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Technical Report No.186

**FIELD STUDY OF
AIR POLLUTION TRANSPORT
IN THE
SOUTH COAST BASIN**

PREPARED FOR
State of California
AIR RESOURCES BOARD
1025 P Street
Sacramento, CA95814

Contract No. ARB 658, ARB2-349

15 MAY 1973



METRONICS ASSOCIATES, INC.

A SERINCO COMPANY
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TRANSPORT IN THE SOUTH COAST
AIR BASIN

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SUMMARY

In order to define the trajectories and dispersion of pollutants emitted from specified areas in the Los Angeles Basin, three different colors of fluorescent particle (FP) air tracer material* were released along freeways and highways in three source areas, i.e., Downtown Los Angeles, Torrance and Santa Ana. These tracers were measured at approximately eighty sampling stations within the Los Angeles Basin and outlying areas. The sampling array included Greater Los Angeles, the San Fernando Valley, San Bernardino, Riverside, Lancaster, Palm Springs, Indio, Oceanside, San Diego and Ventura.

Tests were conducted under typical meteorological conditions during the months of July through October 1972. The season as a whole was not representative of a severe "smog" season. The intensity and persistence of temperature inversions were below normal and smog episodes were less frequent and less serious than usual.

Four tests were conducted, one during the latter part of each month from July through October. The first test was conducted on 26-27 July 1972 under relatively stagnant conditions with a shallow marine layer in the morning and a sea breeze carrying the tracer inland during the afternoon. However, the temperature inversion was broken by heating in the intermediate valleys and tracer concentrations were low throughout the eastern part of the test area.

The second test was conducted on 29-30 August 1972 under relatively neutral stability conditions with considerable cloudiness. The area was influenced by a tropical storm 300-500 miles south of Los Angeles. The sea breeze carried some tracer inland in the afternoon and evening to Riverside, San Bernardino and the mountain areas, but it was diluted considerably by the relatively deep mixing layer.

The third test was conducted on 20-21 September 1972 under relatively stagnant conditions within the surface layer. Northeasterly winds

above the surface layer deflected the tracer toward the east and south-east with relatively little movement to the northern portions of the Los Angeles Basin and the mountain areas. This pattern of movement of the polluted layer has also been observed by Melvin D. Zeldin of the San Bernardino Air Pollution Control District.*

The fourth test was conducted on 24-25 October 1972 under relatively stagnant conditions, with considerable fog and low clouds at the beginning of the test. Santa Ana winds developed in the San Bernardino area about 3:00 P.M. PDT, 24 October, and the pollution and tracers were swept out of the area during the evening.

Estimates of the average frequency of conditions similar to those of test days were made from tabulations of Pasquill stability classes for Los Angeles, Long Beach and Los Alamitos for each month. The estimated frequencies were: Test 1, 18%; Test 2, 30%; Test 3, 17%; and Test 4, 24%.

Comparisons of air pollution and tracer measurements at the same or nearby stations were made for the first day of each test. Ozone (or oxidant) and carbon monoxide were used as representative pollutants. Comparisons were made on records from Downtown Los Angeles, Anaheim, Riverside, San Bernardino, Claremont (near Pomona) and Green River (near Prado Park).

Comparisons at Los Angeles and Anaheim showed that the tracer from the nearby sources was correlated with the morning carbon monoxide peak concentration but the ozone was correlated with the tracer from a more distant source area. This result is to be expected as some transport of the pollutants usually occurs before the peak ozone levels develop.

At Riverside and San Bernardino no correlation of carbon monoxide concentration with tracer concentration was observed. The best correlation of pollutant with tracer at these stations was for ozone. The highest hourly average ozone value at Riverside during the third tracer test was 37 pphm between 4:00 and 5:00 PDT on 20 September. The

*Leighton, Philip A., Perkins, William A., Grinnell, Stuart W., and Webster, Francis X., "The Fluorescent Particle Atmospheric Tracer," Journal of Applied Meteorology, Vol. 4, No. 3, June 1964, pg. 334-348.

*Zeldin, Melvin D., "Oxidant Distribution and Analysis in the San Bernardino Basin," Tech. Report 73-1 San Bernardino Air Pollution and Control District, San Bernardino, California, March 1973.

corresponding tracer from the Downtown Los Angeles source reached a maximum during the period from 3:00 to 6:00 P.M. In Test Four, however, the highest ozone value occurred between 2:00 and 3:00 P.M. and the highest tracer level coinciding with this peak was from the Santa Ana source.

Estimates of pollutants reaching Riverside from the three source areas were made from the volume and distribution of freeway and non-freeway traffic in the Los Angeles Basin* and the standard emission factors for gasoline-powered motor vehicles in 1972 published by the U. S. Environmental Protection Agency.**

The known initial tracer concentrations in the source areas were compared to the estimated carbon monoxide production in the same areas. The dilution of the tracer was then used as a measure of the dilution of inert pollutant along the route to the more distant sampling sites. The highest three-hour average tracer concentrations at Riverside correspond to a contribution of 4 pphm from Downtown Los Angeles, 7 pphm from Torrance and 2 pphm from Santa Ana. All of these concentrations were small with respect to measured concentrations. The total emission of carbon monoxide from these three source areas represents approximately 30% of the total emission within the Los Angeles Basin.

Transport of pollution southward from the Los Angeles Basin to San Diego was observed in Tests 1 and 3. In Test 1, the tracer from Santa Ana arrived between 10:00 A.M. and 4:00 P.M., 27 July (the day following the dispersal). In Test 3 the tracer from Torrance was observed between 10:00 P.M., 21 September, and 4:00 P.M. 22 September, with the highest value between 10:00 A.M. and 4:00 P.M. on 22 September, two days after the dispersal. However, the relative contributions of these sources

*Roberts, Philip J. W., Roth, Philip M., Nelson, Clarence L., "Contaminant Emissions in the Los Angeles Basin--Their Sources, Rates and Distribution," Report 71 SAI-6 Systems Applications, Inc., Beverly Hills, Calif., March 1971.

**Compilation of Air Pollutant Emission Factors (Revised), U. S. Environmental Protection Agency, Office of Air Programs, Research Triangle Park, N.C., Feb. 1972.

to the observed pollution levels at San Diego were very small.

Estimates of tracer from each source remaining in the test area through the second test day were made. The ratio of tracer counts for Day 2 to those for Day 1 are given in Table 1. An overall average ratio of 0.139 or about 14% was computed. This would correspond to the fraction of an inert pollutant remaining in the test area from one day to the next. The number of stations operated longer than two days was small and the tracer concentrations too low to provide reliable estimates for a longer period.

Samples of FP tracer taken on the EPA aircraft were too low to provide statistically reliable estimates of concentrations, largely because the aircraft could not be flown less than 1,000 feet above the terrain.

TABLE 1					
RATIOS OF TOTAL FP COUNTS IN TEST AREA FOR DAY 2 DIVIDED BY TOTAL FOR DAY 1					
TEST NO.	DATE	NO. STATIONS	SOURCE AREA		
			LOS ANGELES	TORRANCE	SANTA ANA
1	26-27 July, 72	50	0.172	0.086	0.045
2	29-30 Aug., 72	51	0.158	0.268	0.204
3	20-21 Sep., 72	52	0.052	0.179	0.093
4	24-25 Oct., 72	41	0.145	0.068	0.199
Average			0.132	0.150	0.135
Standard Deviation			0.046	0.080	0.069
Average for All Sources				0.139	
Standard Deviation				0.067	

CONCLUSIONS

1. The transport and diffusion of air pollution from sources within the Los Angeles Basin may be defined by tracer measurements for distances in excess of 100 miles.
2. Movement of air from the coastal regions as far inland as Riverside and San Bernardino within twelve hours was observed. However, the contribution of pollutants from the three source areas in the Los Angeles Basin to Riverside, San Bernardino and other outlying areas was small under the conditions of these tests. This may be due, in part, to the relatively weak temperature inversions during the 1972 summer and fall which permitted vertical mixing and dilution of the polluted layer and to the lack of a strong onshore pressure gradient to move the polluted layer inland.
3. Morning peak concentrations of carbon monoxide in the area of tracer release correlated well with the tracer concentrations from the same area. Peak concentrations of ozone, however, were usually correlated with tracer from a source area some distance away because of the time required for peak ozone levels to develop.
4. The residual tracer and non-reactive pollutants remaining in the test area from one day to the next averaged approximately 14%. The average residual concentrations for the different source areas were approximately the same although values for individual sources and periods ranged from 4.5% to 27%.
5. Further tests should be conducted during a normal "smog" season and particularly under conditions which produce appreciable transport from the Los Angeles Basin to inland areas.

AIR POLLUTION TRANSPORT IN THE SOUTH COAST AIR BASIN

I. INTRODUCTION.

In order to define the trajectories and dispersion of pollutants emitted in the Los Angeles Basin, it was proposed that three different colors of fluorescent particulate (FP) air tracer be released along freeways and highways within three specified source areas. The tracer material would be collected and measured in the Los Angeles Basin, in the outlying areas of Riverside and San Bernardino, and through the Cajon and San Geronio Passes to the north and east. Measurement would be made for a period of at least 36 hours in order to measure the relative contributions of these sources to air pollution levels throughout this area.

These tests were to be conducted under meteorological conditions which would produce substantial air pollution, i.e., clear to scattered clouds with mixing heights generally below 2,000 feet and the typical diurnal circulation patterns for this season. These tests were to be conducted during the months of July, August, September and October 1972.

II. TEST AREA AND SAMPLER LOCATIONS.

The test area included the western Los Angeles Basin, the San Fernando Valley, the intermediate valleys, San Bernardino and Riverside, outlying areas east of the San Geronio Pass, Palm Springs, Indio, Lancaster, the San Bernardino Mountains, the Cajon Pass, Hesperia and Apple Valley. Samplers were operated at Ventura, Catalina Island, Oceanside and San Diego to measure any tracers reaching these areas. Measurements were also made in mountainous areas including the San Gabriel Canyon, Lake Gregory, Big Bear Lake and Trabuco Canyon southeast of Santa Ana.

Approximately 80 sampling stations were used during each of these tests. Most of these stations are shown on Page 7.

III. AIR TRACER TEST PROCEDURES.

A. Air Tracer Dispersal.

Three colors of FP air tracer materials were dispersed over a two-hour period from 5:00 to 7:00 A.M. PDT from vehicle-mounted

aerosol generators along freeways and highways defining the following source areas:

1. Downtown Los Angeles.

The dispersal route was north on the Long Beach Freeway, west on the San Bernardino and Hollywood Freeways, south on Harbor Freeway and east on Manchester and Firestone Boulevard. Two circuits were made in each test.

2. Torrance.

The dispersal route was south on Harbor Freeway to the Pacific Coast Highway, west and north on the Pacific Coast Highway to Rosecrans Avenue and east on Rosecrans to Harbor Freeway.

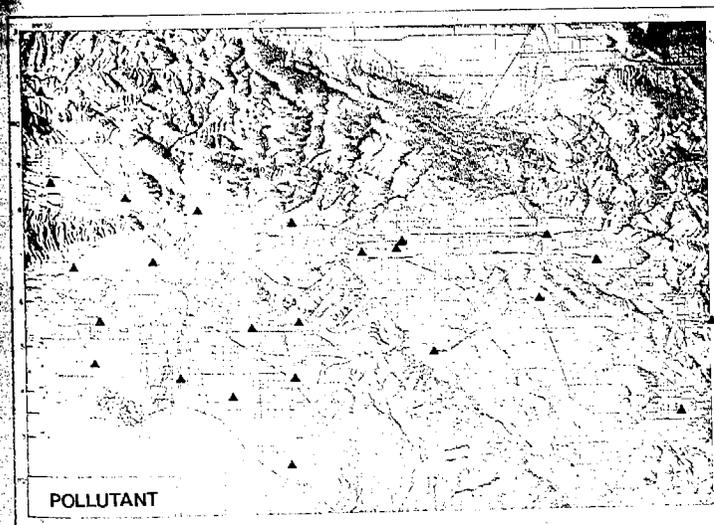
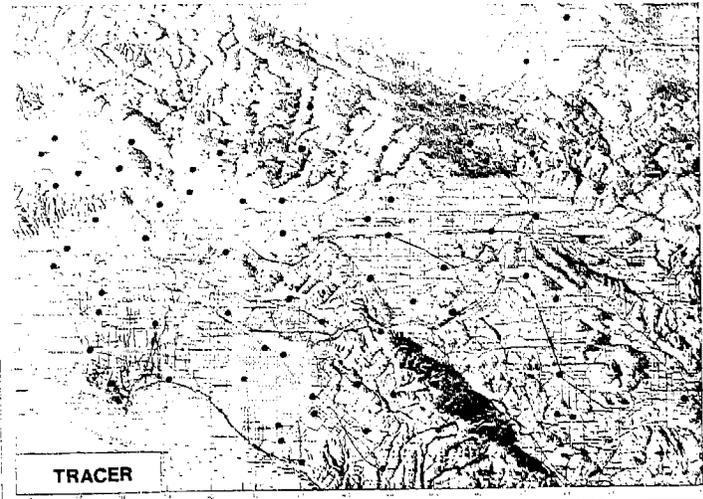
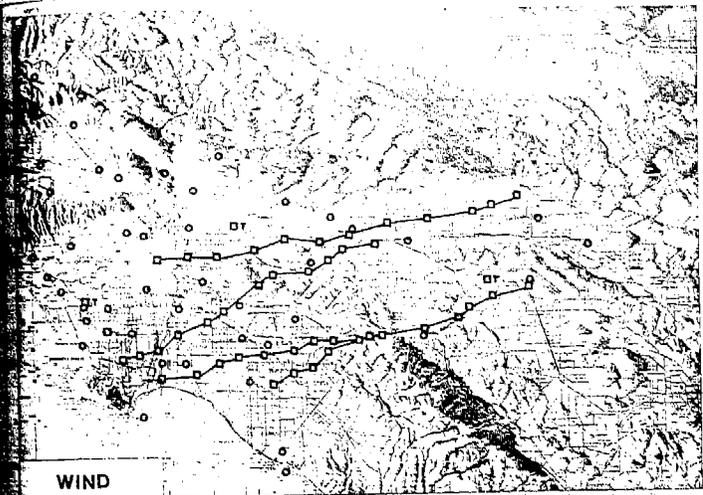
3. Santa Ana.

The dispersal route was north from Dyer Road on the Newport Freeway, west on the Riverside Freeway, south on Valley View Avenue and east on the San Diego Freeway.

The above source areas are shown on Page 7, along with the sampler locations, the wind stations and the air quality monitoring stations. A picture of one of the truck-mounted aerosol generators is shown on Page 8.

B. Sampling Operations.

Most of the sampling stations were operated on a sequential six-hour sampling schedule beginning at 4:00 A.M. PDT on the first day of each test and continuing for a period of 48 hours. Sequential samples were taken at two-hour intervals at downtown Los Angeles, Claremont and the Green River Golf Club, and three-hour samples were taken at San Bernardino, Riverside and Anaheim. Pictures of each sampler type are shown on Page 9. Samples are collected by impaction on the treated surface of a rotating rod. The rod is spun at 2400 RPM and sweeps out a volume of 52 liters of air per minute. Collection efficiency for particles in the size range of tracer material is approximately 65%. A picture of a rotorod sample under natural and ultraviolet illumination is shown on Page 9.



DATA COLLECTION SITES

WIND

- ▣ UPPER LEVEL PIBAL MEASUREMENTS
- SURFACE DATA
- ▽ TEMPERATURE SOUNDINGS

TRACER

- ROTOROD SAMPLING STATION

POLLUTANT

- ▲ AIR MONITORING STATIONS

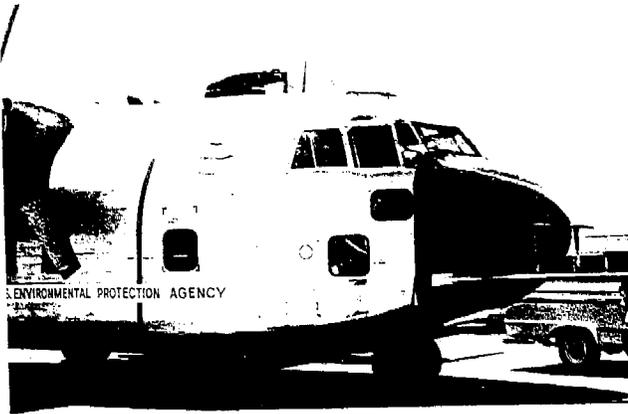
0 5 10 15 20 25 30

Map Scale in Miles

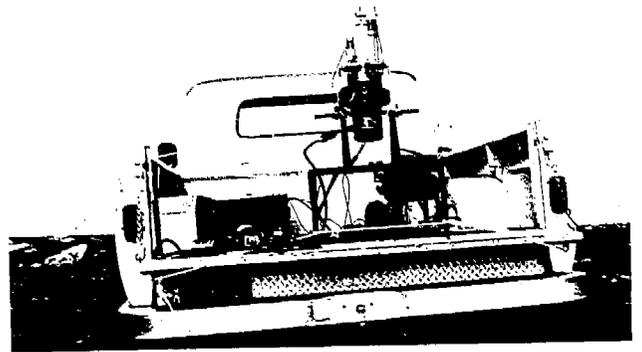
↑

NORTH

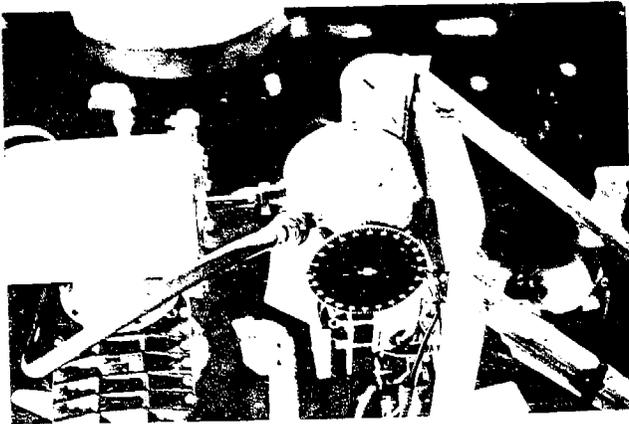
Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



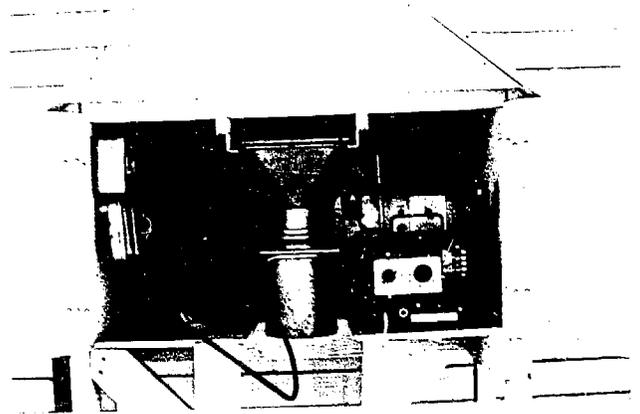
EPA Aircraft Used For Tracer Sampling



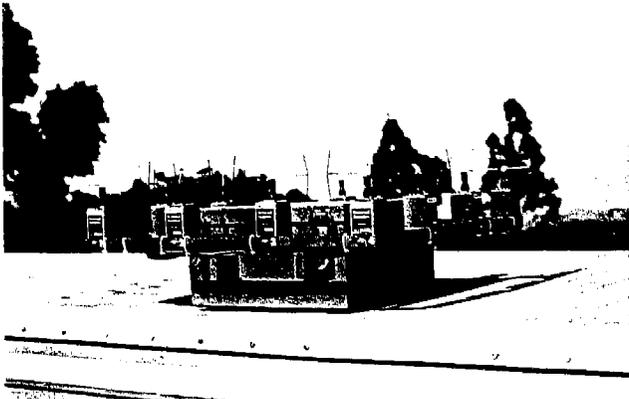
Vehicle Mounted Aerosol Generator



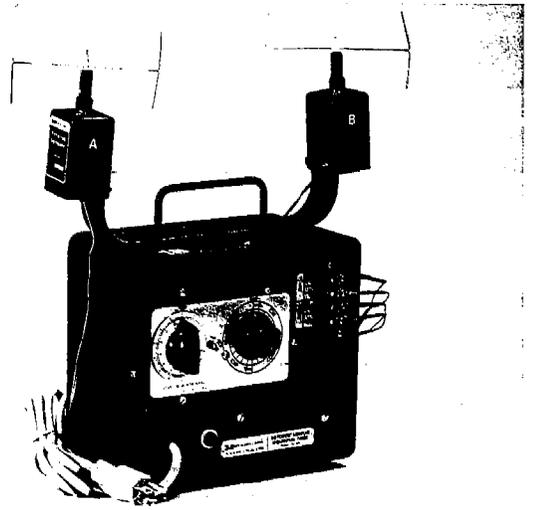
Aircraft Mounted Drum Pulsed Sequential Sampler



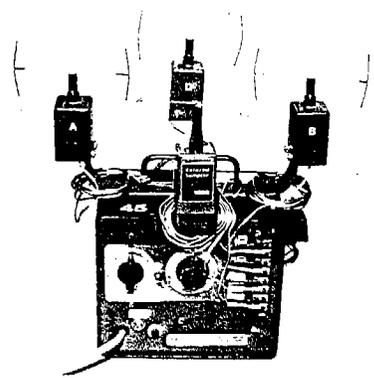
Typical Sampling Station



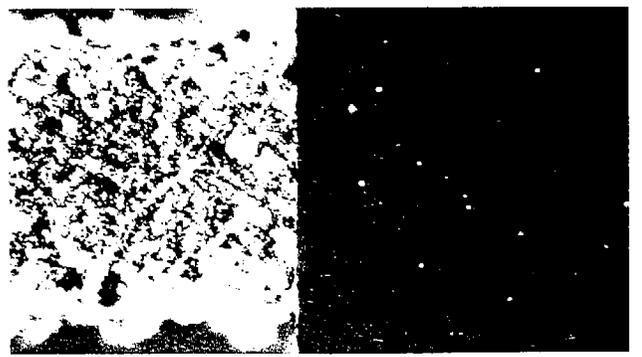
ROTOROD Sequential Sampler Used for 2-hour Samples



ROTOROD Sequential Sampler Used for 6-hour Samples



ROTOROD Sequential Sampler Used for 3-hour Samples



ROTOROD Sampling Surface Under White Light and Ultraviolet Light

At selected stations in Ventura, Van Nuys, San Bernardino, Anaheim, Palm Springs and Oceanside samples were taken for a few days following the normal sampling schedule in order to measure residual levels of the tracer in the test area.

