Monitoring the Air for the Presence of 2,4-D in Kern County, Kings County and San Luis Obispo County A Cooperative California Study

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by

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ENVIRONMENTAL HAZARDS ASSESSMENT PROGRAM

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I. Introduction

There are several formulations of 2,4-D phenoxy herbicides which have been used in California for economical weed control. All 2,4-D formulations are classified in terms of vapor pressures(VP). Those formulations with VP $>10^{-5}$ mm Hg at 20°C are considered "high-volatile" (HV), those with VP = 10^{-5} -10^{6} mm Hg at 20°C are considered "low-volatile" (LV), and those with VP $<10^{-7}$ mm Hg at 20°C are considered "non-volatile" (NV). Ester formulations are classified as either "high-volatile" or "low-volatile". Acid and amine forms are classed as "non-volatile" salts. The unrestricted use of HV and LV phenoxy herbicides prior to 1949 is suspected to have caused serious off-target damage for many growers, especially in vineyard and orchard plantings.[1]

The Director of the California Department of Food and Agriculture (CDFA), under authority stated in Chapter 3, Article 2 of the Food and Agriculture Code(enacted in 1949 and revised 1958 and 1965) adopted regulations restricting the use of 2,4-D phenoxy herbicides and established guidelines for county agricultural commissioners to further restrict their use.[2] Despite these regulations growers in western Kings and Kern Counties have continued to report phenoxy damage to their plantings. Several theories have been postulated as to the source of the phenoxy herbicides:

1. Currently, volatile 2,4-D esters are legally applied only in a specific region of eastern San Luis Obispo County. Drift from these applications is suspected of damanging crops in western Kings and Kern Counties. Researchers in Washington have monitored 2,4-D ester formulation drift under specific conditions up to 50 miles from the application site.[3,4]
2. 2,4-D amine formulations are being applied legally in Kings and Kern

Counties and drift from these applications could be damaging sensitive crops.

3. Possible illegal applications of 2,4-D ester and amine formulations are resulting in drift and damage in Kings and Kern Counties.

This study was conducted to determine the presence and nature of airborne 2,4-D in a wide area of the San Joaquin Valley during the spring of 1980. Study results will be utilized by CDFA and the county agricultural commissioners to evaluate the existing regulations.

II. Materials & Methods

A. Study Design

A 5 x 3 matrix design covering 1500 square miles of the San Joaquin Valley (Figure 1) was developed for this study based upon information about historically observed phenoxy damage supplied by the agricultural commissioners from Kings, Kern and San Luis Obispo Counties. Each cell within the 15 cell matrix measured 10 miles x 10 miles. The matrix design assured spacial distribution of samplers to maximize the possibility of detecting 2,4-D over a large geographical area. Three additional cells were located within eastern San Luis Obispo County where legal applications of 2,4-D high-volatile esters may occur. The matrix was bordered on the north by the Kings County-Fresno County Line, extended 50 miles south, was bordered on the west by the Temblor mountain range and extended east 30 miles.

An instrument sampling site was selected within each cell as close to the center as possible. Accessibility, security, and the availability of 120 volt electricity was the major criteria used to select sampling

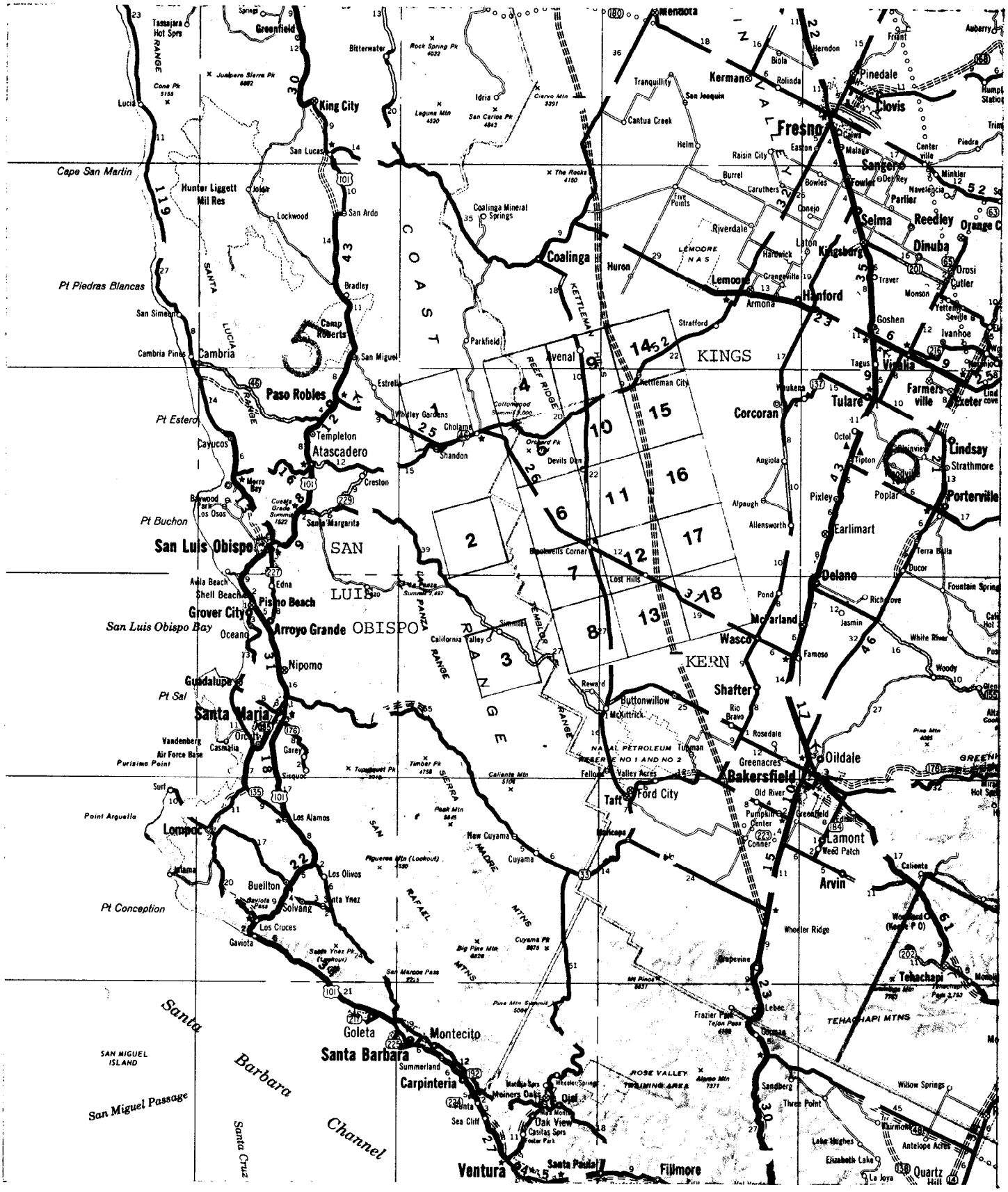


FIGURE 1. Study Location

sites. Many sites could not be established at the centers of their cells because of the lack of suitable locations (Figure 2). Cell #8 was omitted due to hydrocarbon vapors from heavy oil pumping activity that interferred with sampling.

