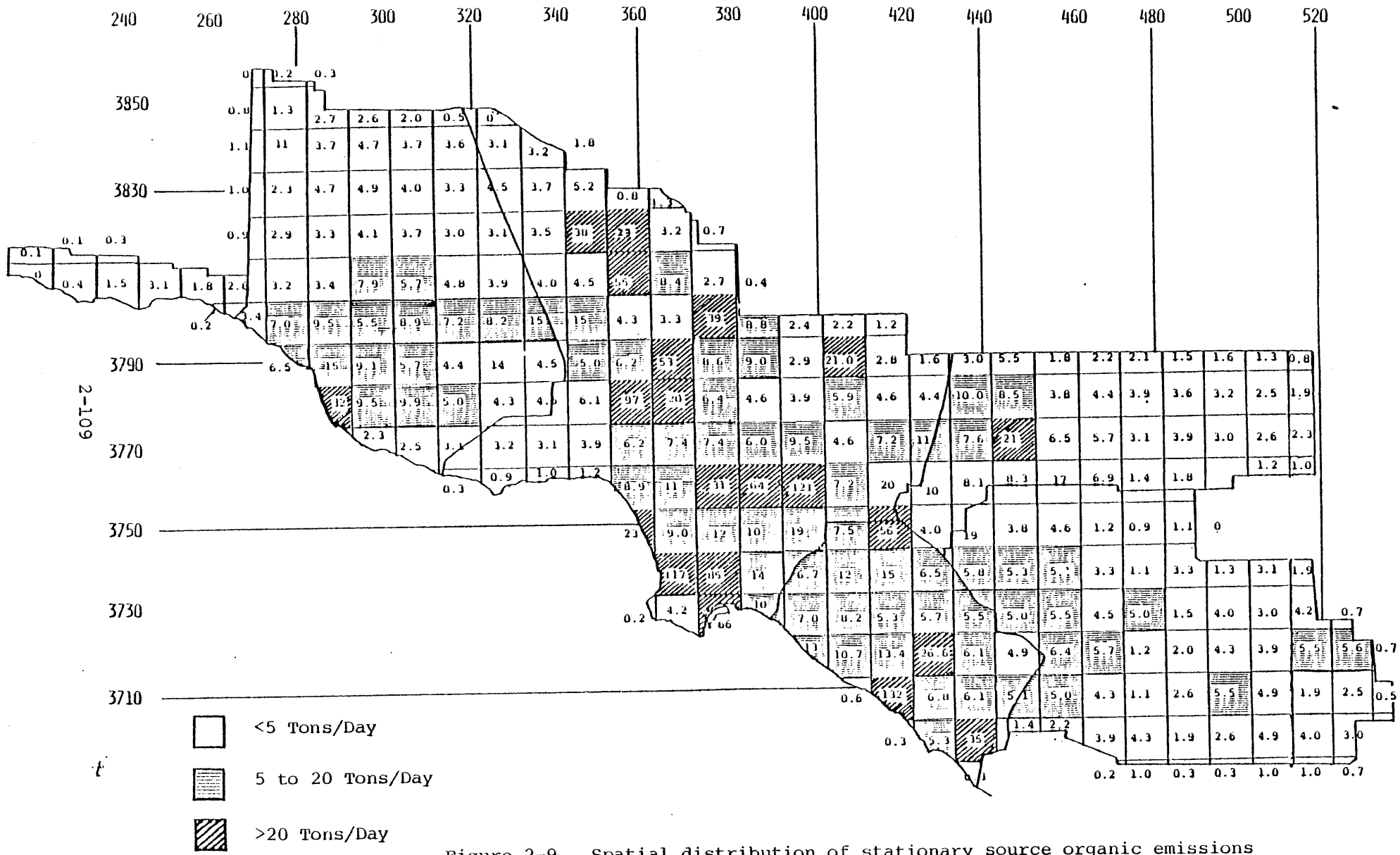

Figure 2-9. Spatial distribution of stationary source organic emissions (numbers in grid indicate emissions in tons/day).

TABLE 2-41. MAJOR 10-KM GRID EMITTERS

UTM Coord. E/W	N/S	Nearest City	Emission Ton/Day	Principal Source Type
290	3780	Oxnard	32	90% Landfill
350	3820	Castaic	38	Landfill
360	3820	Bouquet Cyn	23	Landfill
360	3810	Bouquet Cyn	55	Landfill
360	3780	Sepulveda	97	Landfill
360	3750	LA Intern A/P	23	278 Pt Sources
370	3790	Sunland	53	Landfill
370	3780	Burbank	20	177 Pt Sources
370	3740	Torrance	117	Landfill
380	3800	Ravenna	39	Landfill
380	3760	Downtown LA	31	330 Pt Sources
380	3740	Paramount	85	50% Pt and Area Sources 50% Landfill
380	3730	LA Harbor	66	55 Pt Sources and Oil Production
390	3760	Monterey Park	64	70% Landfill
400	3760	El Monte	121	Landfill
410	3790	Baldwin Park	21	Landfill
420	3750	Diamond Bar	56	Landfill
420	3710	N. Laguna	132	Landfill
430	3720	E. Irvine	27	Landfill
440	3700	S. Clemente	35	Landfill
450	3770	Fontana	21	50% Landfill 50% Pt Sources

KVB 5804-714

REFERENCES FOR SECTION 2.0

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2-2. Grisinger, J. E., "Development of Coordinate System Transformation Equations Required for Air Quality Modeling in the SCAB," CARB Staff Report, July 1977.

2-3. "Compilation of Air Pollution Emission Factors," Supplements 1-7, Publication AP-42, EPA, April 1977.

2-4. "Guidelines for Submittal of Area Source Emissions Data," California Air Resources Board, August 12, 1977.

2-5. Personal communication with Wayne Zwiacher, SCAQMD.

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