In addition to the surface samplers a drum impactor sampler was mounted in a C-123 aircraft furnished by the U. S. Environmental Protection Agency and samples were taken on routes across the Los Angeles Basin and as far east as Palm Springs. Pictures of the aircraft and sampling equipment are shown on Page 9.

C. Meteorological Measurements.

Surface wind data were obtained primarily from the Air Pollution Control Districts of Los Angeles, Orange, San Bernardino and Riverside Counties. Winds aloft were measured by EMSU* stations at Los Angeles International Airport and El Monte and also by Pollution Research and Control at Fla-Bob Airport, Riverside under contract with the Air Resources Board. Additional winds aloft measurements were made by North American Weather Consultants, Inc. at a total of 48 stations along four routes: one route beginning at the center of each source area and one near Long Beach and moving eastward into the intermediate valleys to San Bernardino, Chino, Corona and Riverside. The routes are shown on Page 7.

Temperature and humidity aloft in the morning and at noon were determined from the EMSU stations at Los Angeles International Airport and El Monte. Aircraft temperature soundings were made by Pollution Research and Control at Fla-Bob Airport. In addition to these soundings, aircraft measurements were made by Meteorology Research, Inc., Altadena, at several airports within the Los Angeles Basin and adjacent areas. These soundings were made three times a day beginning in the morning at 8:00-9:00 A.M. PDT with a second series starting at 12:00-1:00 P.M. and a third at 4:00-5:00 P.M. PDT.

Using the above data the general wind flow patterns and mixing heights were determined for each sampling period during the first day of each test.

*Environmental Meteorological Support Unit

D. Analysis of Data.

The air tracer particles collected were counted and the values normalized by dividing the count by the calibrated sampler efficiency and flow rate and by the total number of particles in the source. In addition, the values for each color were corrected for losses by deposition. This source correction was small with the exception of the red FP released from downtown Los Angeles. There was a significant percentage of large particles, which exhibit non-ideal behavior, in this batch of tracer material.

The EMSU balloon soundings and MRI aircraft soundings were used to estimate mixing layer heights. These in turn were used along with size distribution data for the FP tracer to compute deposition of the large particles and make corrections. The adjusted counts for distant stations were as much as 50% higher after the source correction.

The final values plotted on the contour maps represent the total number of particles which would ideally be collected during the six-hour sampling period at a sampling rate of 1 liter per minute from a source of 10^{16} particles. This number is equivalent to the mean concentration, in units of particles per cubic meter, during the six-hour period from a normalized source of 3.6×10^{15} particles. Contours were drawn at levels of 10, 100, 1000, etc.. Corrected values less than 10 were not considered reliable because of statistical uncertainty and possible low-level contamination.

Quantitative air pollution data from the Air Pollution Control Districts at Los Angeles, Orange, San Bernardino and Riverside Counties were obtained from Los Angeles APCD and the Air Resources Board. These data were compared with tracer data at the same or nearby locations. Although the FP tracer does not simulate reactive air pollutants, it allows us to label the air mass which was over the source area at the time of tracer dispersal. Thus, if the arrival time of peak oxidant concentrations correlates with the arrival of FP tracer, we can tell where that air mass began its migration. Concentrations of relatively inert air pollutants, such as CO, would correlate with the tracer concentrations very well, but intermediate and local sources swamp out any

correlation at stations away from the source area. Comparative plots of FP tracer, oxidant and other pollutants were made for the first day of each test to show these correlations.

Frequencies of wind distribution by Pasquill Stability Classes for Los Angeles, Long Beach and Los Alamitos were obtained from the National Climatic Center, Asheville, N. C. The Pasquill Stability Classification is given for each sampling period during a test. Since the classification is applied to a large area with winds of varying directions and speeds, only the total frequency of each stability class was tabulated for the months of July, August, September and October (Table 2). The frequency of situations occurring during each six-hour period could be estimated from this table as could an overall climatological frequency of days similar to the test days.

Air tracer measurements were totalled for all stations operated during Day 1 and Day 2 for each test and the total FP counts for Day 2 were divided by the total counts for Day 1. The resulting ratios of tracer from each source area were a measure of the residual tracer (and inert pollutant) remaining in the test area from one day to the next.

MONTH	CLASS	LOS ANGELES	LONG BEACH	LOS ALAMITOS	AVERAGE
July	A	0.27	3.63	5.00	2.97
	B	7.12	15.81	18.56	13.83
	C	20.75	15.65	16.22	17.54
	D	44.52	31.96	24.74	33.74
	E	11.02	8.74	2.99	7.58
	F	16.32	24.22	32.49	24.34
Aug.	A	0.05	1.83	3.76	1.88
	B	4.73	14.89	17.34	12.32
	C	18.52	14.57	16.05	16.38
	D	47.39	32.72	23.25	34.45
	E	11.77	11.13	3.28	8.73
	F	17.53	24.87	36.32	26.24
Sept.	A	0.00	1.36	1.86	1.07
	B	4.25	11.86	11.28	9.13
	C	11.94	13.75	13.44	13.04
	D	53.75	35.47	36.69	41.97
	E	11.42	9.06	3.69	8.06
	F	18.64	28.50	33.03	26.72
Oct.	A	0.00	0.78	1.69	0.82
	B	4.96	9.41	11.67	8.68
	C	13.37	12.07	13.17	12.87
	D	46.43	38.01	28.95	37.80
	E	11.18	9.41	3.52	8.04
	F	24.06	30.32	40.99	31.79

ANALYSIS OF AIR TRACER TESTS
 TEST NUMBER ONE, 26-27 JULY 1972

A. Meteorology.

On the morning of July 26 the Pacific high was located far to the west with a ridge extending northeastward into British Columbia. A thermal low was centered over northwestern Mexico extending northward into the Coachella Valley (Page 14). A weak offshore pressure gradient was thus established in the Los Angeles Basin. The winds were very light and variable, the visibility was 8-15 miles, and the mixing height was 200-500 meters.

A moderate sea breeze developed during the day with southwest to westerly winds at 6-13 mph. The mixing height was increased by solar heating to 400-700 meters and visibilities were 8-20 miles. These conditions persisted into the late afternoon and early evening. During the night the winds decreased to 3-6 mph but remained westerly in the Los Angeles Basin.

A similar pattern occurred the following day of July 27 (Page 14). Surface winds and winds aloft are shown for each test period on Page 15.

The climatological frequency of days similar to the test days was estimated from Table 2 to be about 18% for the month of July.

B. Air Tracer Test.

Dispersals were begun at approximately 5:00 A.M. PDT, 26 July, at all three source areas and were completed by 7:00 A.M. except for the Torrance dispersal which was continued until 9:00 A.M. to disperse all of the green tracer material.

1. Downtown Los Angeles Source.

The Downtown Los Angeles tracer spread in all directions but principally eastward and southward during the first sampling period from 4:00-10:00 A.M. PDT (Page 16). The tracer cloud extended rapidly eastward and southeastward during the second period 10:00 A.M.-4:00 P.M. PDT (Page 17) reaching as far east as Banning and as far south as Costa Mesa.

Small residual concentrations of FP tracer remained in the area during the night (Page 18) and the following day but disappeared from all but the Los Angeles Basin by the end of the second day.

2. Torrance Source.

The Torrance source spread northward to West Hollywood and eastward to Pomona and Santa Ana during the first two test periods from 4:00 A.M. to 4:00 P.M. PDT (Pages 16 and 17). Portions of the tracer cloud moved eastward through the Santa Ana Canyon as far as Sunnymead and northeastward through the Cajon Pass during the late afternoon and night (Pages 17 and 18). A portion of the tracer remained in the Los Angeles Basin throughout the test period but almost completely disappeared from other areas during the second day.

3. Santa Ana Source.

The Santa Ana tracer cloud spread eastward through the Santa Ana Canyon and northwestward toward Los Angeles during the first two sampling periods from 4:00 A.M. to 4:00 P.M. PDT (Pages 16 and 17) reaching as far east as Perris and Sun City and as far north as West Hollywood during this period. The tracer rapidly disappeared from all but the Los Angeles Basin during the night.

C. Comparison of Air Pollution and Tracer Measurements.

1. Downtown Los Angeles.

The peak hourly average ozone concentration in Downtown Los Angeles occurred between 11:00 and 12:00 A.M. PST on 26 July and was correlated with the FP tracer concentration for the Torrance source which showed a peak between 11:00 A.M. and 1:00 P.M. (Page 20). The peak hourly average carbon monoxide peak occurred between 7:00 and 8:00 A.M. and was closely correlated with the peak FP tracer from the Los Angeles source. The tracer from Santa Ana showed little correlation with either pollutant.

2. Anaheim.

The peak hourly average ozone concentration occurred from 1:00 to 2:00 P.M. PST on 26 July but concentrations were generally high

between 10:00 A.M. and 3:00 P.M. The six-hour average FP tracer concentrations from the Torrance and Los Angeles sources were also highest during this period. The morning carbon monoxide peak occurred between 7:00 and 10:00 A.M. and the highest six-hour average FP concentration from the Santa Ana source occurred between 3:00 and 9:00 A.M.

3. Riverside.

No ozone measurements were available on 26 July. The morning carbon monoxide peak occurred from 6:00 to 7:00 A.M. PST (Page 21). This showed apparent correlation with the FP tracer from Los Angeles. This is most likely an error caused by contamination since no other station between Los Angeles and Riverside showed tracer from the Los Angeles source during this time period.

4. San Bernardino.

The peak hourly average ozone concentration occurred between 4:00 and 5:00 P.M. PST (Page 21) on 26 July and levels were generally above 10 pphm between 2:00 P.M. and 8:00 P.M. The peak three-hour average FP tracer concentrations from Torrance and Santa Ana occurred between 3:00 and 6:00 P.M. and the peak from Los Angeles occurred between 6:00 and 9:00 P.M. The FP tracer from Los Angeles arrived first (before 12:00 noon) but took longer to reach its peak value. The highest hourly carbon monoxide concentration occurred from 11:00 to 12:00 P.M. and showed no correlation with the FP tracer.

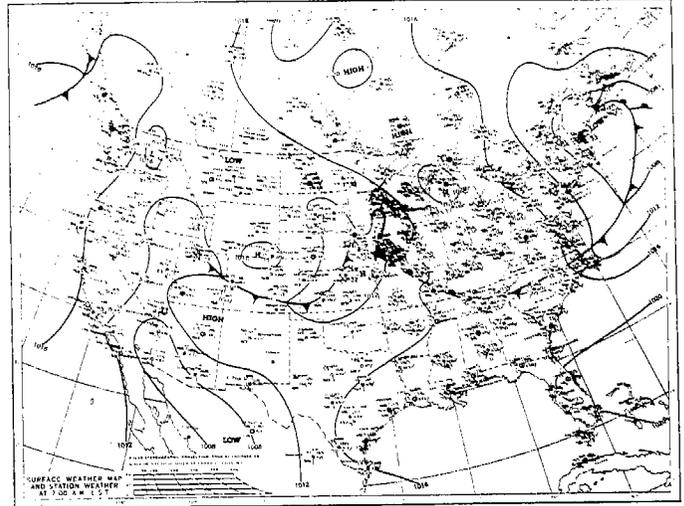
5. Claremont-Pomona.

The hourly average oxidant values at Pomona increased at a uniform rate beginning at 6:00 A.M. and reached a peak between 2:00 and 3:00 P.M. on 26 July (Page 22). The level remained relatively high until 5:00 P.M. decreasing rapidly after this time. The FP tracer from Los Angeles and Torrance both arrived during the period 9:00 A.M. to 3:00 P.M. PST. The Torrance tracer concentration dropped to zero by 9:00 P.M. while the Los Angeles tracer remained measurable until the end of the day.

6. Green River-Prado Park.

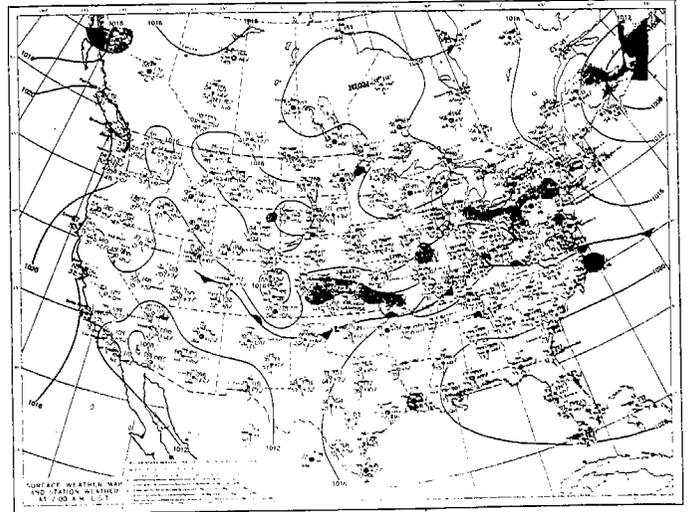
Hourly average oxidant levels increased rapidly at Prado Park after 7:00 A.M. PST. It was 10 pphm by 9:00 A.M. and reached a peak between 2:00 P.M. and 4:00 P.M. (Page 22). The FP tracer sampler was not activated until 2:30 P.M. The tracers from the Torrance and Los Angeles sources showed significant concentrations after this time but tracer from Santa Ana did not reach a peak until after 8:30 P.M.

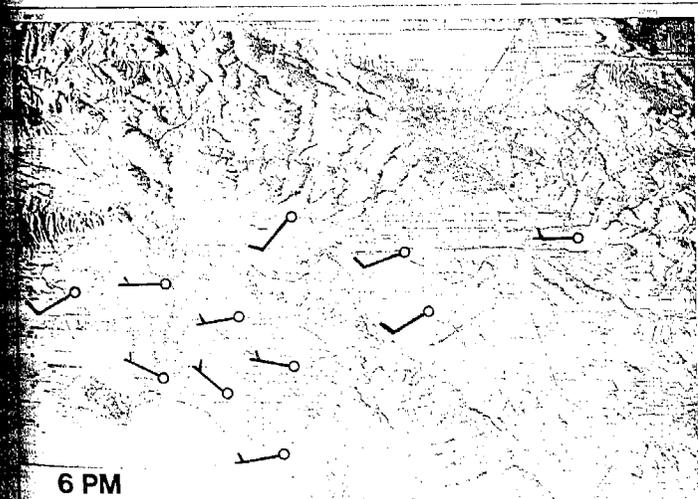
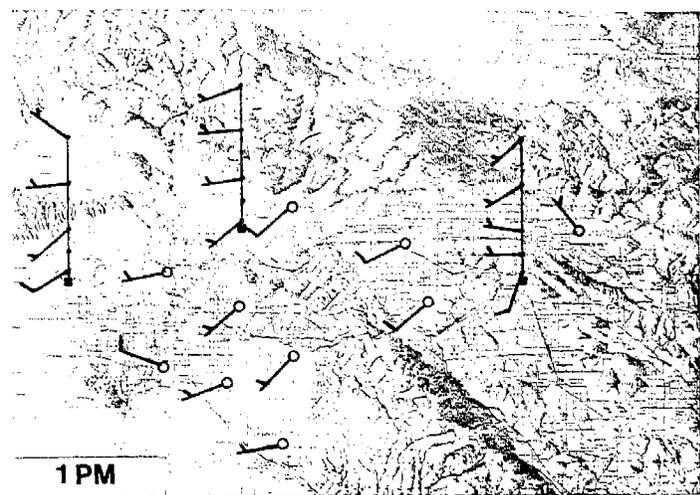
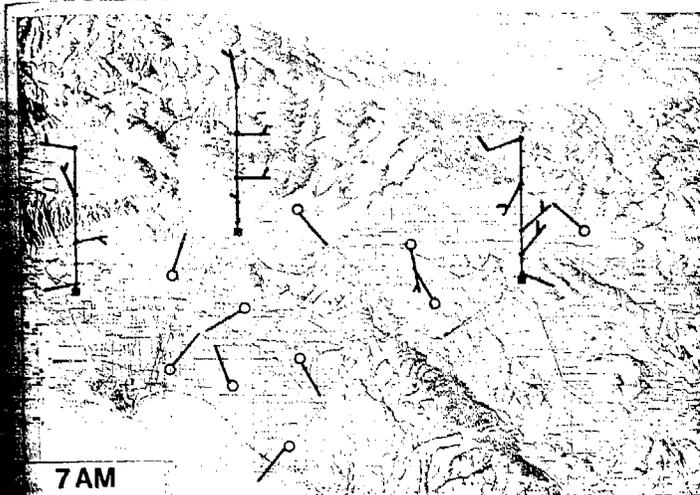
WEDNESDAY, JULY 26, 1972



THURSDAY, JULY 27, 1972

Surface Weather for Air Tracer Test No. One at 5:00 A.M. PDT on 26 and 27 July 1972.





WIND FLOW PATTERNS

AIR TRACER TEST NO. ONE

26 July 1972

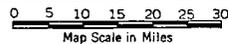
Feet	MPH
3000	32-37
2000	26-31
1000	21-25
500	15-20
100	9-14
Surface	3-8
	1-2

Direction is indicated by the "arrow" as flying with the wind.

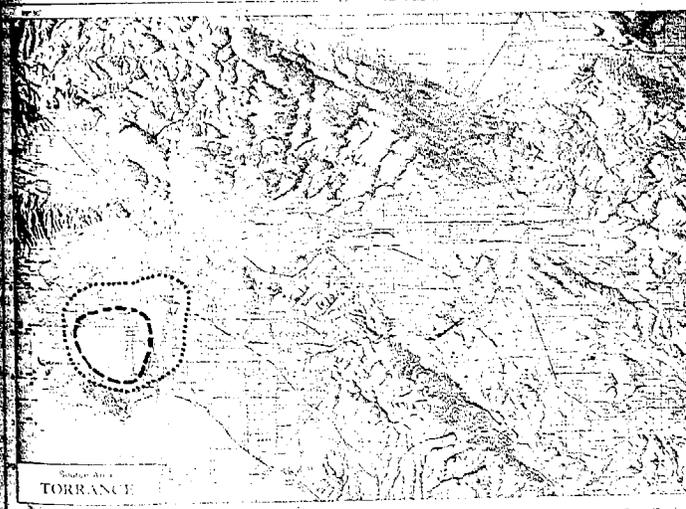
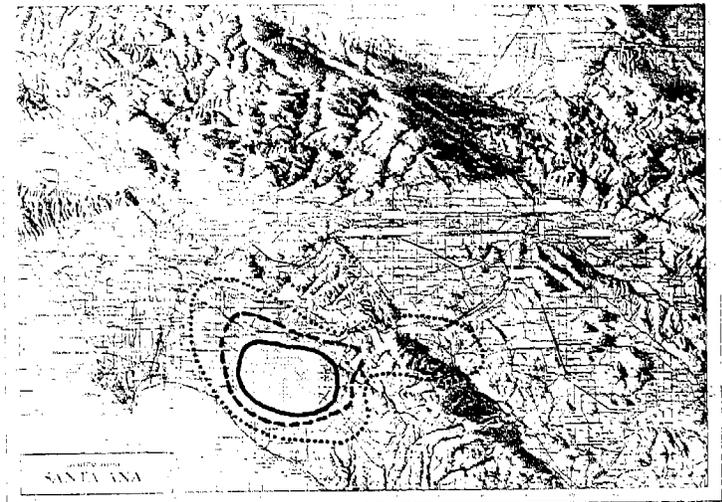
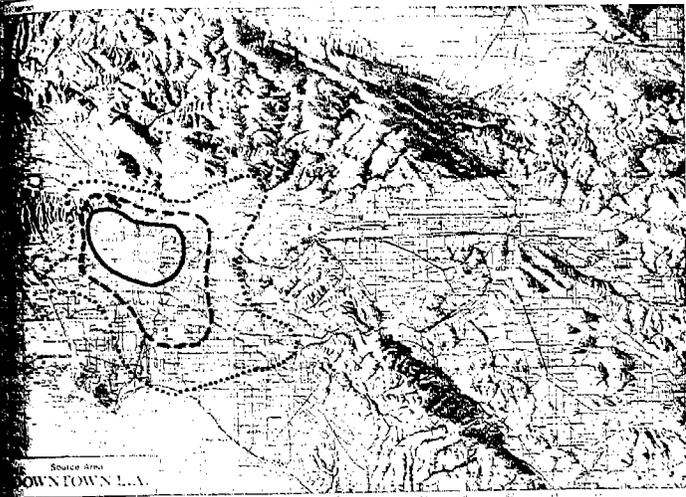
MORNING: Surface winds light and variable. Some flow from east to west at 1000 feet.