Weather data (wind speed, wind direction, temperature, and relative humidity) was obtained for the sampling period at Lemoore Naval Air Station, Lemoore, CA.; National Weather Service, Bakersfield, CA; Blackwell Land Management Company, through Meteorological Information Service, San Jose, CA, (Cell #6); and CDFA mobile weather stations in Cell #1 and #3 (Figure 2).

Weather data is presented as wind roses and temperature graphs for each weather station (Figure 4, p. 15 - p. 33). Wind roses depict the distance potential for drift on 36 points of the compass. These were compiled from one-half hourly readings by taking a summation of values (velocity x time) for each point of the compass over the selected time period. The larger the arrows on the rose the greater the potential distance for drifting compounds. Scale on the rose is indicated by the number in the right corner in units of miles per computed time period. One-half hourly temperature readings in ^{o}F were graphed as the high, average, and low readings for the time period computed.

The sampling period started on February 28, 1980 and ended April 2, 1980. Nine 48-hour sampling runs were completed (Table 1) during this period to characterize 2,4-D applications and potential off-target contamination. The sample runs were distributed uniformly

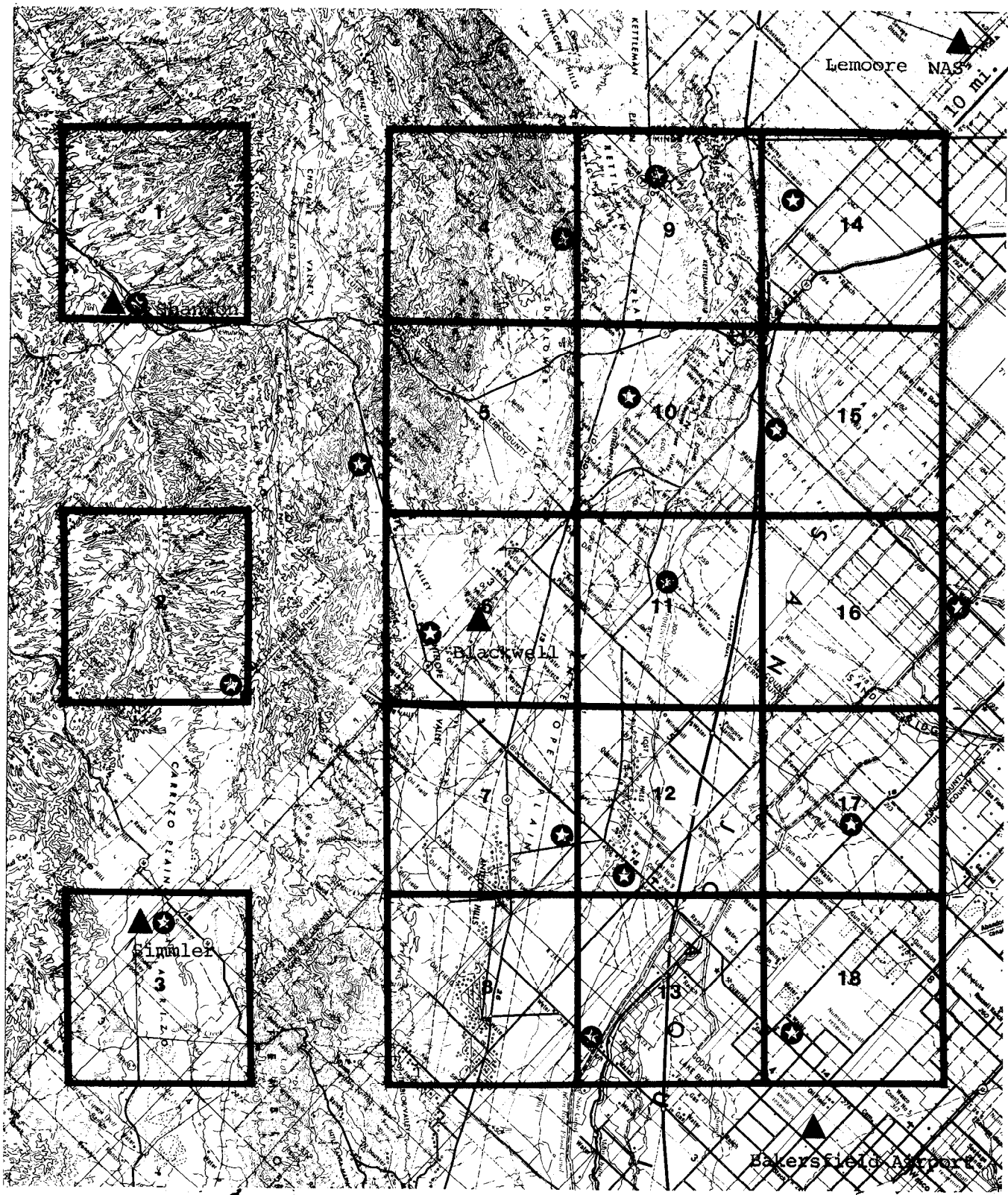


FIGURE 2

Sampling Locations
Weather Stations

over the sampling period.

The area-wide sampling methodology had been utilized previously for 2,4-D monitoring in Washington State and in Saskatchewan, Canada. Detectable levels of ester and amine formulations of 2,4-D were found in both the Washington and Saskatchewan studies utilizing samplers spaced 10-30 miles apart.[4,5,6]

B. Instrumentation and Sampling Media

Low volume samplers (Lo Vol) were used for air monitoring. Each sampler consisted of a carbon vaned pump pulling air through a critical orifice to establish a calibrated air flow of 5.5 liters/min. The air flow was directed through a 47-mm glass fiber filter in series with a 19-mm O.D. glass sampling tube containing amberlite XAD-2 polystyrenedivinyl-benzene resin (Rohm and Hass). The glass sampling tube and filter holder was held in place with a Cajon Ultra Torr adaptor modified to accept a swagelock hose connector (Figure 3). The hose connector was machined to hold the critical orifice plate. Laboratory quality vacuum hose completed the connection to the carbon vane pump.[4] Dayton 7-day timers, model 2E214, were used to start and stop the sampler synchronously. Sampling tubes consisted to 6" lengths of 19-mm O.D. glass tubing covered with aluminum foil and packed with 60 to 80 mesh beads of precleaned amberlite XAD-2. The resin was held in place using glass wool and 150 x 150 mesh stainless screen. The glass tubes were packed with clean resin at the CDFA chemistry laboratory and sealed with Teflon covered stoppers to prevent contamination. The stoppers were replaced in the tubes after sampling to prevent loss and/or contamination of