AFTERNOON: Westerly trend at all levels. Surface generally southwesterly. 1000 foot level veering from southwest on the coast to northwest inland.

EVENING: No upper level winds available. Surface winds light, stronger in the passes, show a westerly trend.



TIMES ARE PACIFIC DAYLIGHT TIME
Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



AIR TRACER TEST RESULTS

SITUATION: 4:00 AM - 10:00 AM, 26 July 1972

METEOROLOGY

SKY: Clear to scattered clouds.
 VISIBILITY: 8-15 miles
 SURFACE WINDS: Light-variable, 1-3 mph.
 WINDS ALOFT: Light-variable, 1-4 mph.
 PASQUILL STABILITY CLASS: C
 MIXING HEIGHT: 700-1600 feet (200-500 Meters).

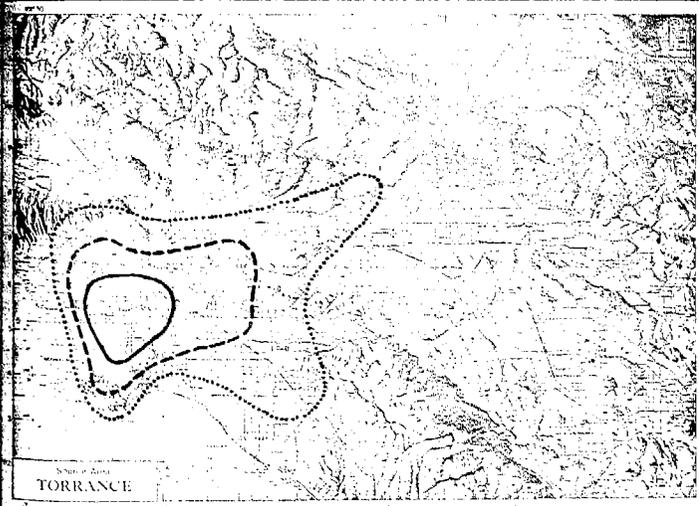
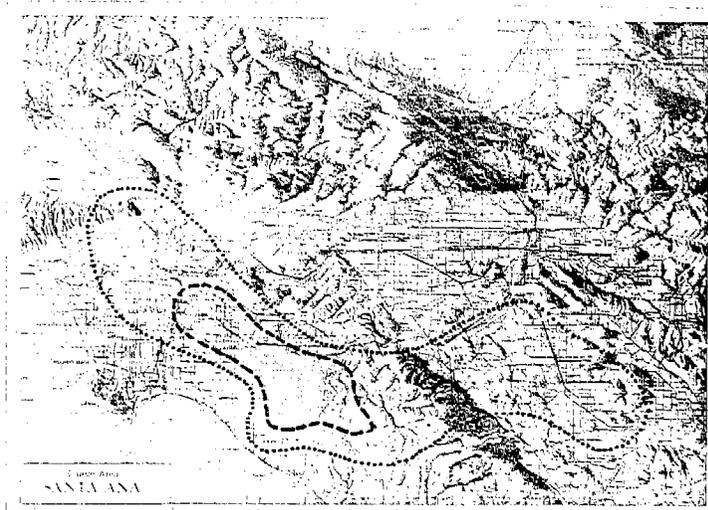
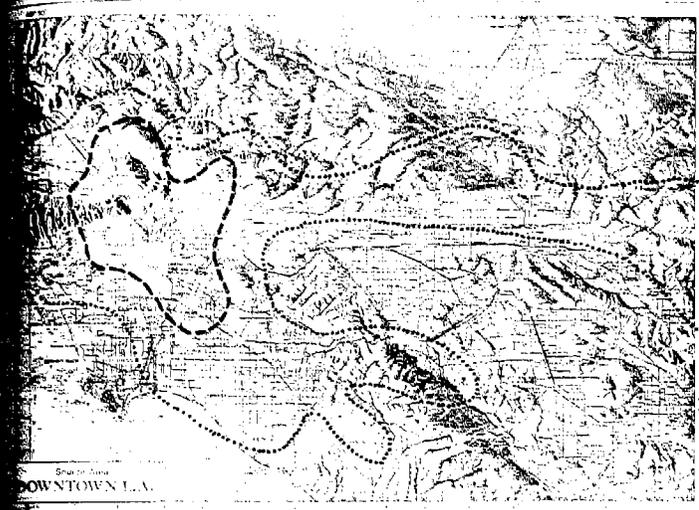
SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	1.2×10^{15}	1.14×10^{14}	3.22×10^{14}
DISPERSAL	5:00 AM to 7:00 AM, 26 JULY 1972		

Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 1 liter per minute from a source of 10^{16} particles.
 = 10 - - - - - = 100 _____ = 1000 Crosshatch = Source Area

0 5 10 15 20 25 30
 Map Scale in Miles

↑
NORTH

TIMES ARE PACIFIC DAYLIGHT TIME
 Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



AIR TRACER TEST RESULTS

SITUATION: 10:00 AM - 4:00 PM, 26 July 1972

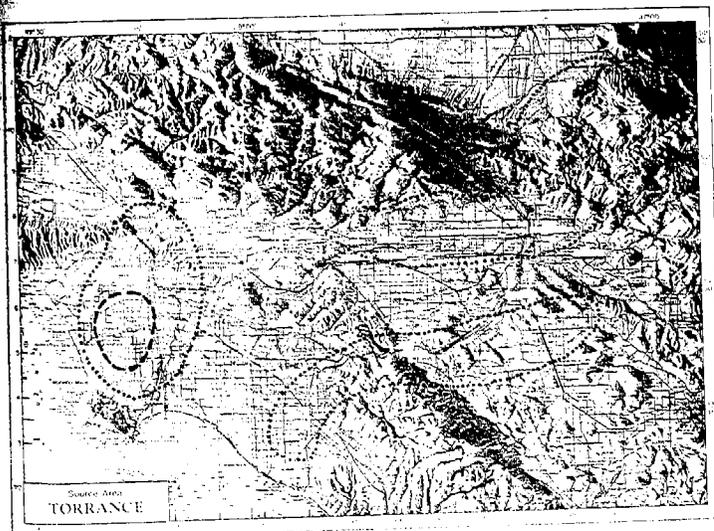
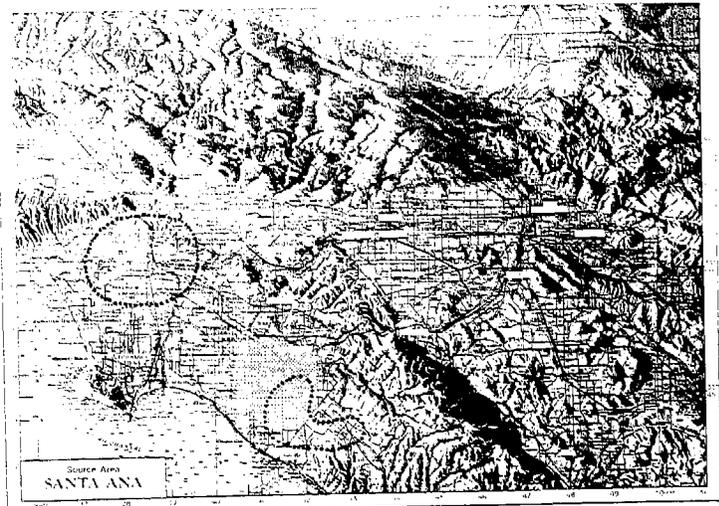
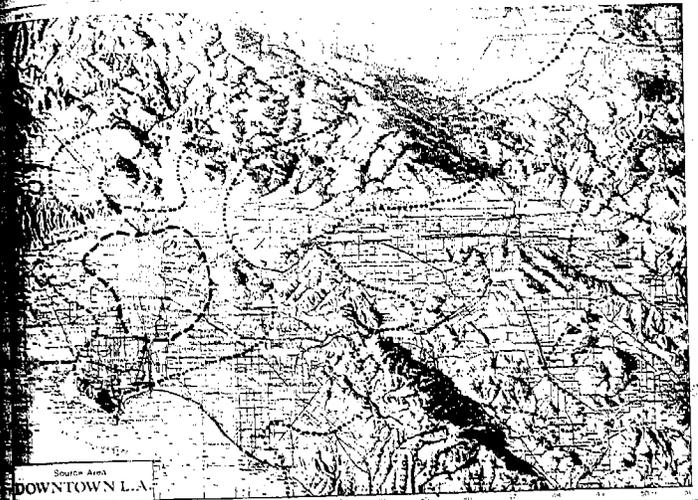
METEOROLOGY

SKY: Clear.
 VISIBILITY: 8-20 miles.
 SURFACE WINDS: SW to W, 6-13 mph.
 WINDS ALOFT: S to W, 5-15 mph.
 PASQUILL STABILITY CLASS: B
 MIXING HEIGHT: 1300-2300 feet (400-700 Meters).

SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	1.2×10^{15}	1.14×10^{14}	3.22×10^{14}
DISPERSAL	5:00 AM to 7:00 AM, 26 JULY 1972		

Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 1 liter per minute from a source of 10^{16} particles.
 = 10 - - - - - = 100 ————— = 1000 Crosshatch = Source Area

0 5 10 15 20 25 30 **NORTH** TIMES ARE PACIFIC DAYLIGHT TIME
 Map Scale in Miles Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



AIR TRACER TEST RESULTS

SITUATION: 4:00 PM - 10:00 PM, 26 July 1972

METEOROLOGY

SKY: Clear.
 VISIBILITY: 15-20 miles.
 SURFACE WINDS: SW to NW, 5-10 mph.
 WINDS ALOFT: No data.
 PASQUILL STABILITY CLASS: C
 MIXING HEIGHT: 1300-2300 feet (400-700 Meters).

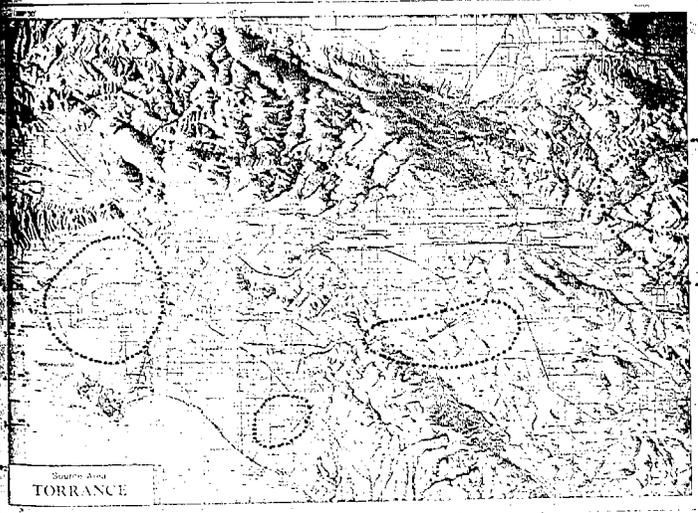
SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	1.2×10^{15}	1.14×10^{14}	3.22×10^{14}
DISPERSAL	5:00 AM to 7:00 AM, 26 JULY 1972		

Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 1 liter per minute from a source of 10^{16} particles.
 = 10 - - - - - = 100 ——— = 1000 Crosshatch = Source Area

0 5 10 15 20 25 30
 Map Scale in Miles

NORTH

TIMES ARE PACIFIC DAYLIGHT TIME
 Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



AIR TRACER TEST RESULTS

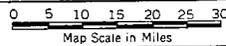
SITUATION: 10:00 PM - 4:00 AM, 26-27 July 1972

METEOROLOGY

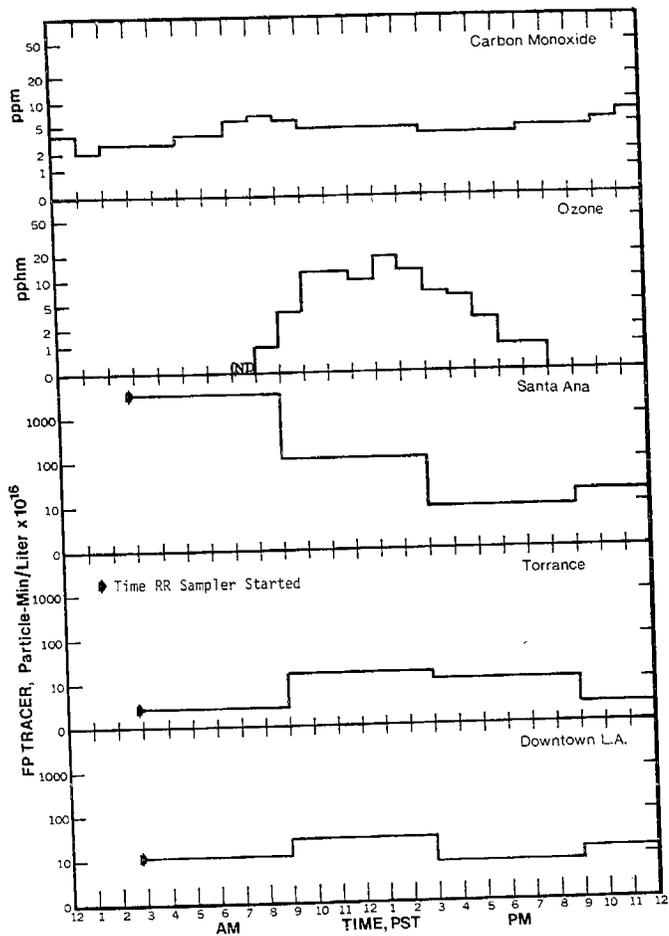
SKY: Clear.
 VISIBILITY: 10-15 miles.
 SURFACE WINDS: SW to NW, 3-6 mph.
 WINDS ALOFT: No data.
 PASQUILL STABILITY CLASS: F
 MIXING HEIGHT: 600-1700 feet (200-500 Meters).

SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	1.2×10^{15}	1.14×10^{14}	3.22×10^{14}
DISPERSAL	5:00 AM to 7:00 AM, 26 JULY 1972		

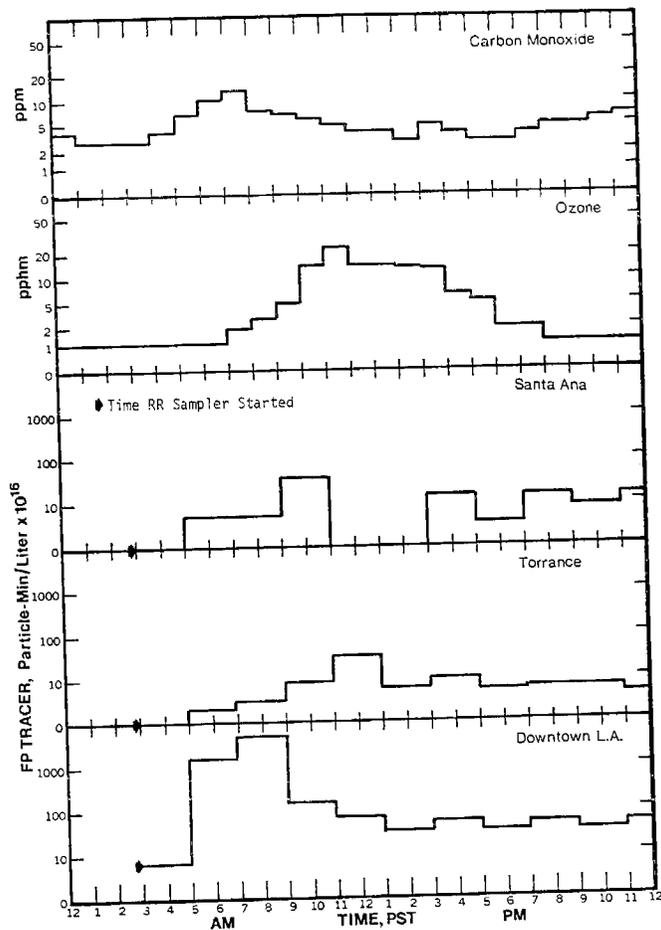
Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 1 liter per minute from a source of 10^{16} particles.
 = 10 - - - - = 100 ——— = 1000 Crosshatch = Source Area



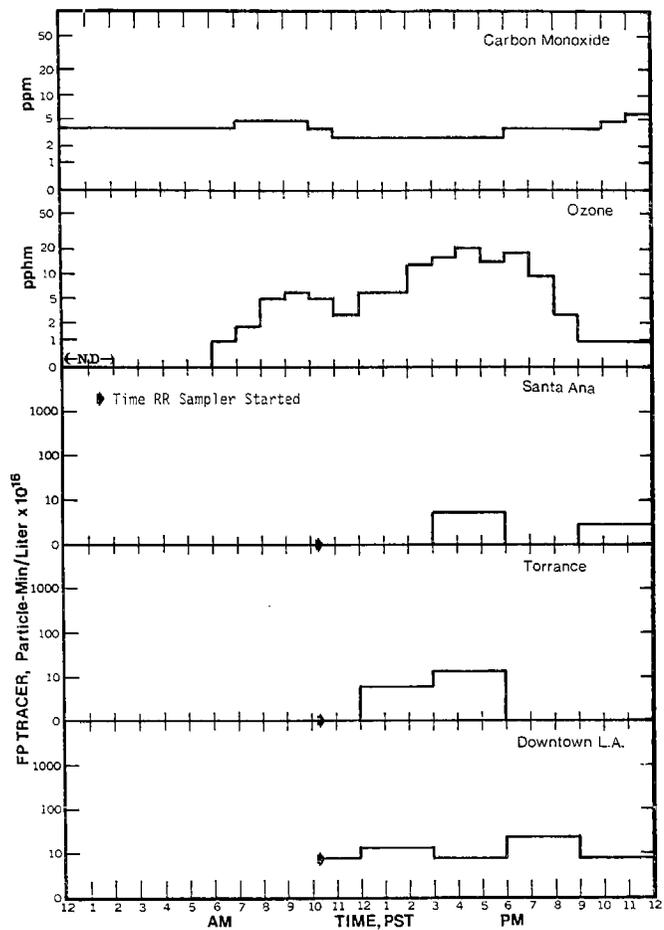
TIMES ARE PACIFIC DAYLIGHT TIME
 Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



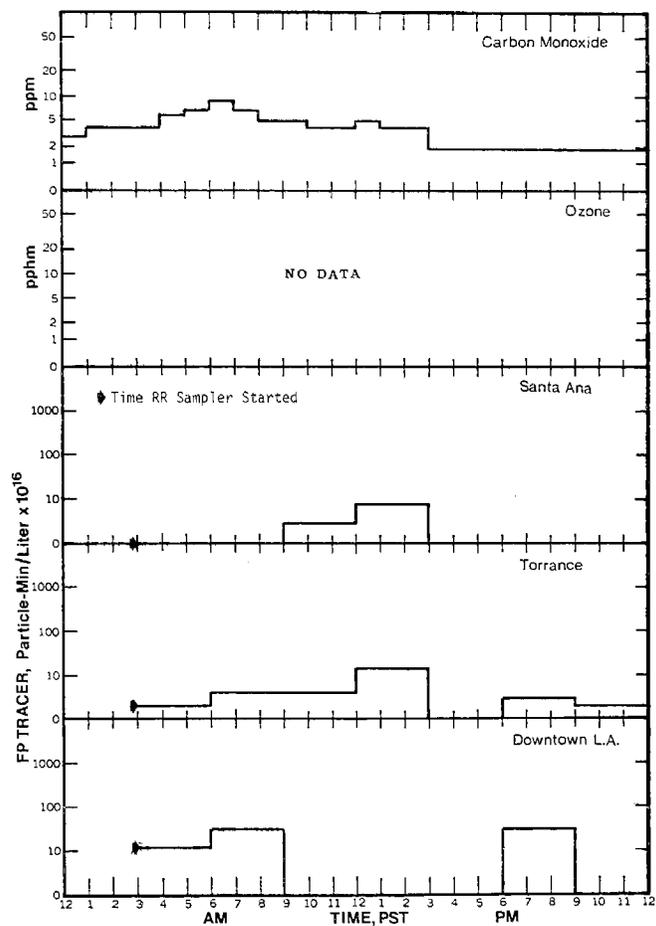
Comparison of Air Pollution and Air Tracer Measurements During Test No. One at Anaheim, 26 July 1972.



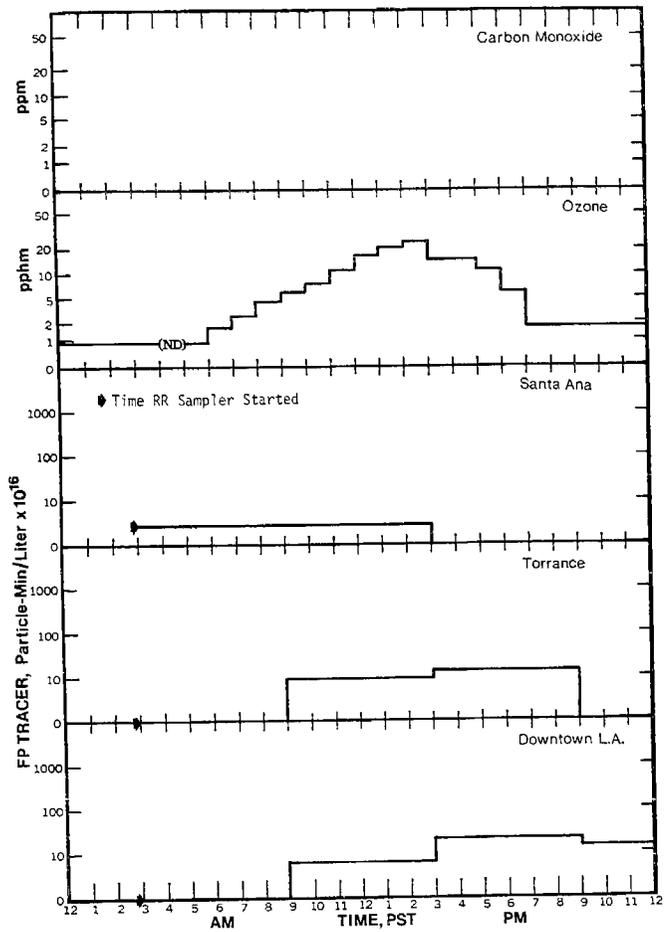
Comparison of Air Pollution and Air Tracer Measurements During Test No. One at Los Angeles APCD, 26 July 1972.



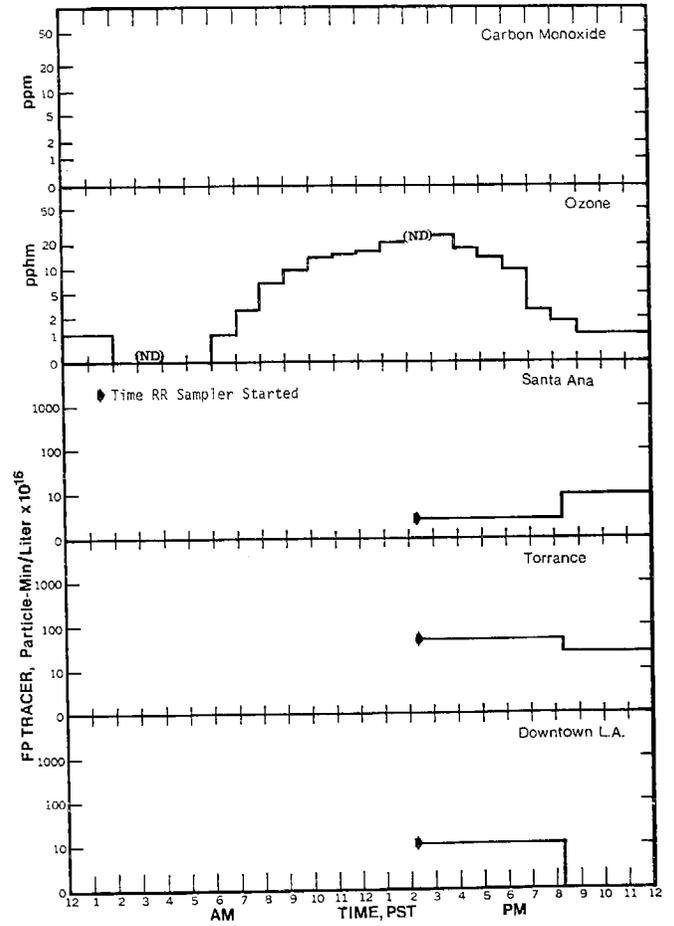
Comparison of Air Pollution and Air Tracer Measurements During Test No. One at San Bernardino, 26 July 1972.



Comparison of Air Pollution and Air Tracer Measurements During Test No. One at Riverside, 26 July 1972.



Comparison of Air Pollution and Air Tracer Measurements During Test No. One at Claremont-Pomona, 26 July 1972.



Comparison of Air Pollution and Air Tracer Measurements During Test No. One at Green River-Prado Park, 26 July 1972.

ANALYSIS OF AIR TRACER TESTS

TEST NUMBER TWO, 29-30 AUGUST 1972

A. Meteorology.

The Pacific high pressure area was centered north of its normal position with a weak low pressure area centered north of Montana. A high pressure ridge was centered over Utah and tropical storm "Gwen" was located approximately 500 miles south of Los Angeles (Page 26). A weak offshore pressure gradient existed at the beginning of the test but a relatively strong south to southwest onshore flow developed during the day. The tropical storm moved northwestward and was centered about 300 miles south of Los Angeles by the morning of 30 August (Page 26).

The entire area was covered with scattered to broken clouds with showers in the northern and mountain regions by the second day.

Mixing layer heights were 150-400 meters during the morning, increasing to 150-1200 meters during the day. Surface winds and winds aloft during the first day are described on Page 27.

Climatological frequencies of days similar to the test days are estimated from Table 2 to be approximately 30%. This classification applies only to the stability which determines the diffusion and transport of air pollutants. The high humidity and cloudiness associated with the tropical storm to the south are not typical of the season.

B. Air Tracer Test.

The dispersals were made from the three major source areas between the hours of 5:00 and 7:00 A.M. PDT, 29 August 1972.

1. Downtown Los Angeles Source.

The Downtown Los Angeles source spread southward and south-eastward during the first six-hour period (4:00-10:00 A.M. PDT) with some movement of the northern fringe northeastward and north-westward toward Pasadena and the San Fernando Valley (Page 28). Rapid expansion of the tracer cloud occurred during the period 10:00 A.M.-4:00 P.M. PDT with portions of the tracer reaching as far east as San Bernardino and Hemet and as far north as the San Gabriel Canyon (Page 29). Portions of the tracer remained in the

northern and northeastern area of the Los Angeles Basin and in the Perris and San Jacinto Valleys during the night with some tracer reaching Summit Lookout in Cajon Pass. Tracer levels were generally low throughout the second day.

2. Torrance Source.

The Torrance source showed a very peculiar and rapid transport northward into the San Gabriel Mountains during the first test period (Page 28). The surface winds and winds aloft in the first 3000 feet were neither in the right direction nor had sufficient speed to move the tracer such a distance. However, rawinsonde measurements at Los Angeles and El Monte airports showed winds above 6000 feet to be 15-20 mph and from the south to south-south-west. A possible mechanism for this peculiar transport would be that a portion of the release on the Pacific Coast Highway was caught in an updraft on the slopes of the Palos Verdes Hills and injected into the upper level wind flow; then the winds transported it to the mountains above the inversion layer.

The tracer within the mixing layer spread eastward into the Santa Ana Canyon and southeastward into Trabuco Canyon during the period 10:00 A.M.-4:00 P.M. PDT (Page 29). During the next period, 4:00-10:00 P.M., the tracer spread rapidly northeastward into the San Bernardino Mountains and southeastward along the coast toward Oceanside (Page 30) with some movement into the San Fernando Valley to the north.

During the evening and nighttime hours (Pages 30 and 31), the tracer remained in the area with peak concentrations in the Claremont region and in the Perris Valley. The tracer cloud was separated into distinct patterns the following day with one in the Los Angeles Basin and the other extending northeastward from Crystal Lake in the San Gabriel Canyon to Hemet in the San Jacinto Valley. The tracer disappeared from all but the Los Angeles Basin by the end of the test at 4:00 A.M. PDT, 31 August.

3. Santa Ana Source.

The Santa Ana source spread northwestward toward Los Angeles, eastward into the Santa Ana Canyon and southeastward along the coast during the period 4:00-10:00 A.M. PDT (Page 28). The tracer spread northeastward into Riverside and San Bernardino and to Upland and Ontario in the second period (10:00 A.M.-4:00 P.M. PDT) with some movement southward along the coast (Page 29). The tracer cloud spread northeastward past the San Bernardino Mountains and southeastward into the Perris and San Jacinto Valleys during the evening, 4:00-10:00 P.M. (Page 30) and except for a residual cloud in the Santa Ana area the tracer moved eastward during the night (Page 31) and almost completely disappeared the second day.

Comparison of Air Pollution and Tracer Measurements.

1. Downtown Los Angeles.

The hourly average ozone concentration increased after 6:00 A.M. to a peak of 20 pphm between 11:00 A.M. and 12:00 noon PST (Page 32). Levels remained relatively high until 7:00 P.M. and decreased sharply after this time. The Los Angeles tracer showed a peak between 3:00 and 5:00 A.M. and decreased rapidly after 7:00 A.M. Tracer from the Torrance area showed a minor peak between 3:00 and 5:00 A.M. but its major peak occurred between 9:00 A.M. and 1:00 P.M., corresponding to the oxidant peak that day.

The carbon monoxide levels were generally above 10 pphm from the beginning of the day until 11:00 A.M. with a peak between 6:00 and 7:00 A.M. The peak tracer concentration from the Los Angeles source was well correlated with the peak carbon monoxide levels.

2. Anaheim.

Two peaks in the hourly averages of ozone concentration occurred, one between 10:00 and 11:00 A.M. PST and one between 2:00 and 4:00 P.M. PST on 29 August. Relatively high levels between these two periods (Page 32) were also observed. Tracer concentrations from the Torrance and Santa Ana source areas were both high

during the period from 9:00 A.M. to 12:00 noon but the Santa Ana tracer decreased after 12:00 noon while the Torrance tracer remained high until 3:00 P.M., corresponding to the extended period of high oxidant concentrations. A small contribution from the Los Angeles source appeared between 12:00 noon and 3:00 P.M.

The carbon monoxide peak occurred between 6:00 and 7:00 A.M. Only the Santa Ana tracer was present during this period.

3. Riverside.

Oxidant levels rose sharply after 7:00 A.M. to a morning peak of 6 pphm from 8:00 to 10:00 A.M. PST. The highest hourly average of 10 pphm occurred between 5:00 and 6:00 P.M. (Page 33). The highest three-hour average tracer concentration from the Santa Ana source occurred between 3:00 and 6:00 P.M. The tracer from Torrance showed a smaller peak between 3:00 and 9:00 P.M. A small rise in oxidant level after 10:00 P.M. coincided with the arrival of tracer from the Los Angeles source.

4. San Bernardino.

Oxidant levels increased after 7:00 A.M. showing two small peaks of 3 pphm, one between 9:00 and 10:00 A.M. and one between 12:00 noon and 1:00 P.M. The highest peak, 5 pphm, occurred between 4:00 and 5:00 P.M. Tracer from Los Angeles reached the area between 9:00 A.M. and 12 noon and reached a peak between 12:00 noon and 3:00 P.M. Tracer from Santa Ana and Torrance arrived between 12:00 noon and 3:00 P.M. The highest tracer levels from all three sources occurred between 12:00 noon and 6:00 P.M., corresponding to the highest oxidant levels.

A sharp carbon monoxide peak occurred between 6:00 and 7:00 A.M. but no tracer was evident during the period of 6:00 to 9:00 A.M.

5. Claremont-Pomona.

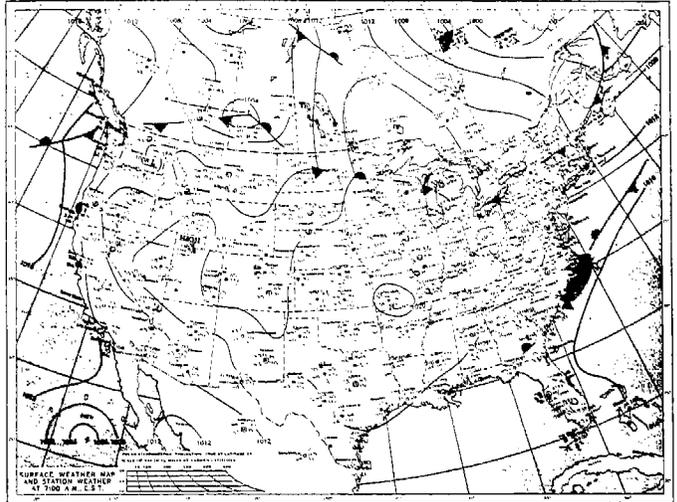
The oxidant level at Pomona increased after 7:00 A.M. to a peak between 10:00 and 11:00 A.M. with a second peak between 1:00 and 5:00 P.M. (Page 34). Due to equipment problems we were not able to take tracer samples at this location until noon. Peak tracer concentrations at Claremont from both the Santa Ana and the

Torrance sources occurred between 1:30 P.M. and 3:00 P.M. A small peak in the oxidant value occurred between 9:00 and 11:00 P.M. This might be associated with the tracer from Los Angeles which arrived between 5:00 and 11:00 P.M.

6. Green River-Prado Park.

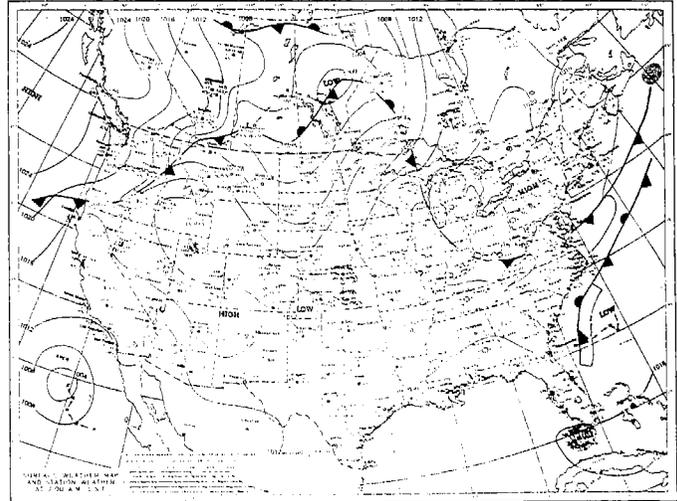
No FP tracer samples were taken at Green River during this test.

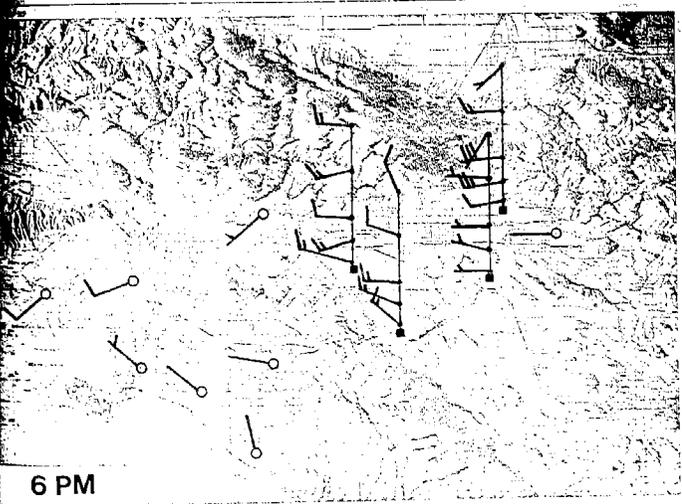
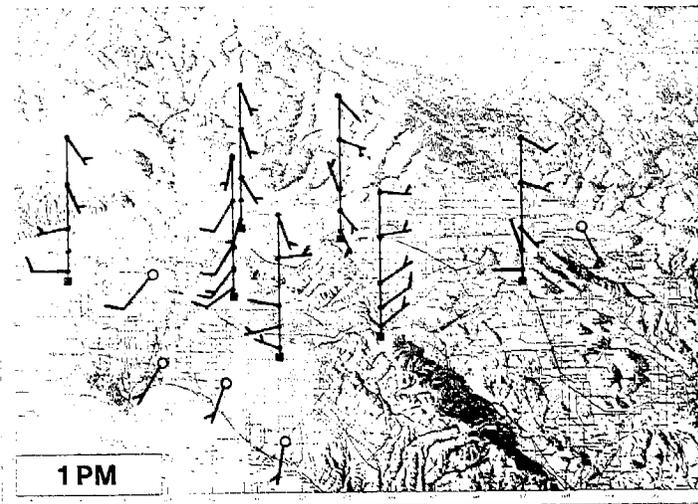
TUESDAY, AUGUST 29, 1972



Surface Weather for Air Tracer Test No. Two at 5:00 A.M. PDT on 29 and 30 August 1972.

WEDNESDAY, AUGUST 30, 1972





WIND FLOW PATTERNS

AIR TRACER TEST NO. TWO

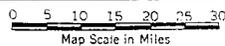
29 August 1972

Feet	MPH
3000	32-37
2000	26-31
1000	21-25
500	15-20
100	9-14
Surface	3-8
	1-2

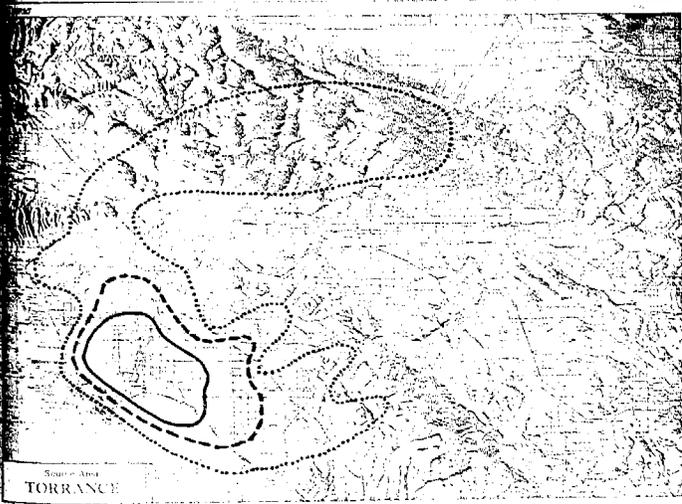
Direction is indicated by the "arrow" is flying with the wind.

MORNING: Light winds. Northwestern winds along the coast at the surface but some northeast winds further inland. At 2000 feet a southeast flow. At 3000 feet winds light and tending from east-southeast. Rawinsonde measurements at Los Angeles and El Monte airports show strong south wind above 6000 feet (not shown).

AFTERNOON: Southwest surface winds along the coast. Winds veering from east to south at upper levels. Northeast surface winds in the passes. **EVENING:** Overall westerly wind flow established. Light along the coast, stronger inland and in passes.



TIMES ARE PACIFIC DAYLIGHT TIME
Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



AIR TRACER TEST RESULTS

SITUATION: 4:00 AM - 10:00 AM, 29 August 1972

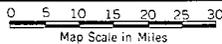
METEOROLOGY

SKY: Scattered to broken clouds at 10,000 and 20,000 feet.
 VISIBILITY: 3-10 miles in smoke and haze.
 SURFACE WINDS: S to W, 2-6 mph, shifting to N to W, 2-12 mph.
 WINDS ALOFT: NW to NE, 2-12 mph.
 PASQUILL STABILITY CLASS: D
 MIXING HEIGHT 500 - 1200 feet (150-400 Meters).

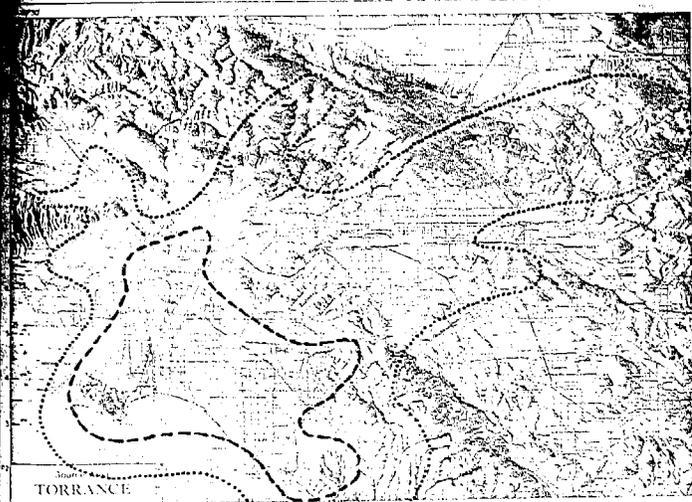
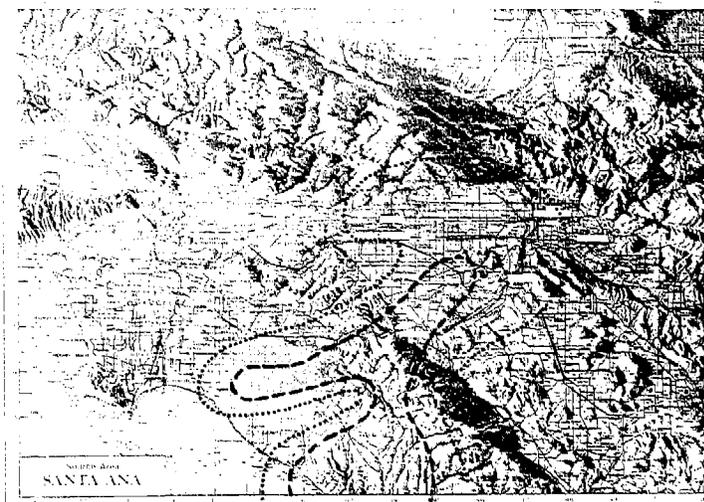
SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	1.84×10^{14}	9.69×10^{13}	6.39×10^{14}
DISPERSAL	5:00 AM to 7:00 AM, 29 AUGUST 1972		

Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 1 liter per minute from a source of 10^{16} particles.

..... = 10 - - - - = 100 ——— = 1000 Crosshatch = Source Area



TIMES ARE PACIFIC DAYLIGHT TIME
 Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



AIR TRACER TEST RESULTS

SITUATION: 10:00 AM - 4:00 PM, 29 August 1972

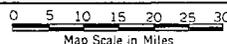
METEOROLOGY

SKY: Broken to overcast at 10,000 to 20,000 feet.
 VISIBILITY: 5-15 miles.
 SURFACE WINDS: S to W, 5-15 mph.
 WINDS ALOFT: SE to W, 5-25 mph.
 PASQUILL STABILITY CLASS: D
 MIXING HEIGHT: 500-4000 feet (150-1200 meters).