TABLE 1

SAMPLING DATES AND ACREAGE SPRAYED WITH 2,4-D

SAMPLE PERIOD	DATES	COUNTY	ACREAGE SPRAYED WITH 2,4-D AMINE	ESTER
1	2-25/3-01-80	Kings	7,741	None
2/28, 0600 hrs-		Kern	3,220	None
3/01, 0600 hrs		San Luis Obispo	None	2,148
2	3-02/3-08-80	Kings	10,662	None
3/06, 0600 hrs-		Kern	1,870	None
3/08, 0600 hrs		San Luis Obispo	1,599	330
3	3-09/3-15-80	Kings	17,798	None
3/13, 0600 hrs-		Kern	5,767	None
3/15, 0600 hrs		San Luis Obispo	380	6,830
4	3-16/3-18-80	Kings	72	None
3/16, 0600 hrs-		Kern	314	None
3/18, 0600 hrs		San Luis Obispo	None	None
5	3-19/3-21-80	Kings	None	None
3/19, 0600 hrs-		Kern	310	None
3/21, 0600 hrs		San Luis Obispo	None	None
6	3-22/3-24-80	Kings	None	None
3/22, 0600 hrs-		Kern	None	50
3/24, 0600 hrs		San Luis Obispo	2,094	1,230
7	3-25/3-27-80	Kings	None	None
3/25, 0600 hrs-		Kern	None	None
3/27, 0600 hrs		San Luis Obispo	None	1,605
8	3-28/3-30-80	Kings	None	None
3/28, 0600 hrs-		Kern	None	None
3/30, 0600 hrs		San Luis Obispo	1,219	None
9	3-31/4-02-80	Kings	None	None
3/31, 0600 hrs-		Kern	40	None
4/02, 0600 hrs		San Luis Obispo	None	None

the samples. All samples were frozen with dry ice after being removed from the Lo Vol samplers.

The glass sampling tubes were modified to connect with 47-mm filter holders containing quartz fiber filters. The quartz fiber filter was added to trap and isolate NV 2,4-D amine salt particulates. Theoretically HV and LV 2,4-D esters would penetrate the quartz filter and be adsorbed on the XAD-2 resin (Figure 3). The quartz fiber filters were individually packaged in paper envelopes at the CDFA chemistry laboratory and assembled into the filter holder in the field. At the conclusion of each sample collection period, the quartz fiber filter samples were removed from their holders in the field, sealed in aluminum foil, replaced in their respective envelopes and frozen with dry ice for storage and shipment to the laboratory.

Each XAD-2 resin tube and quartz fiber filter had an assigned code number and a corresponding chain of custody form. The chain of custody documented each sample's history from the laboratory to the field site, collection, storage, shipment and receipt by the laboratory for analysis.

C. Chemical Analysis

Collection and extraction efficiencies for 2,4-D esters and amine were performed at the Department of Food and Agriculture Chemistry Laboratory in Sacramento (Table 2). The percentages obtained compared favorably with the values accrued by Robinson and Fox[4] and Grover, et al.[5] using similar solid adsorbant techniques.

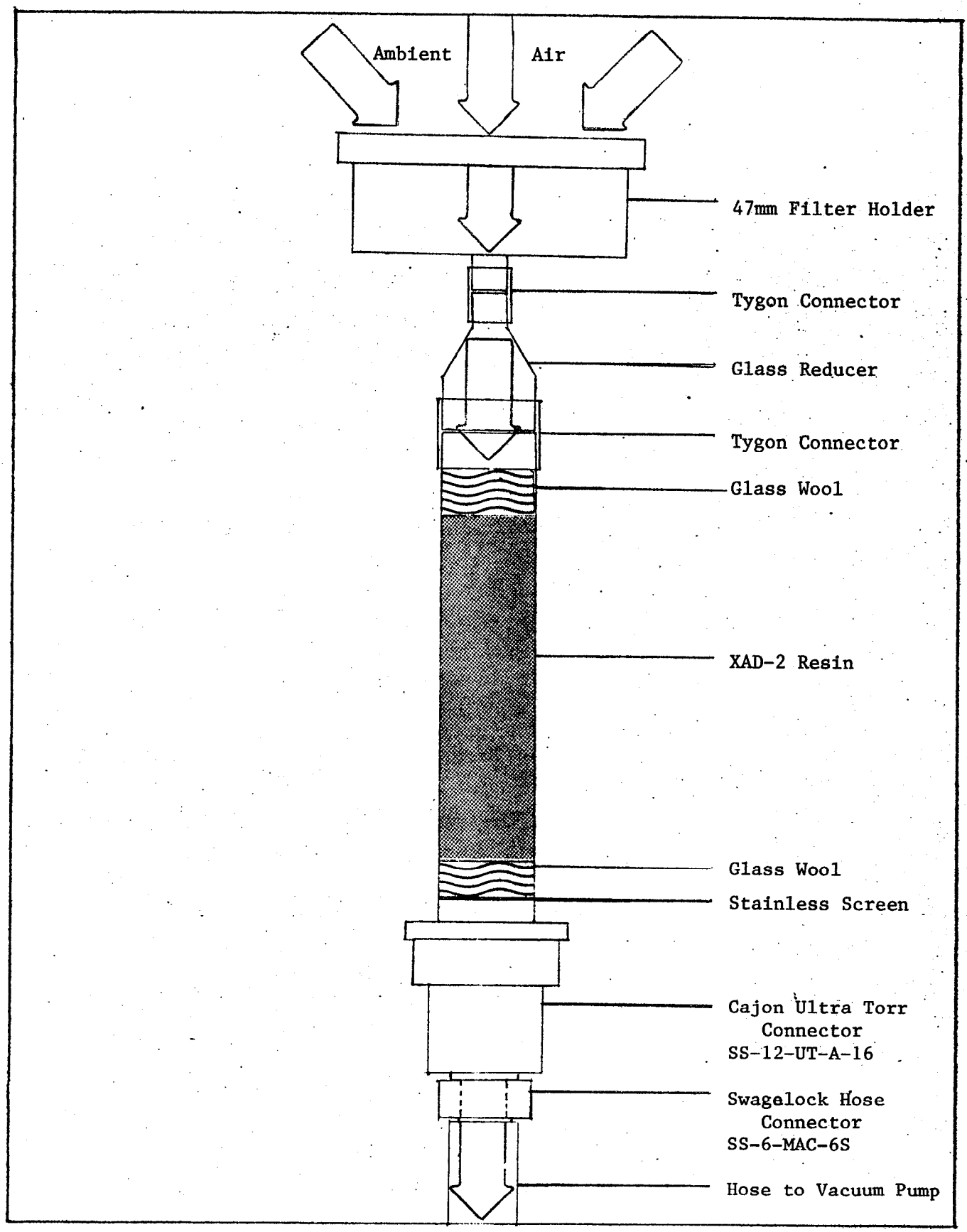


FIGURE 3. Sampling Apparatus

TABLE 2. EXTRACTION AND RECOVERY EFFICIENCIES

FOR 2,4-D FROM THE XAD-2 RESIN TUBES

TUBE #	ISOBUTYL ESTER AMOUNT SPIKED (µg)	ISOBUTYL ESTER AMOUNT RECOVERED (µg)	DIETHYLAMINE SALT AMOUNT SPIKED (µg)	DIETHYLAMINE SALT AMOUNT RECOVERED (µg)
1	10	8.1	10	9.0
2	10	9.2	10	9.5
3	10	8.2	10	9.3
4	10	9.0	10	9.2
MEAN VALUE		8.6 (86%)		9.3 (93%)

Extraction studies conducted on the quartz fiber filters showed that both the isobutyl ester and diethylamine salt of 2,4-D were recovered quantitatively. The Amberlite XAD-2 resin was precleaned by a distilled water/hydrochloric acid (100:1) wash, then rinsed with distilled water until the rinse water did not turn cloudy upon the addition of a silver nitrate solution. The XAD-2 resin was then rinsed with acetone and extracted for 24 hours with nanograde methanol in a Sohxlet extractor. After drying in a vacuum oven, the XAD-2 was packed and sealed into the glass sampling tubes.

The collected 2,4-D esters were removed from the resin by elution with 60 ml of nanograde hexane. The collected hexane elutant was then evaporated to a volume of 5 ml. Two microliters of the hexane solution was injected into the gas chromatographs for analysis.

The non-volatile 2,4-D salts were removed from the quartz fiber filters by elution with 60 ml of 0.05N KOH in 20% water/80% methanol solution. The collected elutant was then acidified to pH <2 with an aqueous sulfuric acid solution (1:1 vv). The solution volume was reduced, using a steam bath, to about 20 ml. Next, the solution was extracted with two 60 ml aliquots of diethyl ether. The combined ether aliquots were evaporated to near dryness on a steam bath and 0.5 to 1 ml of methanol was added. A solution of diazomethane in ether was then added until the yellow color persisted (about 2 ml). The solution was then allowed to sit for at least 15 minutes. Finally the solution was evaporated to near dryness and the resulting methyl ester of 2,4-D was picked up in 1 ml nanograde hexane. Two microliters of this solution was used for the analysis. Samples were analyzed on gas chromatographs equipped with Ni^{63} electron capture detectors. A 10" x ¼" O.D. glass column packed with 4% OV 101 on 100/120-mesh Gas Chrom Q was employed in all the GE/ECD analyses. The column was held isothermally at 170°C during the analysis of the derivatized non-volatile 2,4-D samples and operated at a programmed rate of 5°C/min from 180°C (held for three minutes) to a final temperature of 210°C (held for six minutes) during the analysis of the 2,4-D esters.

D. Results

A total of 368 samples were collected between February 27, 1980 and April 2, 1980. All of these were analyzed by the Department of Food and Agriculture State Chemistry Laboratory in Sacramento (Table 3).

One quartz fiber filter collected March 13 - March 15, 1980 in Cell 10 contained 2.4 μg of NV 2,4-D amine. This sample was collected in the proximity of barley fields that were sprayed during the sampling period (Figure 4, p. 20 - p. 21). The remaining quartz fiber filters and the XAD-2 resin samples did not contain detectable levels of 2,4-D. The corresponding down-stream XAD-2 resin tube for the March 13 - March 15 quartz fiber filter run in Cell 10 showed no trace of NV 2,4-D amine thus confirming that the NV salt does not penetrate the quartz fiber filter.

The lack of positive air monitoring results despite numerous 2,4-D applications (Figure 4 and Appendix I) immediately adjacent to monitoring locations indicate that in 1980 regulations were successful in preventing large scale 2,4-D drift (Figure 4). The single exception to this situation was the detection of 2,4-D amine salt formulations and <u>not</u> the more mobile ester. No positive HV or LV 2,4-D ester samples were found in either San Luis Obispo, Kern, or Kings County air monitoring locations. It is of interest to note that no 2,4-D ester was detected at any time period despite the San Luis Obispo County applications which occurred in late March 1980.