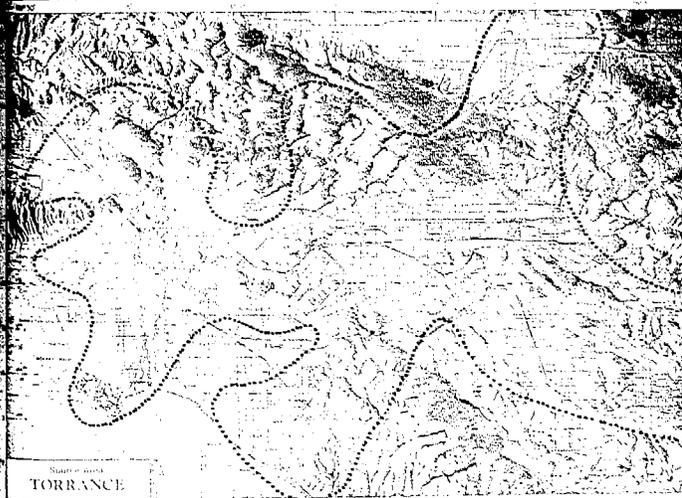
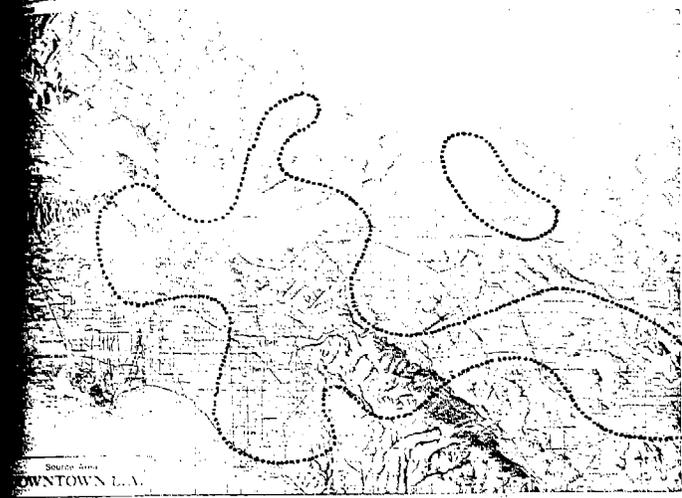
SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	1.84×10^{14}	9.69×10^{13}	6.39×10^{14}
DISPERSAL	5:00 AM to 7:00 AM, 29 AUGUST 1972		

Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 1 liter per minute from a source of 10^{16} particles.

..... = 10 - - - - - = 100 _____ = 1000 Crosshatch = Source Area



TIMES ARE PACIFIC DAYLIGHT TIME
 Map Grid - Universal Transverse Mercator Grid - 10,000 Meters



AIR TRACER TEST RESULTS

SITUATION: 4:00 PM - 10:00 PM, 29 August 1972

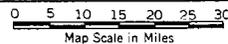
METEOROLOGY

SKY: Broken to overcast at 12,000 to 20,000 feet.
 VISIBILITY: 7-15 miles.
 SURFACE WINDS: SW to NW, 3-10 mph.
 WINDS ALOFT: S to NW, 10-30 mph.
 PASQUILL STABILITY CLASS: D
 MIXING HEIGHT: 400-3,000 feet (120-900 meters).

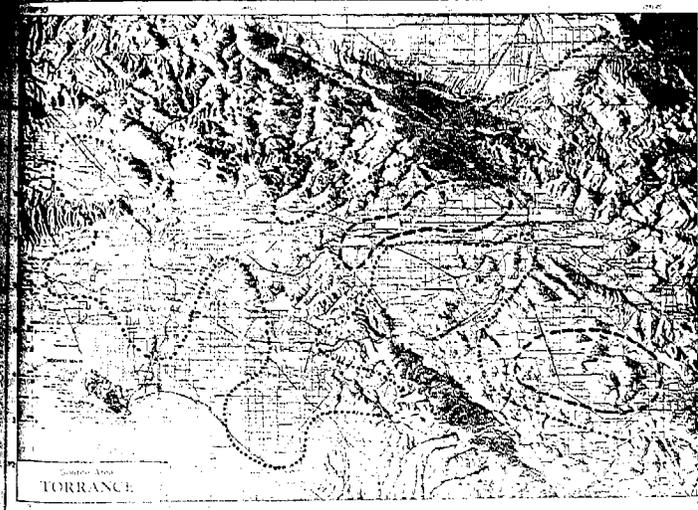
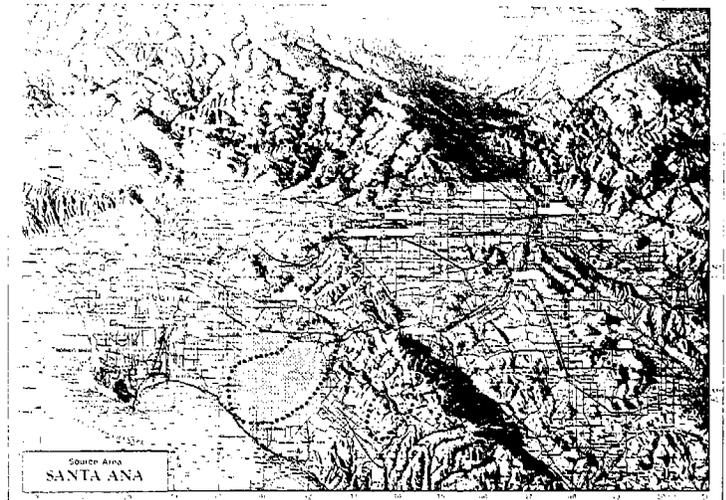
SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	1.84×10^{14}	9.69×10^{13}	6.39×10^{14}
DISPERSAL	5:00 AM to 7:00 AM, 29 AUGUST 1972		

Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 1 liter per minute from a source of 10^{16} particles.

..... = 10 - - - - - = 100 - - - - - = 1000 Crosshatch = Source Area



TIMES ARE PACIFIC DAYLIGHT TIME
 Map Grid - Universal Transverse Mercator Grid - 10,000 Meters



AIR TRACER TEST RESULTS

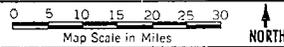
SITUATION: 10:00 PM - 4:00 AM, 29-30 August 1972

METEOROLOGY

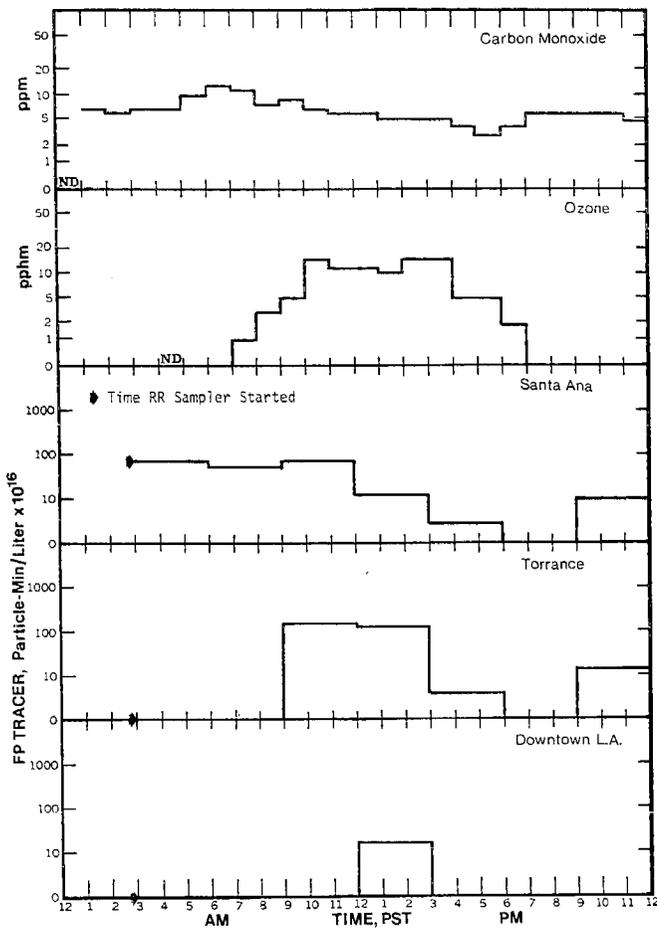
SKY: Broken to overcast, clouds at 12,000 to 14,000 feet.
 VISIBILITY: 7-15 miles.
 SURFACE WINDS: SE to W, 4-9 mph.
 WINDS ALOFT: No data
 PASQUILL STABILITY CLASS: D
 MIXING HEIGHT: 1000-1500 feet (300-500 meters).

SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	1.84×10^{14}	9.69×10^{13}	6.39×10^{14}
DISPERSAL	5:00 AM to 7:00 AM, 29 AUGUST 1972		

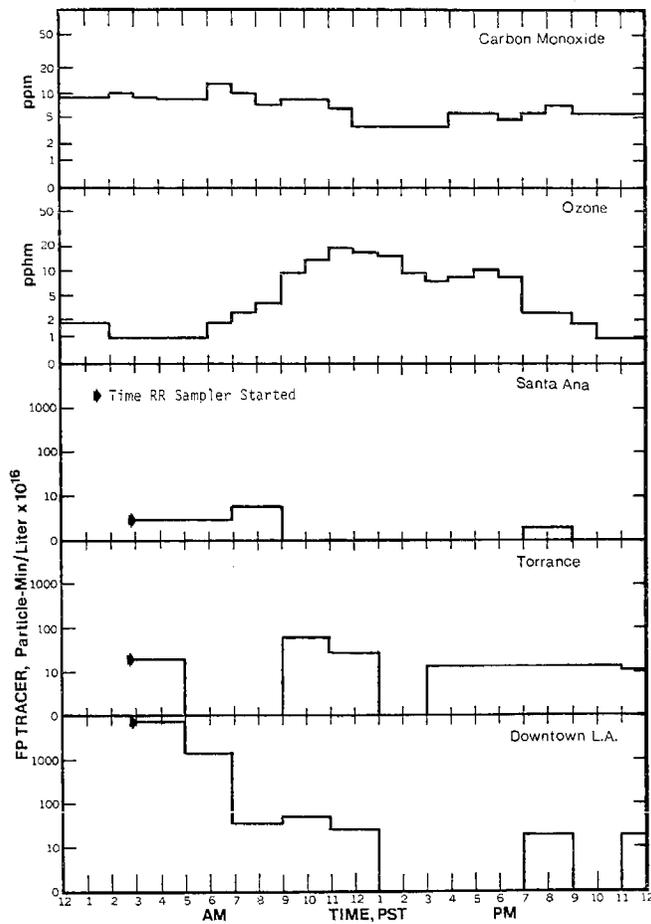
Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 1 liter per minute from a source of 10^{16} particles.
 = 10 - - - - - = 100 _____ = 1000 Crosshatch = Source Area



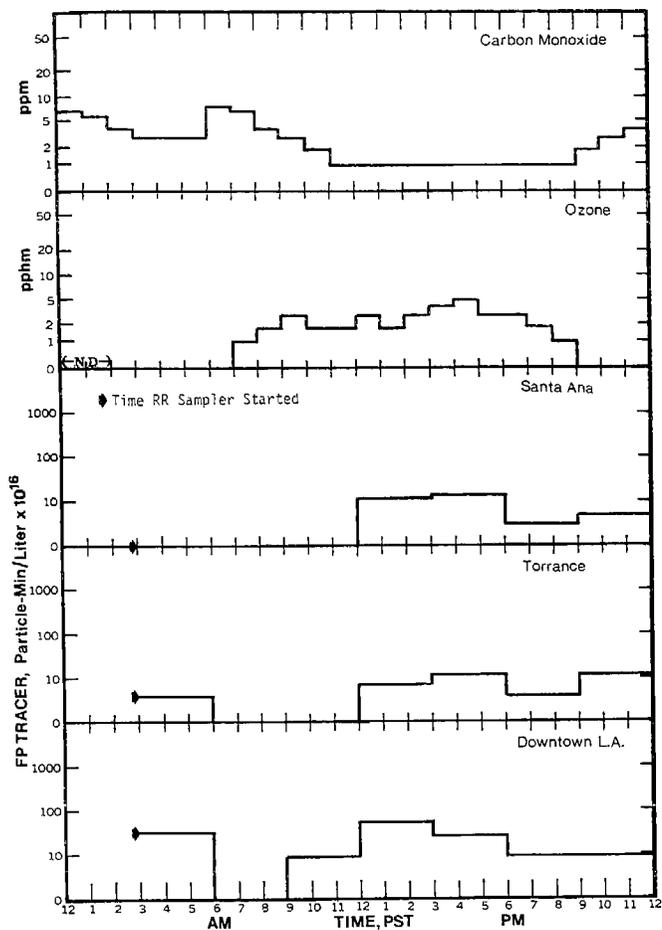
TIMES ARE PACIFIC DAYLIGHT TIME
 Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



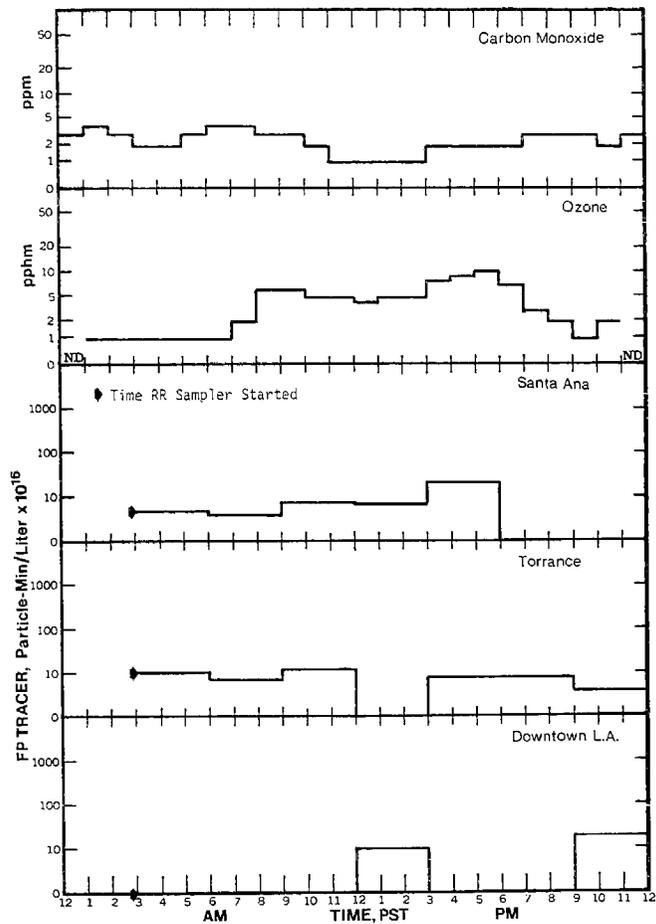
Comparison of Air Pollution and Air Tracer Measurements During Test No. Two at Los Angeles APCD, 29 August 1972.



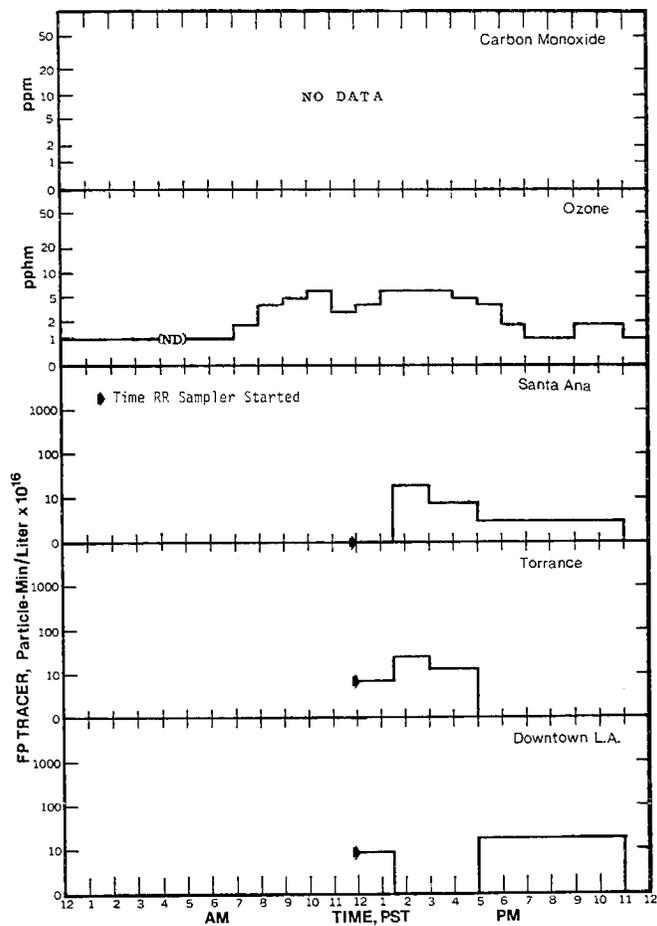
Comparison of Air Pollution and Air Tracer Measurements During Test No. Two at Anaheim, 29 August 1972.



Comparison of Air Pollution and Air Tracer Measurements During Test No. Two at San Bernardino, 29 August 1972.



Comparison of Air Pollution and Air Tracer Measurements During Test No. Two at Riverside, 29 August 1972.



Comparison of Air Pollution and Air Tracer Measurements During Test No. Two at Claremont-Pomona, 29 August 1972.

ANALYSIS OF AIR TRACER TESTS

TEST NUMBER THREE, 20-21 SEPTEMBER 1972

A. Meteorology.

On the morning of 20 September a ridge of high pressure extended eastward into Oregon, Nevada and Northern California (Page 37). A storm was centered about 200 miles off the coast of British Columbia. Skies were generally clear and there was a weak offshore pressure gradient in the Los Angeles Basin.

The high pressure area spread rapidly inland and was centered in Nebraska by the next morning (Page 37) and the storm moved to the coast of British Columbia with a cold front extending southward through Washington.

The high pressure inland coupled with a weak trough off the coast of Southern California produced a weak Santa Ana flow aloft but not strong enough to move the marine layer from the Los Angeles Basin. The mixing layer was low in the morning, 150-500 meters, increasing to 240-900 meters during the day. Surface winds were light northerly along the coast and variable inland. At 300 meters the winds were easterly to northeasterly (Page 38). The surface winds shifted to west in the afternoon but remained easterly at the higher levels. In the late afternoon very strong westerly winds developed in the intermediate valleys and passes.

The frequency of days similar to the test days were estimated for Table 2 to be approximately 17% for the month of September.

B. Air Tracer Test.

Dispersals were made from the three source areas between the hours of 5:00 and 7:00 A.M. PDT, 20 September. An error by the vehicle driver in the Downtown Los Angeles source resulted in a dispersal of some of the tracer along Harbor Freeway toward the Pacific Coast Highway. This produced a somewhat larger area source than intended but the difference in results was not believed to be serious.

1. Downtown Los Angeles Source.

The Downtown Los Angeles tracer spread southward and eastward through the Santa Ana Canyon during the first period, 4:00-10:00 A.M. PDT (Page 39), then branched southeastward along the coast and northeastward toward Pasadena and Azusa during the period 10:00 A.M.-4:00 P.M. PDT (Page 40) and then rapidly spread eastward to San Bernardino, Riverside and Palm Springs in the evening (Page 41). The tracer almost completely disappeared from the inland area during the night but a substantial residue remained in the Los Angeles Basin through the night (Page 42). The tracer level decreased rapidly the following day throughout the area.

2. Torrance Source.

The tracer from the Torrance area spread rapidly eastward to the Santa Ana Canyon and southeastward along the coast during the first period 4:00-10:00 A.M. PDT (Page 39). Some tracer moved northward along the coast to the Santa Monica Mountains. Further spreading northward and eastward occurred during the period 10:00 A.M.-4:00 P.M. PDT (Page 40), with some of the tracer reaching Riverside. Additional movement northeastward to San Bernardino and southeastward into the Perris and San Jacinto Valleys occurred during the evening (Page 41) but with relatively high concentration remaining in the area near Los Alamitos. The tracer was separated into distinct patterns during the night with the peak concentrations in the Anaheim and Riverside areas (Page 42). A low residual level of the tracer remained in the area the second day.

3. Santa Ana Source.

The Santa Ana tracer spread southward and eastward to Corona del Mar and Green River during the first period 4:00-10:00 A.M. PDT (Page 39), then spread southeastward into the mountains southeast of Santa Ana during the day (Page 40). The tracer cloud remained in the Santa Ana area during the evening but was diluted to low levels during the night (Page 41) and rapidly disappeared the following day.

Comparison of Air Pollution and Tracer Measurements.

1. Downtown Los Angeles.

No oxidant measurements were available between 7:00 A.M. and noon, but the peak hourly average after noon occurred between 12:00 and 1:00 P.M. (Page 43). The tracers from both Los Angeles and Torrance showed peak concentrations between 11:00 A.M. and 1:00 P.M. Tracer concentrations from the Santa Ana source were negligible. Peak morning carbon monoxide concentrations occurred between 5:00 and 7:00 A.M. Only tracer from the Los Angeles source was present at this time.

2. Anaheim.

Hourly oxidant concentrations increased rapidly after 8:00 A.M. to a peak of 13 pphm between 1:00 and 4:00 P.M. and decreased rapidly to zero by 6:00 P.M. Malfunction of a timer on the FP tracer sampling unit at this location resulted in a loss of temporal resolution between 3:00 A.M. to 12:15 P.M. PST. Tracer concentrations from both the Santa Ana and Torrance source areas were high during this period. The tracer concentrations from Santa Ana decreased after 12:15 P.M. while that from Torrance increased slightly from 12:15 to 4:00 P.M. and decreased rapidly thereafter. The tracer from Los Angeles increased to a maximum between 4:00 P.M. and 9:00 P.M. The oxidant peak showed best correlation with the tracers from Torrance and Los Angeles.

Carbon monoxide concentrations showed no sharp peaks but secondary peaks occurred between 6:00 and 8:00 A.M. and between 11:00 A.M. and 1:00 P.M. with a sustained high level from 8:00 P.M. to midnight. The Santa Ana tracer concentration was high until 12:15 P.M. and the tracer from Torrance persisted until 4:00 P.M. The Los Angeles tracer increased after 12:15 P.M. and remained high throughout the remainder of the day, corresponding to the high level of carbon monoxide in the late evening.