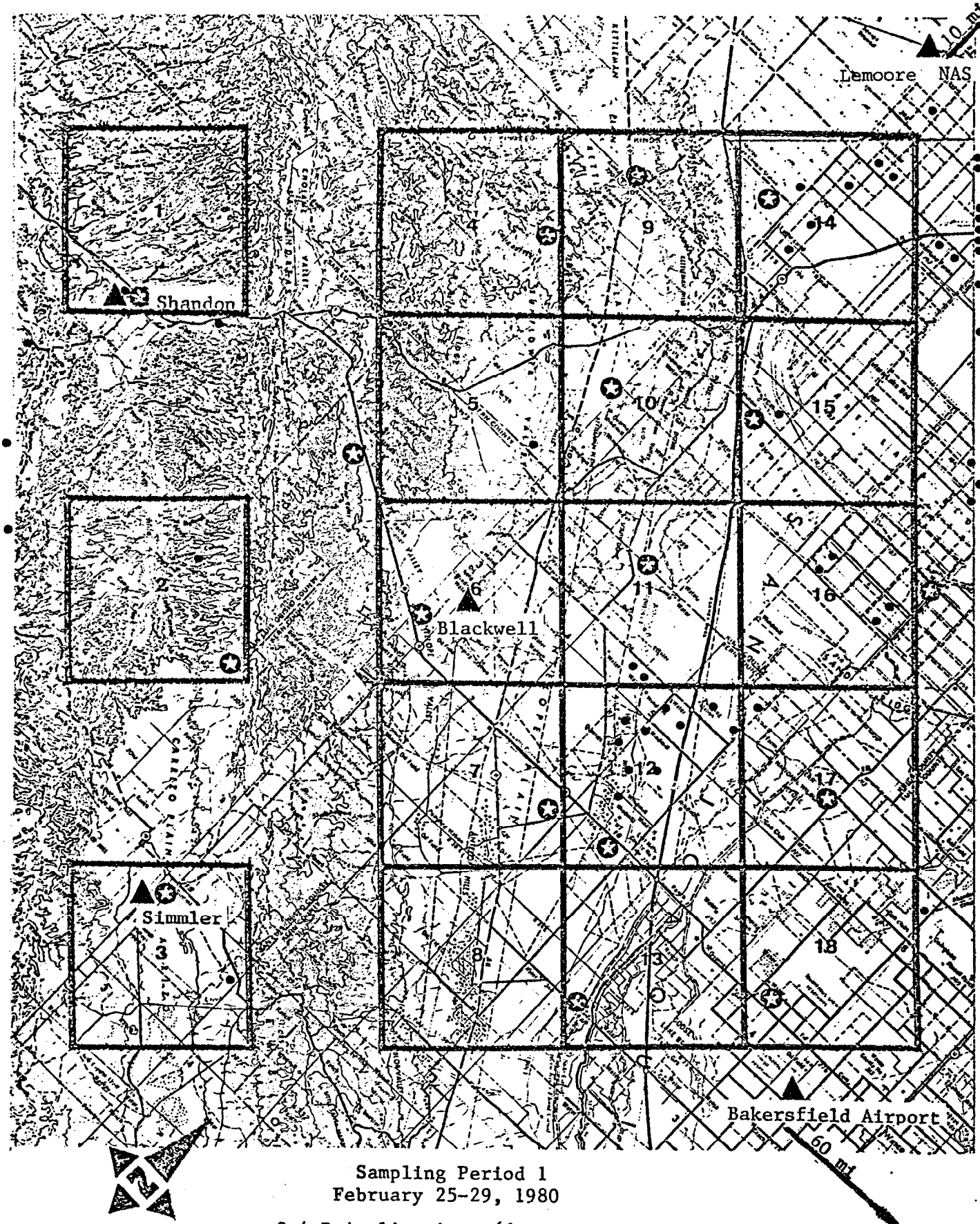
TABLE 3

2,4-D EXTRACTED FROM XAD-2 AND 47mm FIBER FILTERS

SITES SAMPLED	2/28/80-3/01/80		3/06/80-3/08/80		3/13/80-3/15/80		3/16/80-3/18/80		3/19/80-3/21/80		3/22/80-3/24/80		3/25/80-3/27/80		3/28/80-3/30/80		3/31/80-4/02/80	
	XAD-2	FIBER FILTER	XAD-2	FIBER FILTER	XAD-2	FIBER FILTER	XAD-2	FIBER FILTER	XAD-2	FIBER FILTER	XAD-2	FIBER FILTER	XAD-2	FIBER FILTER	XAD-2	FIBER FILTER	XAD-2	FIBER FILTER
1	--	--	Samples		--	--	Samples		Samples		--	--	Samples		--	--	--	--
2	--	--	Invalid		--	--	Invalid		Invalid		--	--	Invalid		--	--	--	--
3	--	--	- Rain		--	--	- Rain		- Rain		Invalid		- Rain		Invalid		--	--
4	--	--			--	--					--	--			--	--	--	--
5	--	--			Invalid						--	--			--	--	--	--
6	--	--			--	--					--	--			--	--	--	--
7	--	--			--	--					--	--			--	--	--	--
8	--	--			--	--					--	--			--	--	--	--
9	--	--			--	--					--	--			--	--	--	--
10	--	--			--	2.4µg					--	--			--	--	--	--
11	--	--			--	--					--	--			Invalid		--	--
12	--	--			--	--					--	--			--	--	--	--
13	--	--			--	--					--	--			--	--	--	--
14	--	--			--	--					--	--			--	--	--	--
15	--	--			--	--					--	--			--	--	--	--
16	--	--			--	--					--	--			--	--	--	--
17	--	--			--	--					--	--			--	--	--	--
18	--	--			--	--					--	--			--	--	--	--

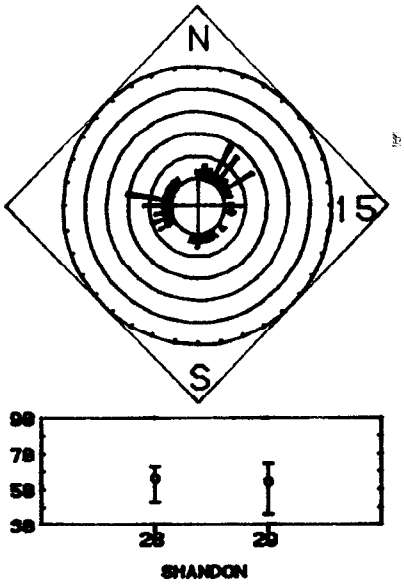
FIGURE 4. LOCATION MAPS FOR 2,4-D APPLICATIONS AND WIND ROSES WITH TEMPERATURE DATA.

FEBRUARY 25, 1980 - APRIL 2, 1980

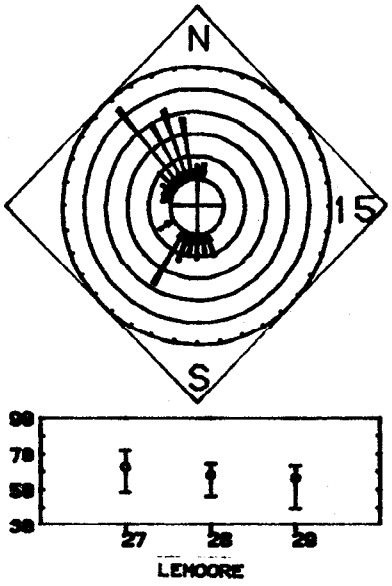


Sampling Period 1
February 25-29, 1980

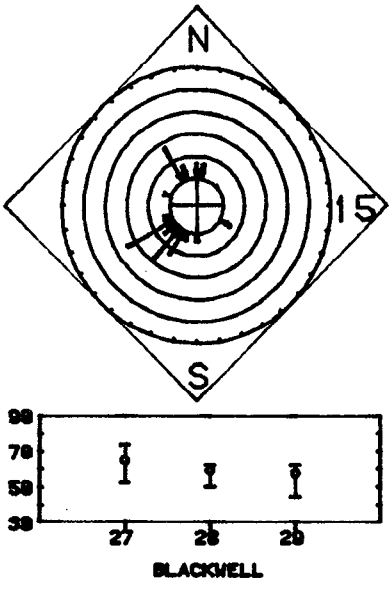
- 2,4-D Applications (dots on margin indicate applications within 5 miles)
- Sampling Sites
- Weather Stations



SHANDON



LEMOORE

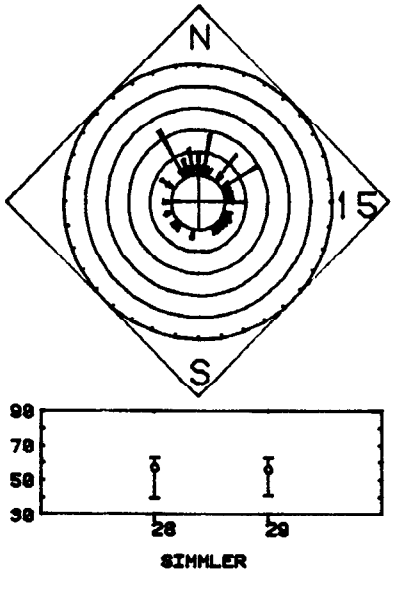


BLACKWELL

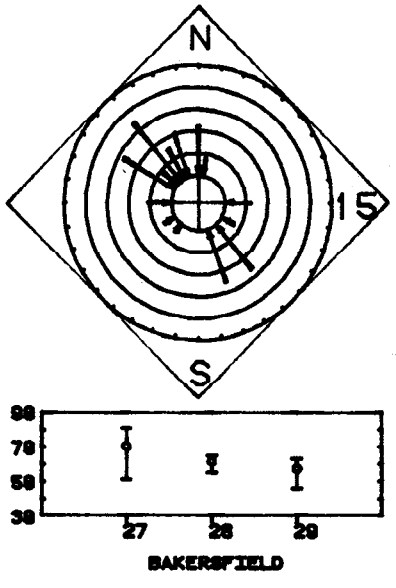
Wind Velocity Rose and Temperature Patterns
0600 - 1800 hrs. February 27-29, 1980

Rose Arrows show (velocity x time) in 3 mile increments.

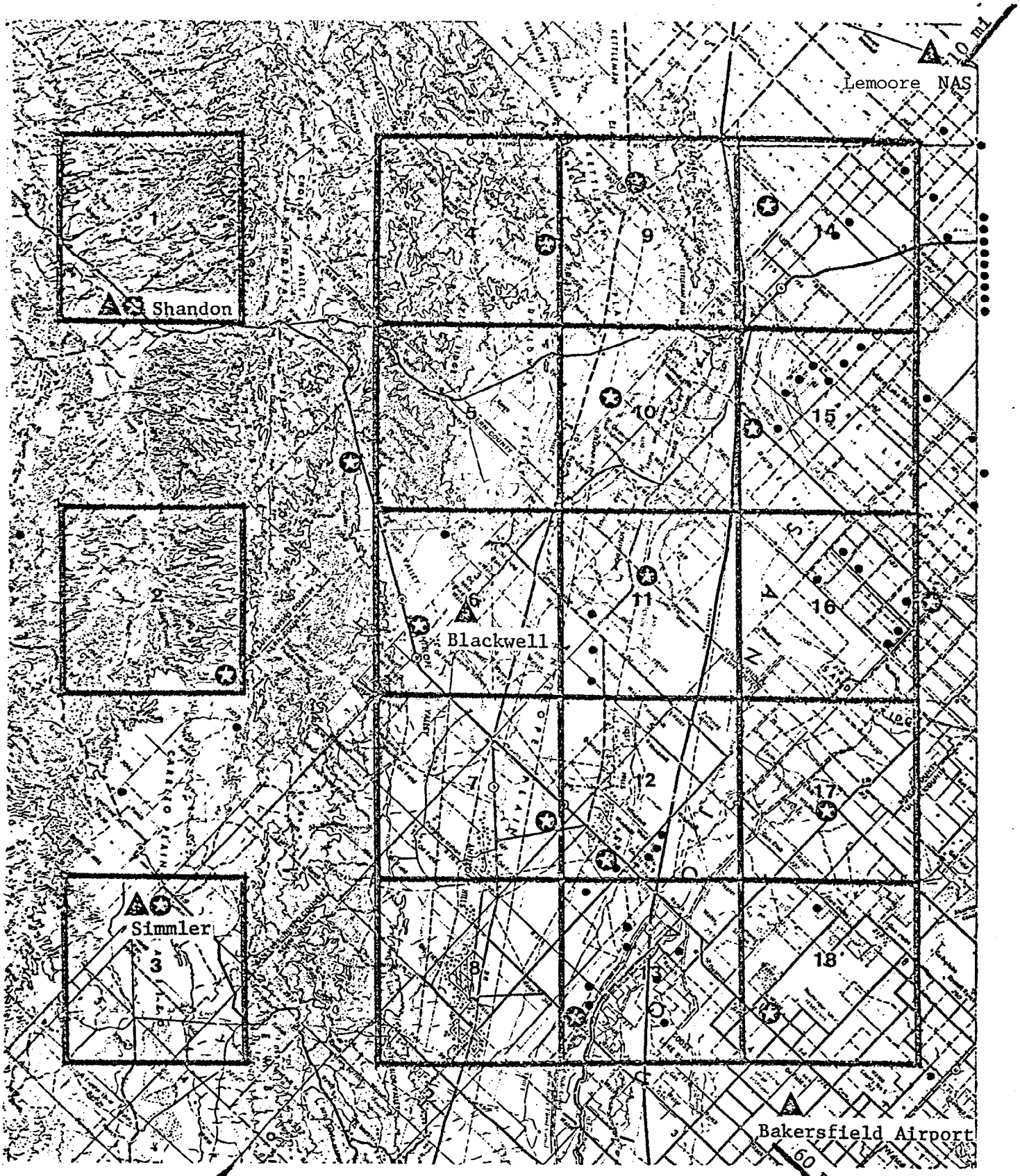
Temperatures shown are the high, low, and averaged values for time intervals.



SIMMLER

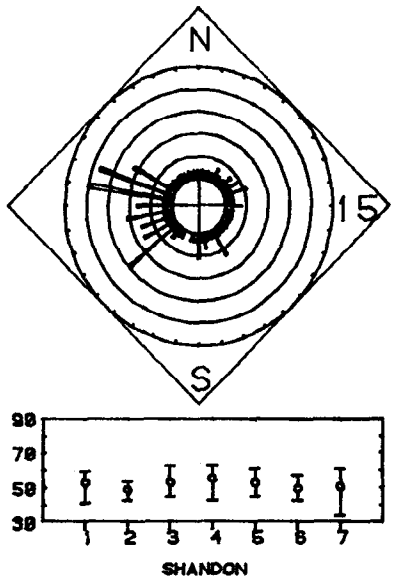


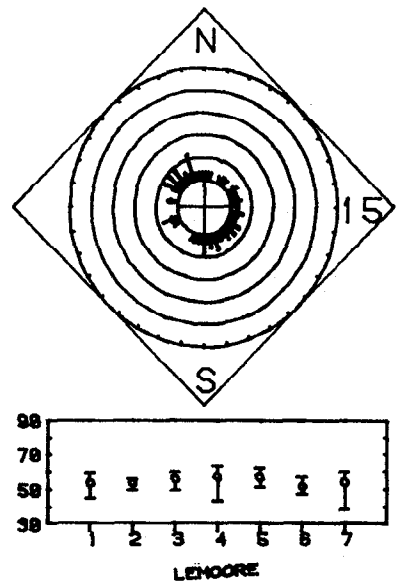
BAKERSFIELD

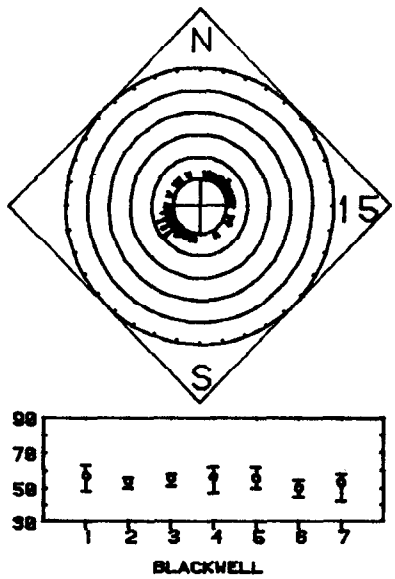


Sampling Period 2
March 1-7, 1980

- 2,4-D Applications (dots on margin indicate applications within 5 miles)
- Sampling Sites
- Weather Stations