3. Riverside.

Oxidant levels increased rapidly after 7:00 A.M. to 11 pphm by 11:00 A.M. and increased again in the afternoon to 37 pphm between

4:00 and 5:00 P.M. Tracer concentrations were generally low. The highest concentrations observed were from the Los Angeles source between 3:00 and 6:00 P.M. coinciding with the highest oxidant concentrations.

4. San Bernardino.

Oxidant levels rose sharply after 8:00 A.M. to a peak of 6 pphm between 10:00 and 11:00 A.M. and to a higher peak of 13 pphm between 4:00 and 5:00 P.M. (Page 44). Tracer levels were generally low. Tracer from Los Angeles arrived after 3:00 P.M. and from Torrance after 6:00 P.M.

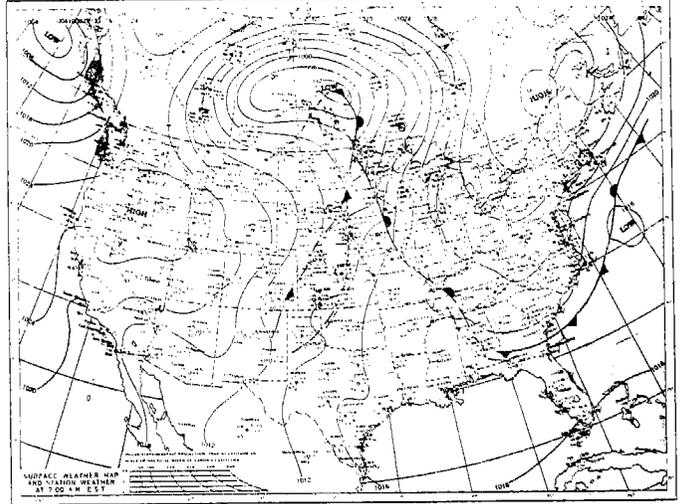
5. Claremont-Pomona.

The FP tracer sampler at Claremont malfunctioned during this test.

6. Green River-Prado Park.

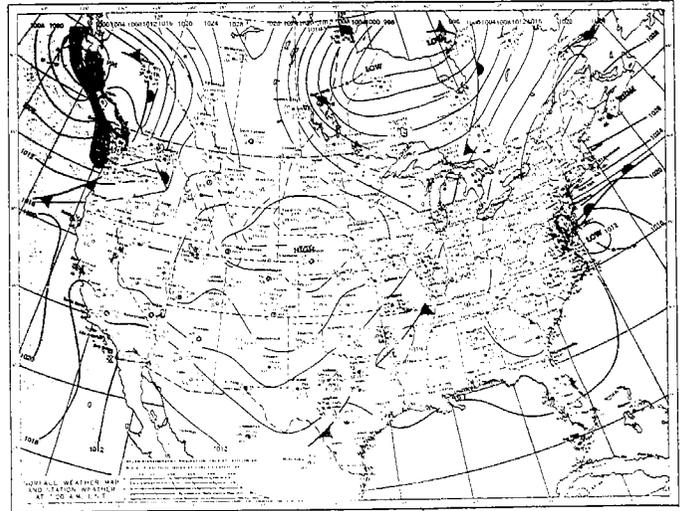
Oxidant levels at Prado Park increased rapidly after 7:00 A.M. to a peak value of 26 pphm between 3:00 P.M. and 4:00 P.M., decreasing rapidly after 5:00 P.M. The tracer concentrations at Green River were low. The tracers from Santa Ana and Torrance reached the highest concentrations between 9:00 and 11:00 A.M. and the Los Angeles tracer was highest between 11:00 A.M. and 1:00 P.M. and again between 7:00 P.M. and 9:00 P.M. There was no apparent correlation of the ozone peak with any of the three tracers.

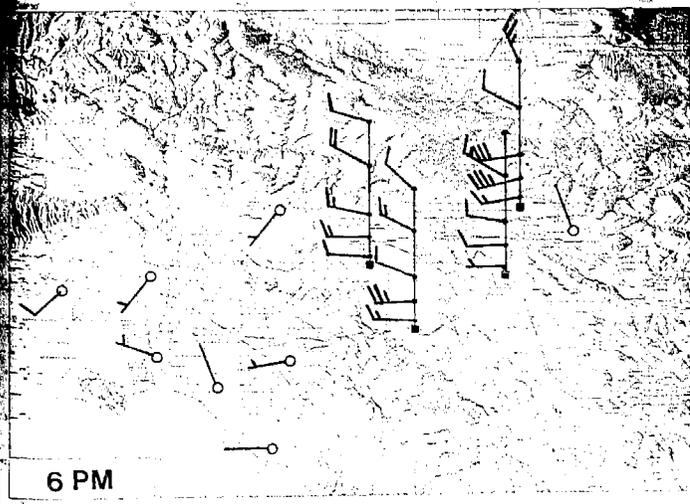
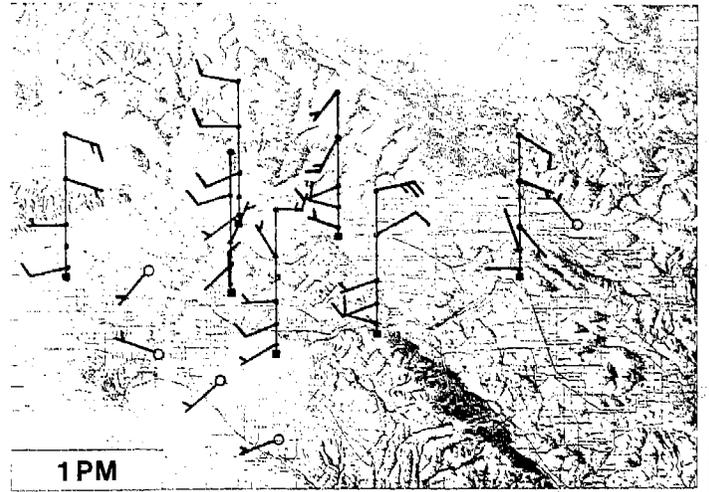
WEDNESDAY, SEPTEMBER 20, 1972



Surface Weather for Air Tracer Test No. Three at 5:00 A.M. PDT on 20 and 21 September 1972.

THURSDAY, SEPTEMBER 21, 1972





WIND FLOW PATTERNS

AIR TRACER TEST NO. THREE 20 September 1972

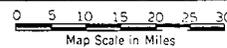
Feet	MPH
3000	32-37
2000	26-31
1000	21-25
500	15-20
100	9-14
Surface	3-8
	1-2

Direction is indicated by the "arrow" as flying with the wind.

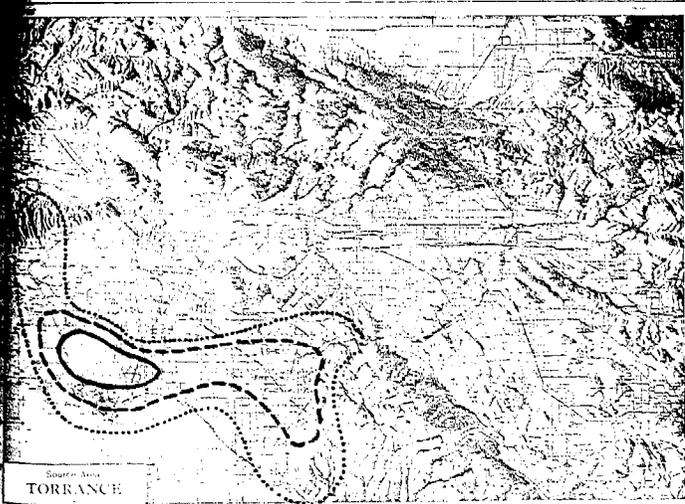
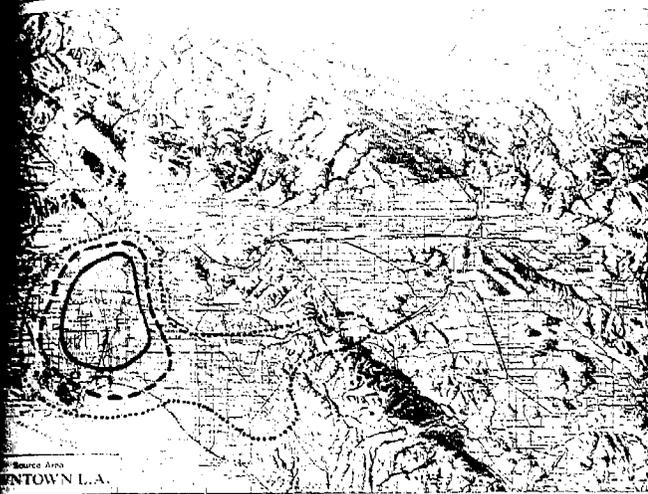
MORNING: Surface winds were light from the north along the coast. Variable inland. At 1000 feet flow from the east and northeast.

AFTERNOON: Surface flow from the west but upper levels still easterly.

EVENING: Strong west winds in the eastern basin and passes.



TIMES ARE PACIFIC DAYLIGHT TIME
Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



AIR TRACER TEST RESULTS

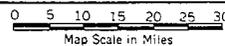
SITUATION: 4:00 AM - 10:00 AM, 20 September 1972

METEOROLOGY

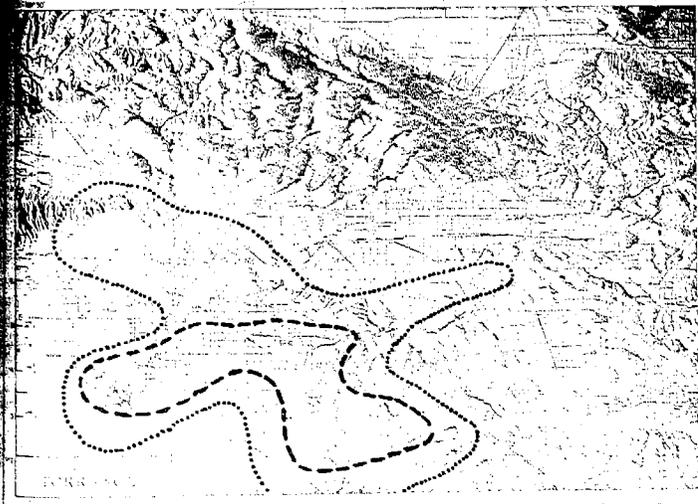
SKY: Clear.
 VISIBILITY: 3-10 miles with smoke and haze.
 SURFACE WINDS: N to NE, 1-4 mph.
 WINDS ALOFT: NW to SE, 3-15 mph.
 PASQUILL STABILITY CLASS: C
 MIXING HEIGHT: 500-1600 feet (150-500 meters).

SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	1.86×10^{14}	1.10×10^{14}	5.89×10^{14}
DISPERSAL	5:00 AM to 7:00 AM, 20 SEPTEMBER 1972		

Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 1 liter per minute from a source of 10^{16} particles.
 = 10 - - - - - = 100 ——— = 1000 Crosshatch = Source Area



TIMES ARE PACIFIC DAYLIGHT TIME
 Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



AIR TRACER TEST RESULTS

SITUATION: 10:00 AM - 4:00 PM, 20 September 1972

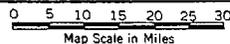
METEOROLOGY

SKY: Clear.
 VISIBILITY: 4-15 miles.
 SURFACE WINDS: SW to W, 4-16 mph.
 WINDS ALOFT: SW to NW, 3-25 mph.
 PASQUILL STABILITY CLASS: C
 MIXING HEIGHT: 800-3000 feet (240-900 meters).

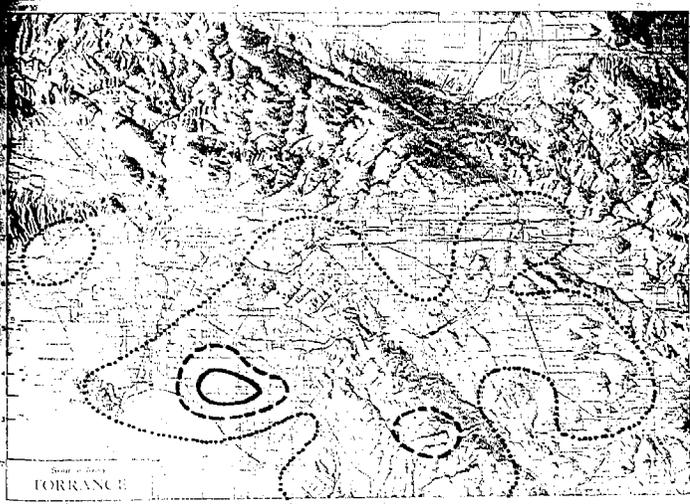
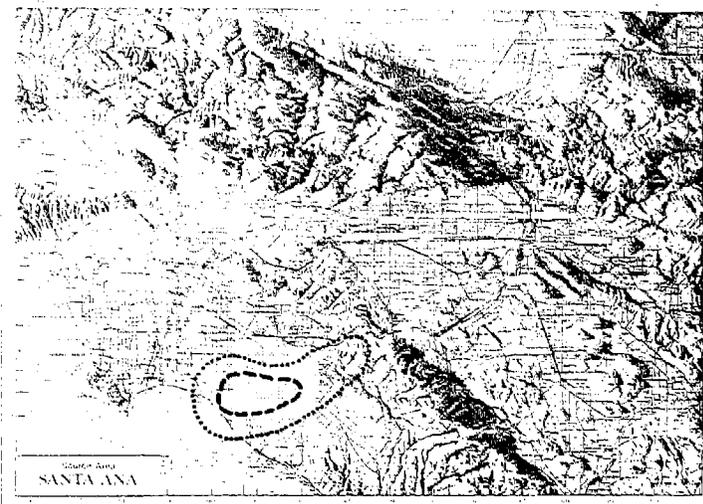
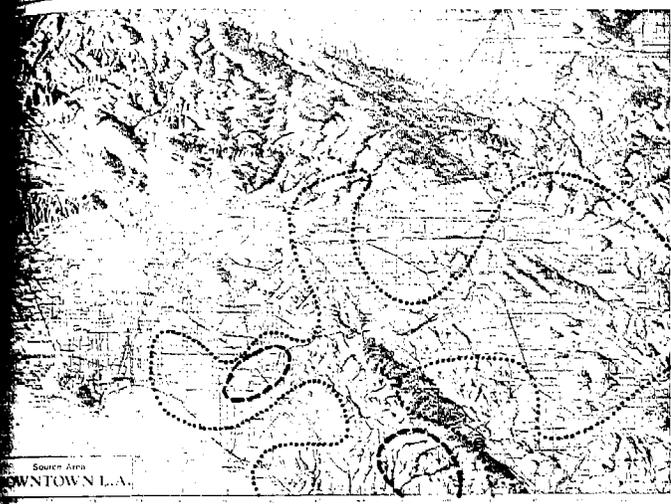
SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	1.86 x 10 ¹⁴	1.10 x 10 ¹⁴	5.89 x 10 ¹⁴
DISPERSAL	5:00 AM to 7:00 AM, 20 SEPTEMBER 1972		

Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 1 liter per minute from a source of 10¹⁶ particles.

..... = 10 - - - - = 100 ——— = 1000 Crosshatch = Source Area



TIMES ARE PACIFIC DAYLIGHT TIME
 Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



AIR TRACER TEST RESULTS

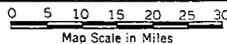
SITUATION: 4:00 PM - 10:00 PM, 20 September 1972

METEOROLOGY

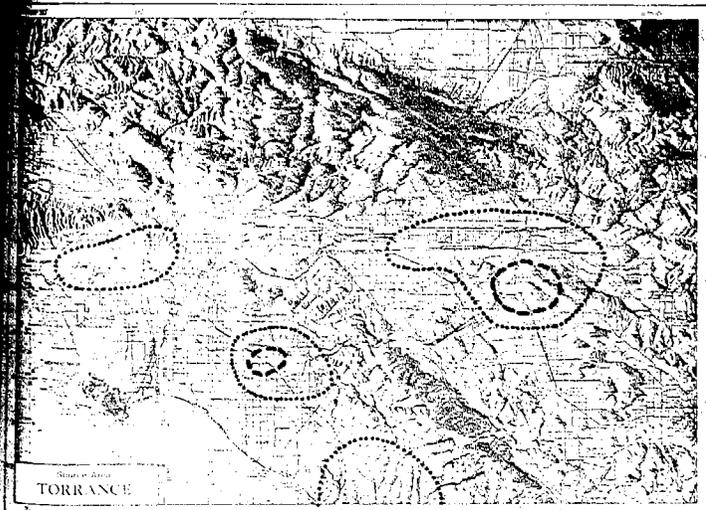
SKY: Clear to scattered.
 VISIBILITY: 6-20 miles.
 SURFACE WINDS: SW to NW, 6-12 mph shifting to E to SE, 3-6 mph.
 WINDS ALOFT: SW to NW, 12-30 mph.
 PASQUILL STABILITY CLASS: C
 MIXING HEIGHT: 800-2400 feet (240-730 meters).

SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	1.86×10^{14}	1.10×10^{14}	5.89×10^{14}
DISPERSAL	5:00 AM to 7:00 AM, 20 SEPTEMBER 1972		

Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 1 liter per minute from a source of 10^{16} particles.
 = 10 - - - - - = 100 _____ = 1000 Crosshatch = Source Area



TIMES ARE PACIFIC DAYLIGHT TIME
 Map Grid - Universal Transverse Mercator Grid - 10,000 Meters



AIR TRACER TEST RESULTS

SITUATION: 10:00 PM-4:00 AM, 20-21 September 1972

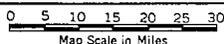
METEOROLOGY

SKY: Clear.
 VISIBILITY: 5-15 miles.
 SURFACE WINDS: NE to E, 1-4 mph.
 WINDS ALOFT: No data.
 PASQUILL STABILITY CLASS: F
 MIXING HEIGHT: 800-1800 feet (240-550 meters).

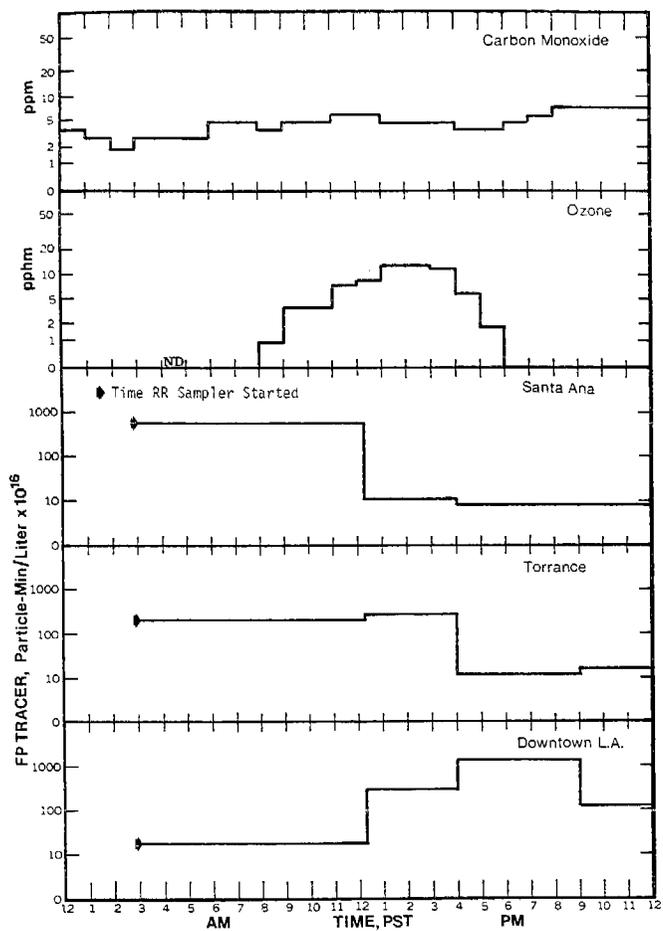
SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	1.86×10^{14}	1.10×10^{14}	5.89×10^{14}
DISPERSAL	5:00 AM to 7:00 AM, 20 SEPTEMBER 1972		

Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 1 liter per minute from a source of 10^{16} particles.