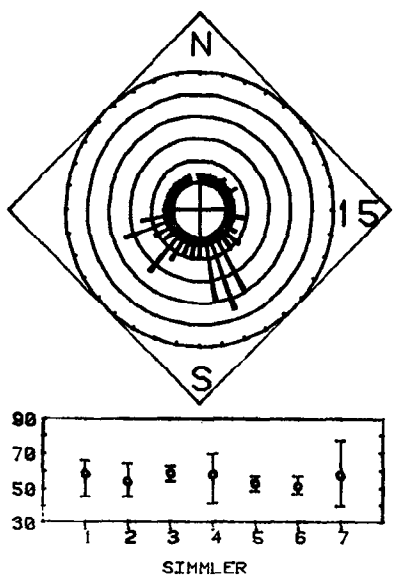


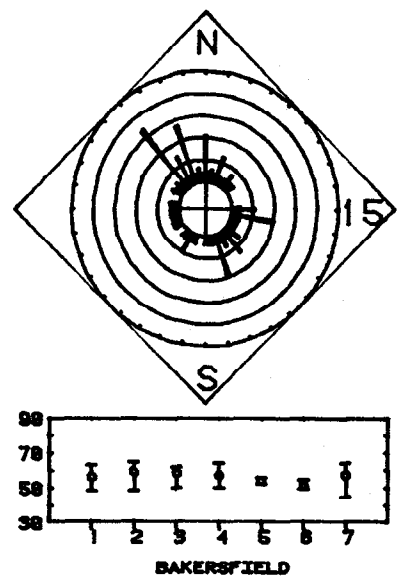


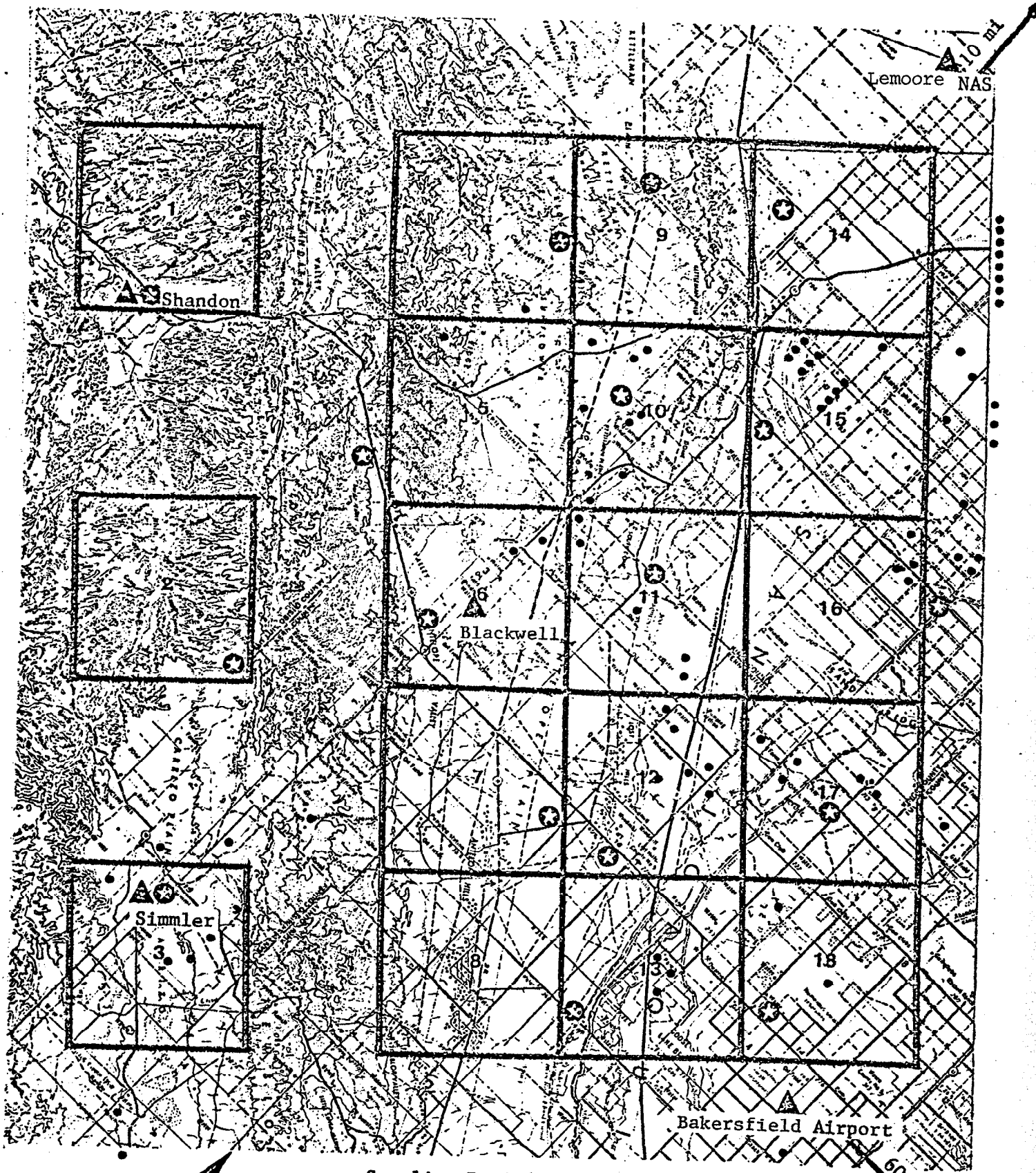
Wind Velocity Rose and Temperature Patterns
0600 - 1800 hrs. March 1-7, 1980

Rose Arrows show (velocity x time) in 3 mile increments.

Temperatures shown are the high, low, and averaged values for the time interval.