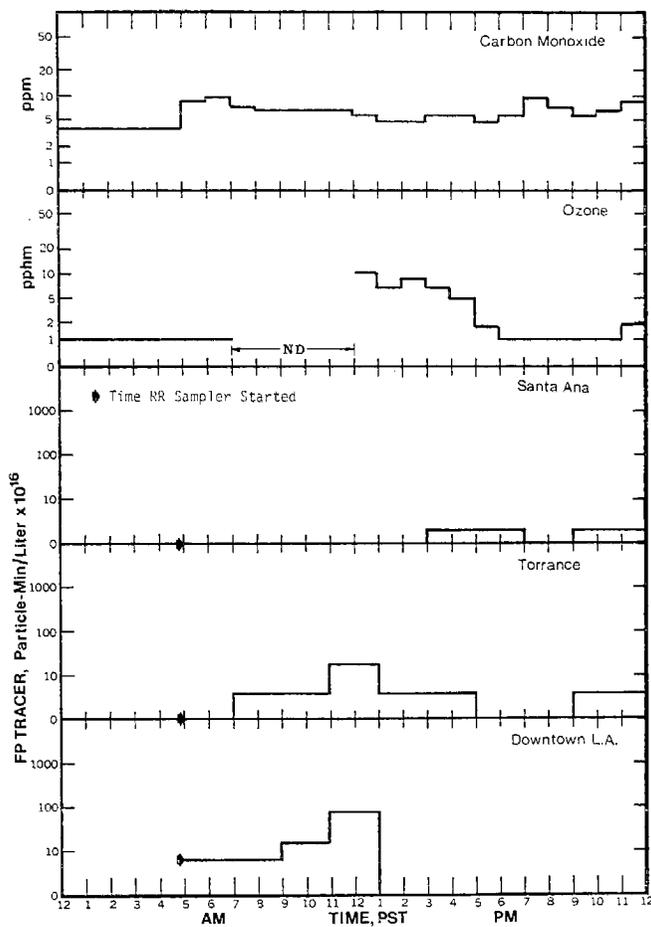
..... = 10 - - - - - = 100 - - - - - = 1000 Crosshatch = Source Area



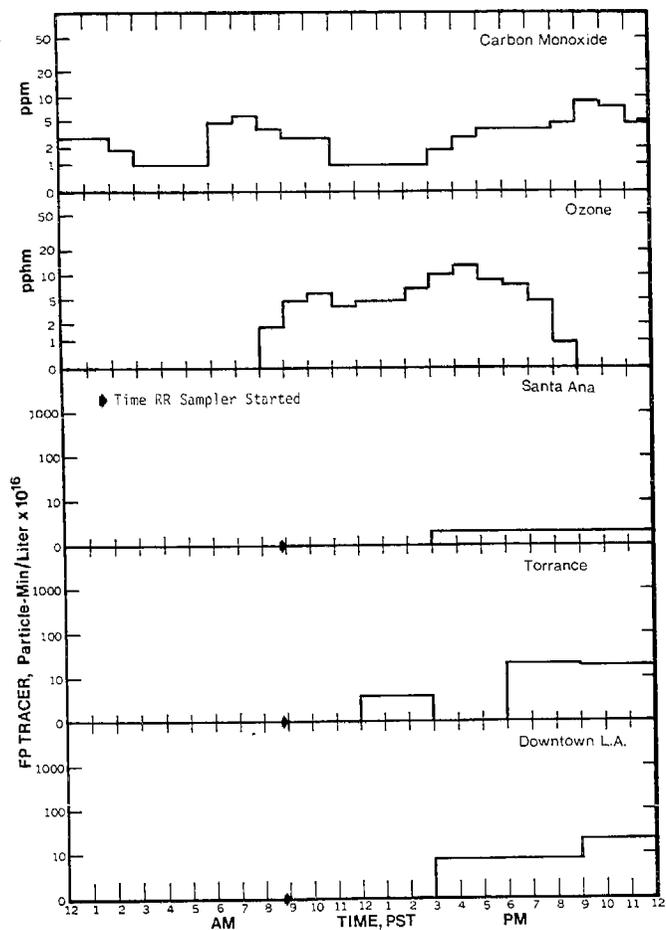
TIMES ARE PACIFIC DAYLIGHT TIME
 Map Grid - Universal Transverse Mercator Grid - 10,000 Meters



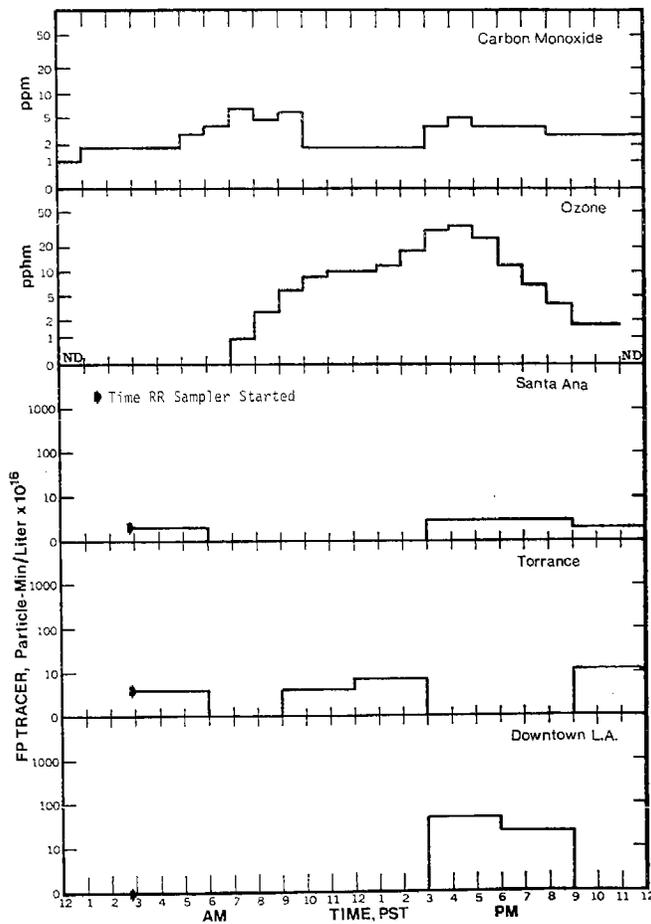
Comparison of Air Pollution and Air Tracer Measurements During Test No. Three at Anaheim, 20 September 1972.



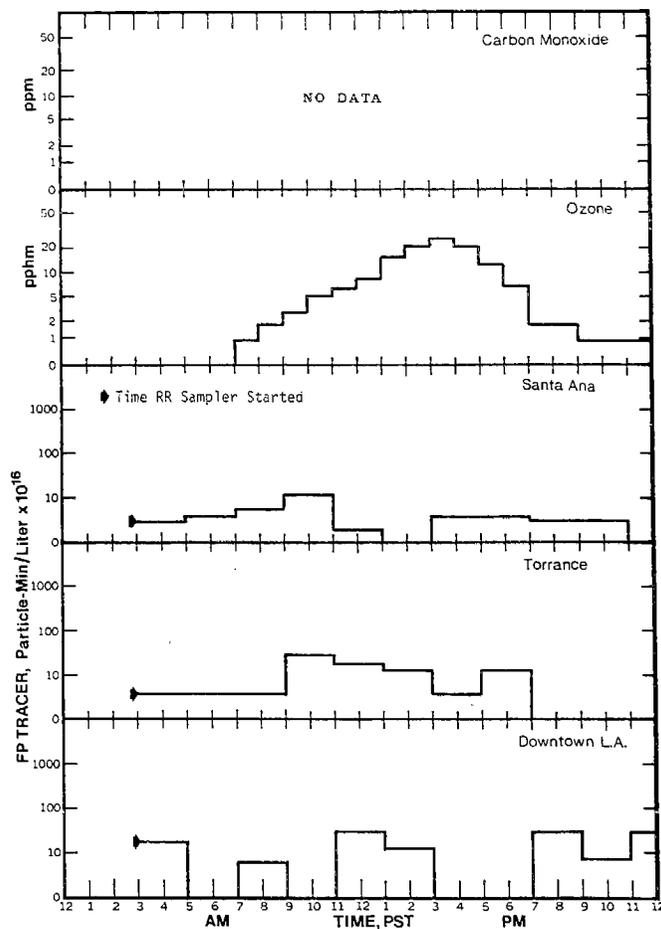
Comparison of Air Pollution and Air Tracer Measurements During Test No. Three at Los Angeles APCD, 20 September 1972.



Comparison of Air Pollution and Air Tracer Measurements During Test No. Three at San Bernardino, 20 September 1972.



Comparison of Air Pollution and Air Tracer Measurements During Test No. Three at Riverside, 20 September 1972.



Comparison of Air Pollution and Air Tracer Measurements During Test No. Three at Green River-Prado Park, 20 September 1972.

ANALYSIS OF AIR TRACER TESTS

TEST NUMBER FOUR, 24-25 OCTOBER 1972

A. Meteorology.

A high pressure area was centered over Washington with a low pressure trough off the California coast on the morning of 24 October (Page 49). Fog was widespread in the Los Angeles Basin with visibility generally one-half to three miles with fog, smoke and haze. Winds were light and variable. The high pressure area was moving southward and the low pressure trough over Southern California deepened (Page 49).

Santa Ana winds developed in the San Bernardino and Riverside area during the late afternoon of 24 October and continued through the following day.

Mixing heights were 240-600 meters in the Los Angeles Basin during the morning of 24 October increasing to 400-700 meters during the day and into the evening. Mixing heights were unlimited in the San Bernardino and Riverside areas after the Santa Ana winds reached the area.

The surface winds and winds aloft show the development of the sea breeze during the day but with the onset of the Santa Ana flow, the onshore flow weakened and reversed during the night.

The climatological frequency of days similar to the first test day was estimated for Table 1 to be about 24% for the month of October.

B. Tracer Test.

Dispersals for the three major source areas were made between the hours of 5:00-7:00 A.M. PDT as in the preceding tests.

1. Downtown Los Angeles Source.

The tracer from Downtown Los Angeles spread southeasterly toward Santa Ana and into the Santa Ana Canyon during the first period, 4:00-10:00 PDT with some movement northwestward into the San Fernando Valley (Page 50).

The tracer cloud spread rapidly eastward during the second period, 10:00 A.M.-4:00 P.M. PDT reaching as far east as San Bernardino and Banning. The development of Santa Ana winds quickly diluted and removed the tracer from the eastern basin during the

evening (Page 51), leaving only a small amount of the tracer in the Santa Ana region during the night (Page 52).

2. Torrance Source.

The Torrance tracer spread northward along the coast and south-eastward to Santa Ana during the first period (Page 49). During the period 10:00 A.M.-4:00 P.M. PDT the tracer spread eastward to Mira Loma and Claremont with peak concentrations at Norwalk and the Palos Verdes Hills (Page 51). Some tracer remained in the Los Angeles Basin during the evening (Page 52) but virtually all tracer disappeared during the night.

3. Santa Ana Source.

The Santa Ana source spread eastward through the Santa Ana Canyon and southeastward toward El Toro during the first period (Page 50). The tracer reached as far east as Riverside during the day (Page 51) but was quickly removed by the Santa Ana winds during the evening (Page 52).

C. Comparison of Air Pollution and Tracer Measurements.

1. Downtown Los Angeles.

The sequential FP tracer sampler was not operated during this Test.

2. Anaheim.

Oxidant levels at Anaheim climbed sharply after 10:00 A.M. to a peak of 5 pphm between 11:00 A.M. and 1:00 P.M. and dropped sharply to zero after 4:00 P.M. (Page 54). The only significant FP tracer sources observed during this period were Santa Ana and Los Angeles.

The morning peak hourly average carbon monoxide concentration of 10 pphm occurred between 8:00 and 11:00 A.M. The tracer from Santa Ana was highest during this period with small contributions from the Los Angeles and Torrance sources.

3. Riverside.

The hourly oxidant levels increased after 7:00 A.M. to a peak of 22 pphm between 2:00 and 3:00 P.M., then decreased to 2-3 pphm

after 5:00 P.M. (Page 55). The FP tracers from Santa Ana and Los Angeles arrived between 12:00 noon and 3:00 P.M. The tracer concentrations from Santa Ana dropped to a low level after 3:00 P.M. while that from Los Angeles increased between 3:00 and 6:00 P.M., then dropped to zero after 6:00 P.M. The tracer concentrations from the Torrance area were very low and did not contribute significantly to the total.

The morning peak carbon monoxide concentration was 7 pphm between 7:00 A.M. and 8:00 A.M. and a secondary peak of 4 pphm occurred between 2:00 and 3:00 P.M. The Santa Ana and Los Angeles tracer sources roughly correspond with the afternoon peaks.

4. San Bernardino.

The hourly oxidant levels increased sharply after 9:00 A.M. to a peak of 11 pphm between 1:00 and 2:00 P.M. and dropped after 3:00 P.M. to 2-3 pphm. The only significant tracer concentrations during the peak oxidant period were from the Los Angeles source area with the highest concentration between 12:00 noon and 3:00 P.M. No carbon monoxide data were obtained during this period.

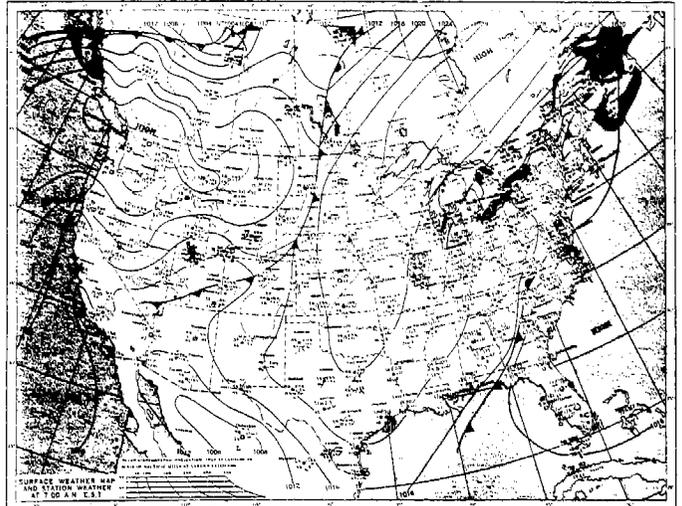
5. Claremont-Pomona.

Oxidant levels at Pomona increased after 9:00 A.M. to a peak of 14 pphm between 1:00 and 2:00 P.M. then decreased to 1-2 pphm after 5:00 P.M. Tracer from Los Angeles arrived at Claremont after 11:00 A.M. with peak concentrations between 11:00 A.M. and 1:00 P.M. but continued significant levels until 5:00 P.M., dropping to zero between 5:00 and 7:00 P.M. Secondary peaks arrived between 7:00 and 9:00 P.M. and 11:00 P.M. to 1:00 A.M. No significant tracer concentrations from Santa Ana and only small contributions from the Torrance area were observed.

6. Green River-Prado Park.

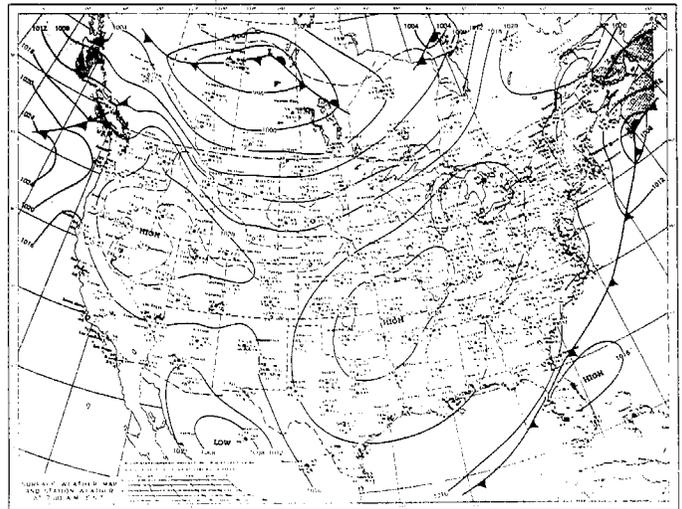
The sequential FP sampler at Green River was not operated during this test.

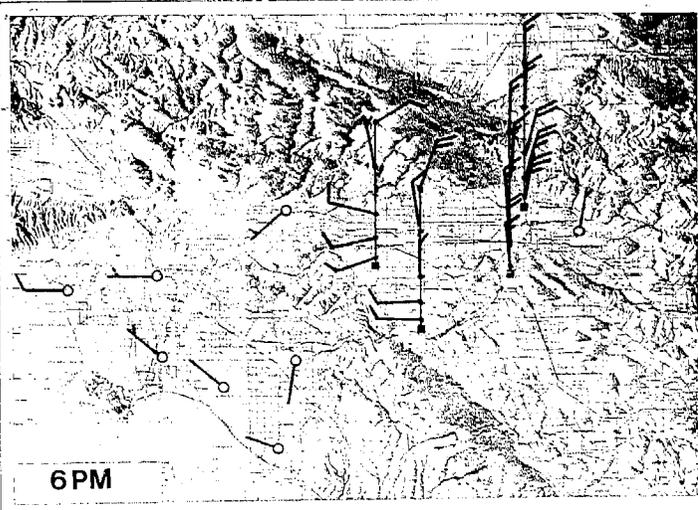
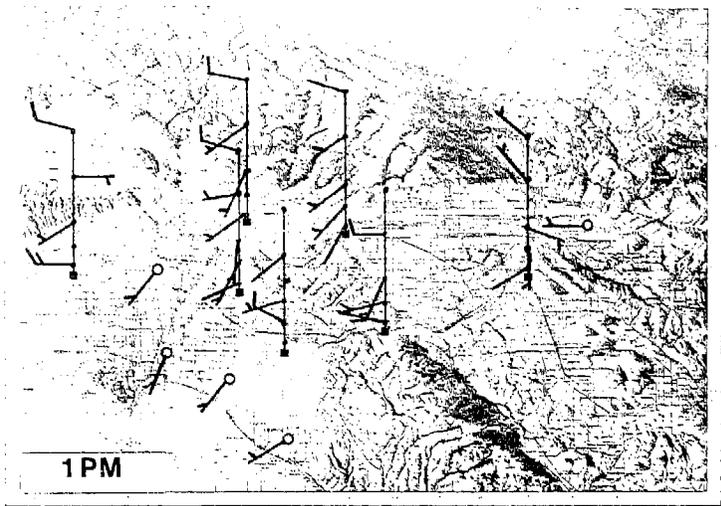
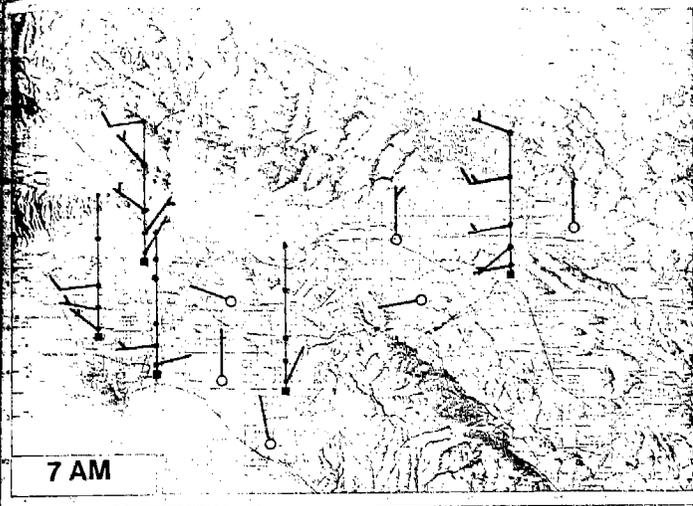
TUESDAY, OCTOBER 24, 1972



Surface Weather for Air Tracer Test No. Four at 5:00 A.M. PDT on 24 and 25 October 1972.

WEDNESDAY, OCTOBER 25, 1972





WIND FLOW PATTERNS

AIR TRACER TEST NO. FOUR 24 October 1972

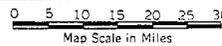
Foot	MPH
3000	32-37
2000	26-31
1000	21-25
500	15-20
100	9-14
Surface	3-8
	1-2

Direction is indicated by the "arrow" as flying with the wind.

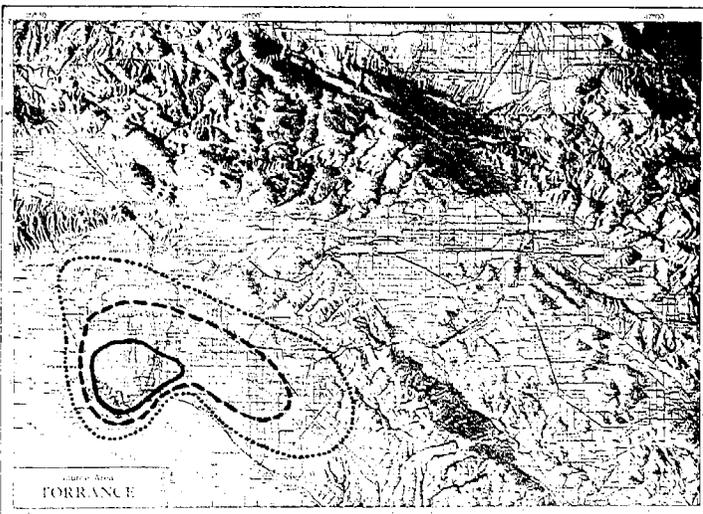
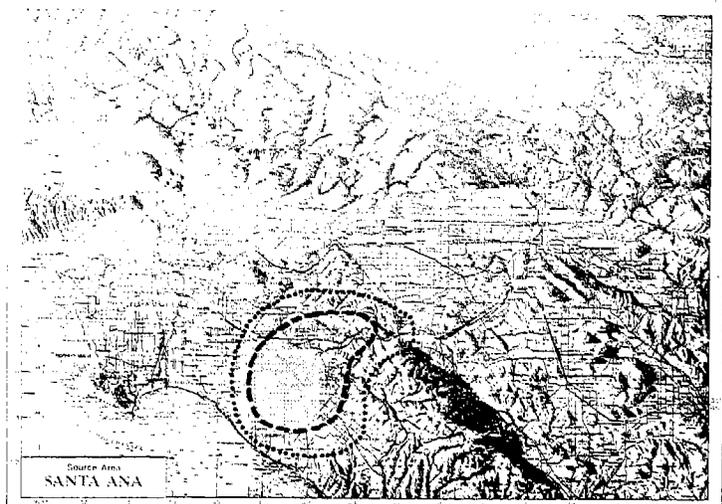
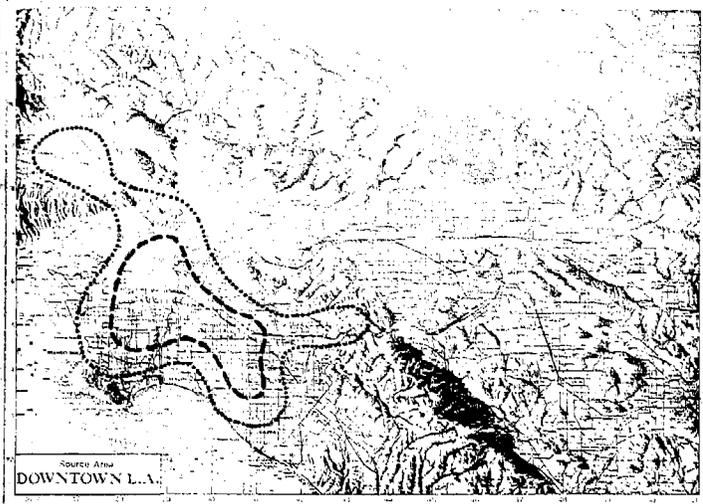
MORNING: Fog and low clouds limited upper level observations, surface winds light and variable.

AFTERNOON: Light and variable but generally southwesterly, 3000 foot levels indicate northwest.

EVENING: Eastern basin shows strong north-east winds especially at upper levels and through canyons, but western basin only shows light west and northwest winds at the surface.



TIMES ARE PACIFIC DAYLIGHT TIME
Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



AIR TRACER TEST RESULTS

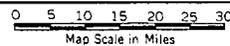
SITUATION: 4:00 AM - 10:00 AM, 24 October 1972

METEOROLOGY

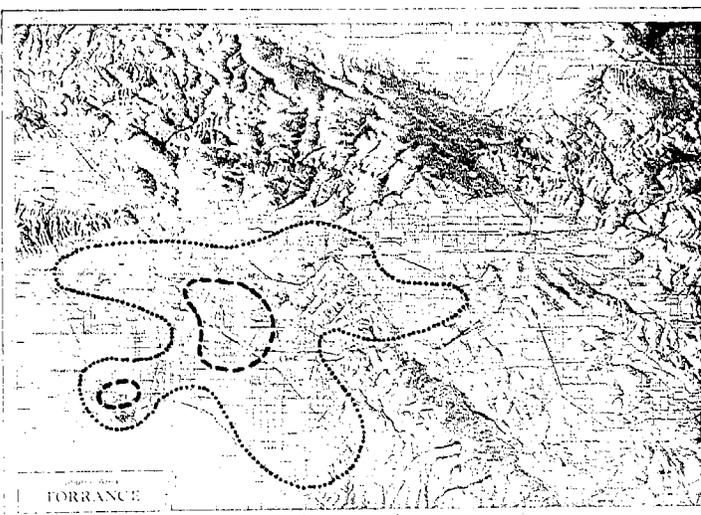
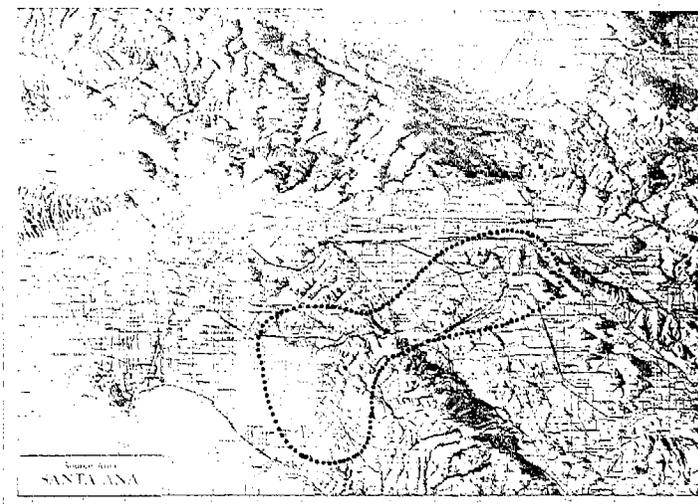
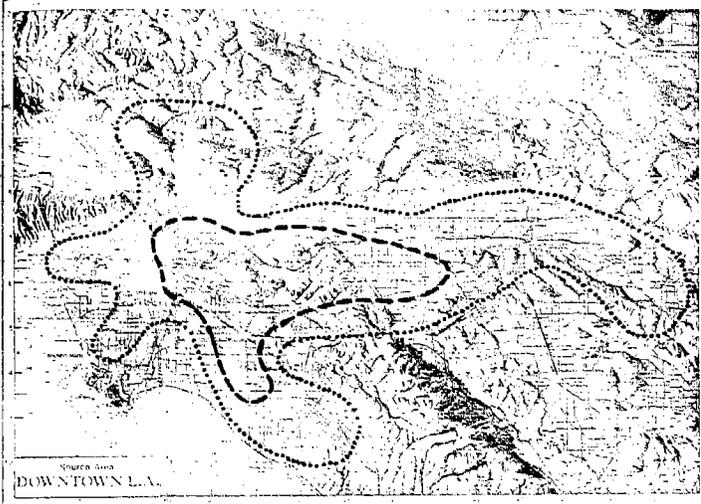
SKY: Scattered to broken clouds.
 VISIBILITY: 1/2-3 miles with fog, smoke and haze.
 SURFACE WINDS: SW to NE, 1-7 mph.
 WINDS ALOFT: NE to SW, 1-8 mph.
 PASQUILL STABILITY CLASS: D
 MIXING HEIGHT: 800-2000 feet (240-600 Meters).

SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	5.33×10^{14}	1.49×10^{14}	5.68×10^{14}
DISPERSAL	5:00 AM to 7:00 AM, 24 OCTOBER 1972		

Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 3 liter per minute from a source of 10^{16} particles.
 = 10 - - - - - = 100 - - - - - = 1000 Crosshatch = Source Area



TIMES ARE PACIFIC DAYLIGHT TIME
 Map Grid - Universal Transverse Mercator Grid - 10,000 Meters



AIR TRACER TEST RESULTS

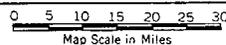
SITUATION: 10:00 AM - 4:00 PM, 24 October 1972

METEOROLOGY

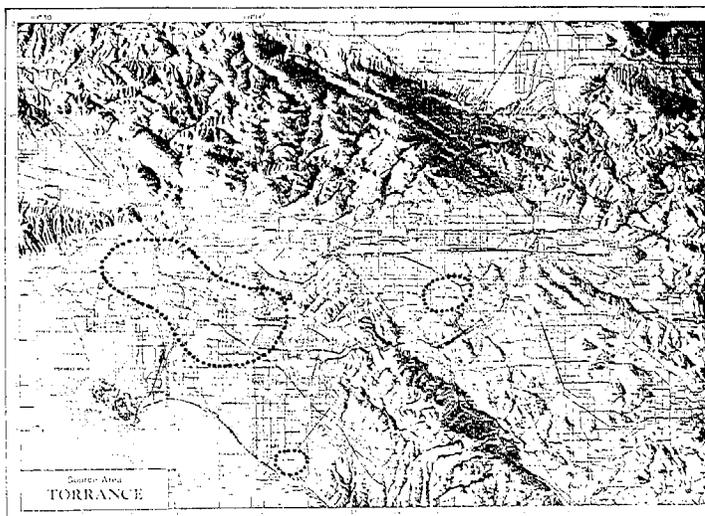
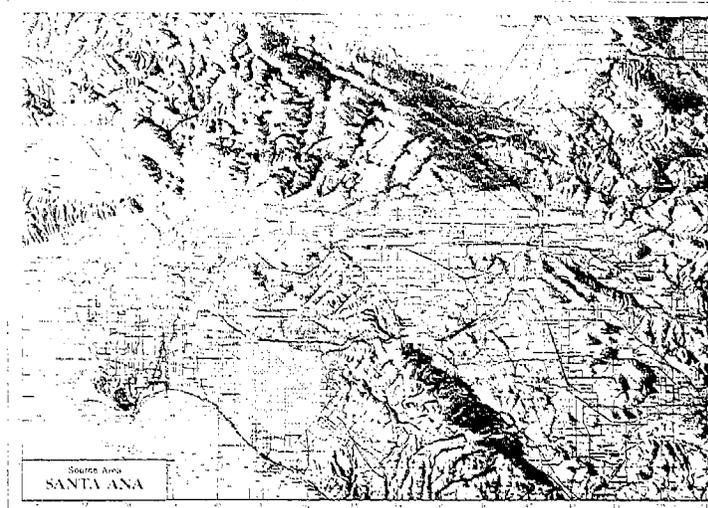
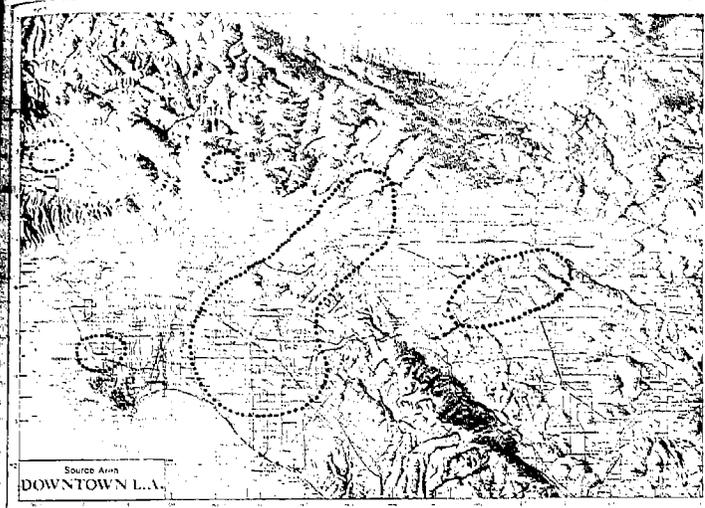
SKY: Scattered to broken clouds.
 VISIBILITY: 2-5 miles with smoke and haze.
 SURFACE WINDS: SW to NW, 2-5 mph, shifting to S to SW, 4-10 mph.
 WINDS ALOFT: Light-variable, 1-5 mph, shifting to SW to NW, 5-20 mph.
 PASQUILL STABILITY CLASS: C
 MIXING HEIGHT: 1400-2400 feet (430-730 Meters).

SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	5.33 x 10 ¹⁴	1.49 x 10 ¹³	5.68 x 10 ¹⁴
DISPERSAL	5:00 AM to 7:00 AM, 24 OCTOBER 1972		

Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 1 liter per minute from a source of 10¹⁶ particles.
 = 10 - - - - - = 100 _____ = 1000 Crosshatch = Source Area



TIMES ARE PACIFIC DAYLIGHT TIME
 Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



AIR TRACER TEST RESULTS

SITUATION: 4:00 PM - 10:00 PM, 24 October 1972

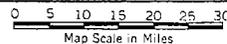
METEOROLOGY

SKY: Scattered to broken clouds.
 VISIBILITY: 3-5 miles with smoke and haze.
 SURFACE WINDS: SW to NW, 3-10 mph.
 WINDS ALOFT: SW to NW, 10-25 mph, with Santa Ana winds near San Bernardino, N, 22-60 mph.
 PASQUILL STABILITY CLASS: D
 MIXING HEIGHT: 1300-2300 feet (400-700 Meters).

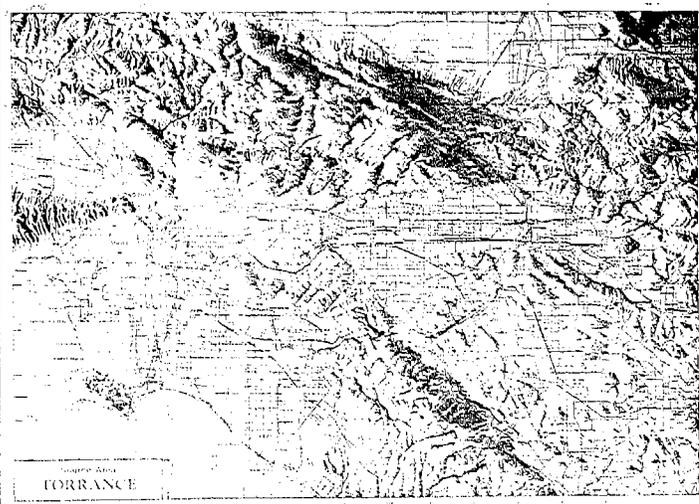
SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	5.33×10^{14}	1.49×10^{14}	5.68×10^{14}
DISPERSAL	5:00 AM to 7:00 AM, 24 OCTOBER 1972		

Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 1 liter per minute from a source of 10^{16} particles.

..... = 10 - - - - = 100 _____ = 1000 Crosshatch = Source Area



TIMES ARE PACIFIC DAYLIGHT TIME
 Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



AIR TRACER TEST RESULTS

SITUATION: 10:00 PM-4:00 AM, 24-25 October 1972

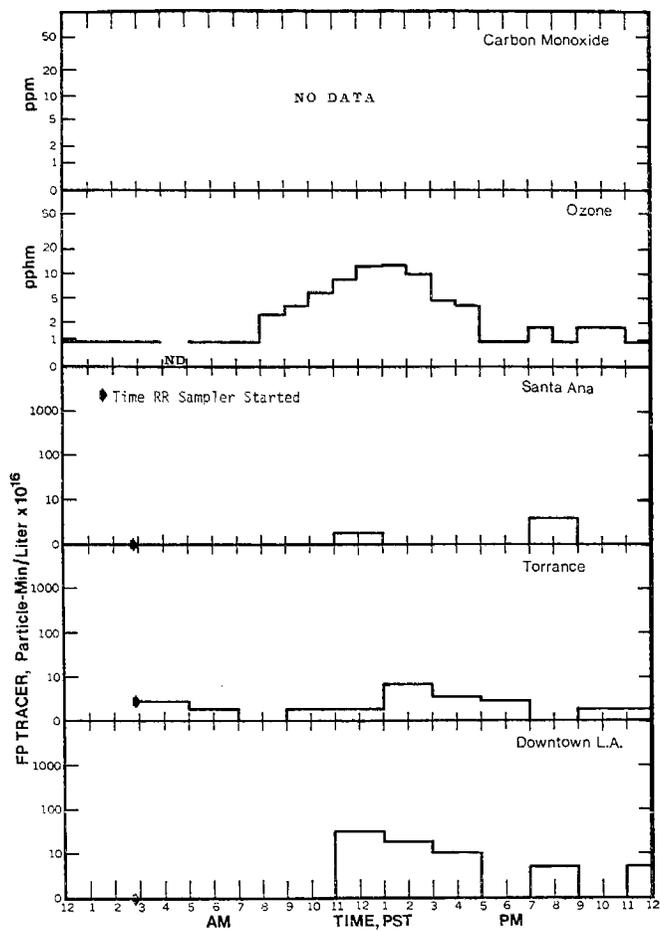
METEOROLOGY

SKY: Scattered to broken clouds.
 VISIBILITY: 2-5 miles with fog, smoke and haze.
 SURFACE WINDS: S to NW, 1-5 mph, shifting to N to E, 1-4 mph.
 WINDS ALOFT: No data.
 PASQUILL STABILITY CLASS: E
 MIXING HEIGHT: 800-1000 feet (240-300 Meters).

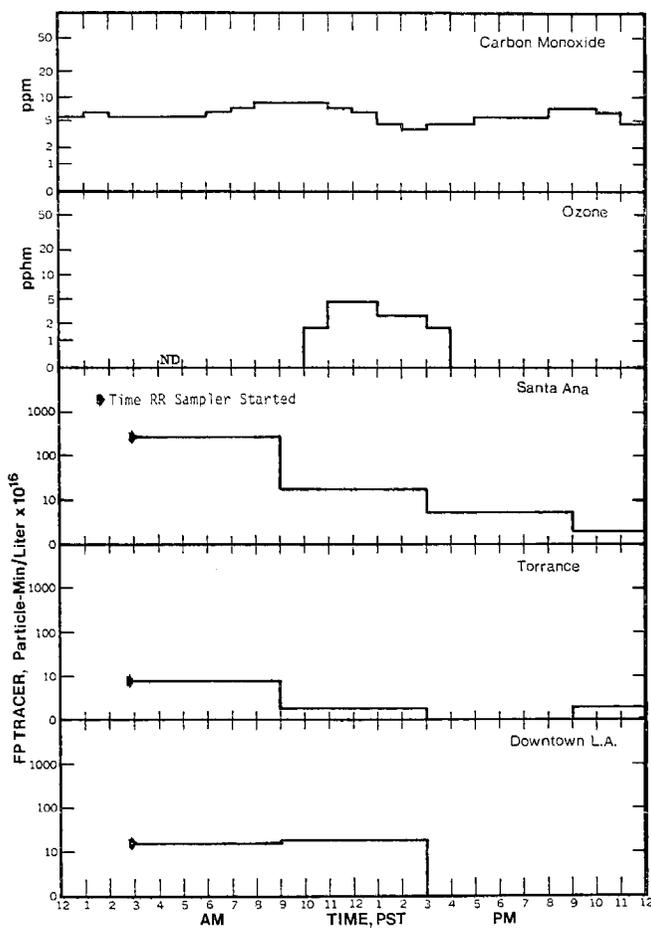
SOURCE	DOWNTOWN L.A.	TORRANCE	SANTA ANA
STRENGTH (Particles)	5.33×10^{14}	1.49×10^{14}	5.68×10^{14}
DISPERSAL	5:00 AM to 7:00 AM, 24 OCTOBER 1972		

Contours represent the number of particles that would be collected in 6 hours at a sampling rate of 1 liter per minute from a source of 10^{16} particles.
 = 10 - - - - - = 100 _____ = 1000 Crosshatch = Source Area

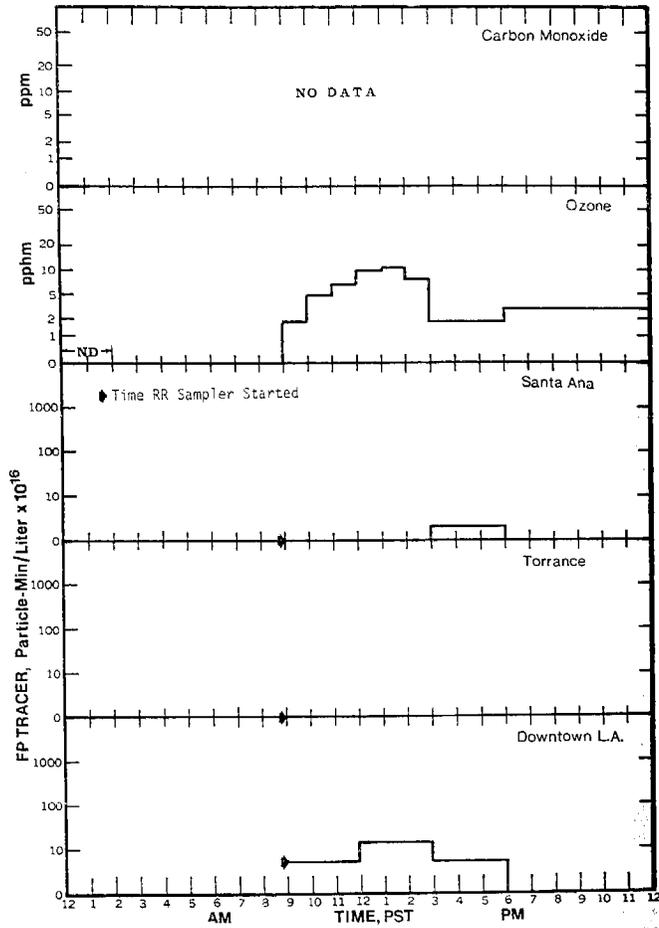
0 5 10 15 20 25 30 NORTH TIMES ARE PACIFIC DAYLIGHT TIME
 Map Scale in Miles Map Grid - Universal Transverse Mercator Grid = 10,000 Meters



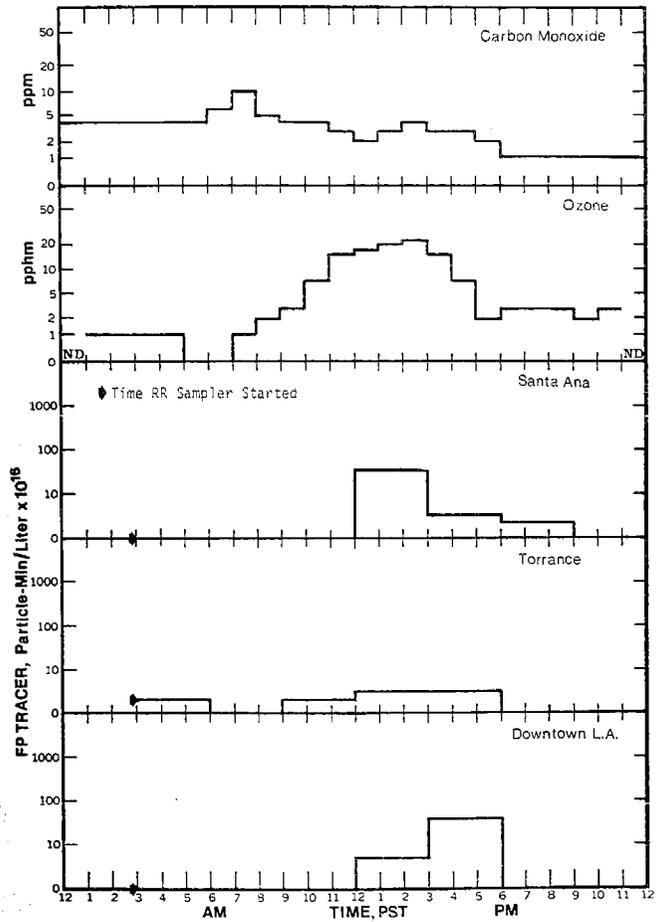
Comparison of Air Pollution and Air Tracer Measurements During Test No. Four at Claremont-Pomona, 24 October 1972.



Comparison of Air Pollution and Air Tracer Measurements During Test No. Four at Anaheim, 24 October 1972.



Comparison of Air Pollution and Air Tracer Measurements During Test No. Four at San Bernardino, 24 October 1972.



Comparison of Air Pollution and Air Tracer Measurements During Test No. Four at Riverside, 24 October 1972.