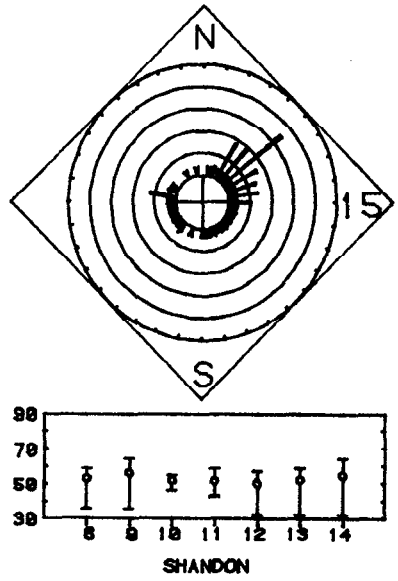


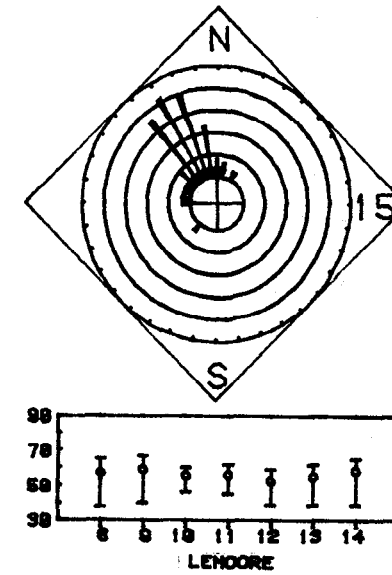


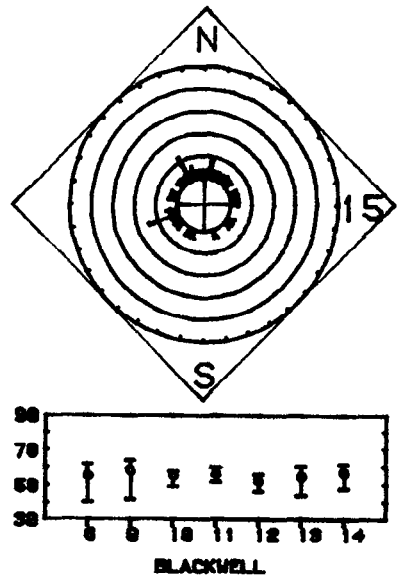


Sampling Period 3
March 8-14, 1980

- 2,4-D Applications (dots on margin indicate applications within 5 miles)
- Sampling Sites
- Weather Stations



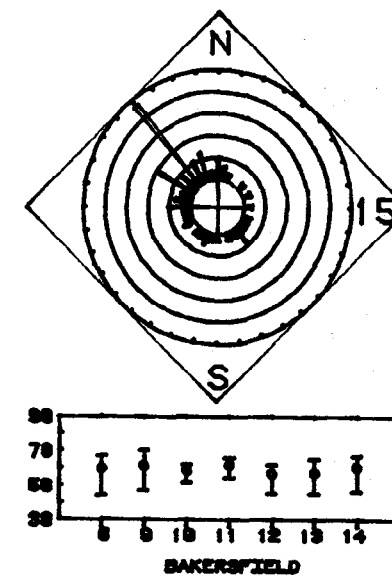


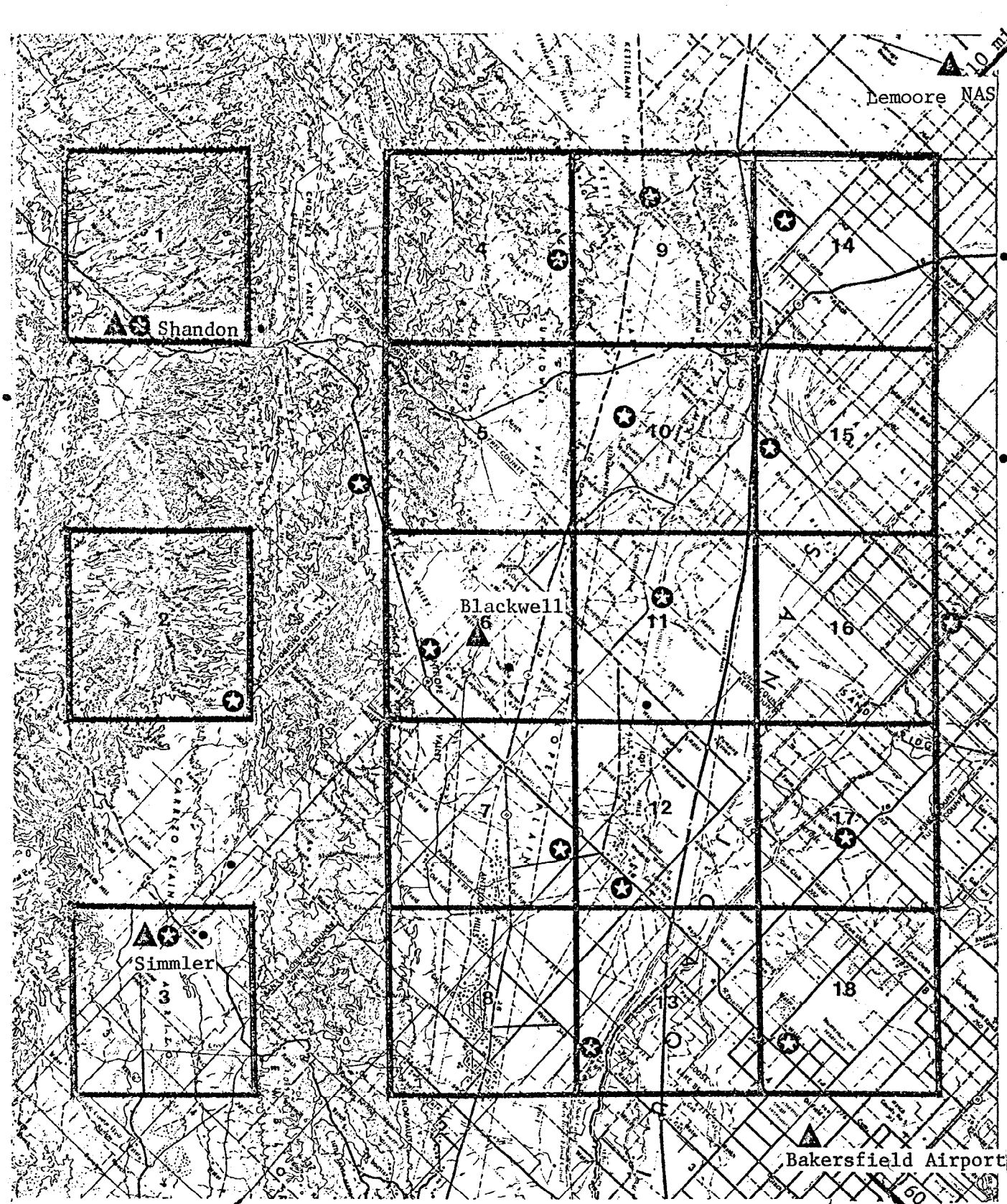


Wind Velocity Rose and Temperature Patterns
0600 - 1800 hrs. March 8-14, 1980

Rose Arrows show (velocity x time) in 3 mile increments.

Temperatures shown are the high, low and averaged values for the time interval.



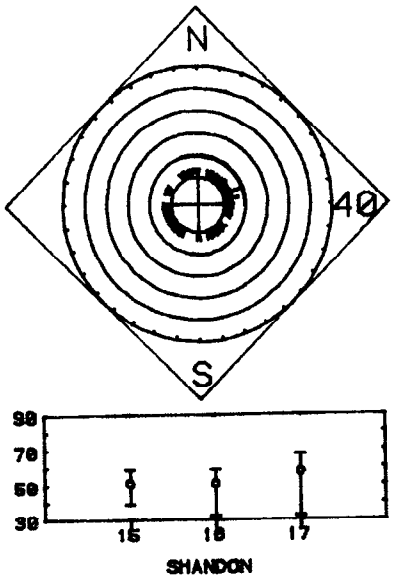


Sampling Period 4, 5 & 6
March 15-23, 1980

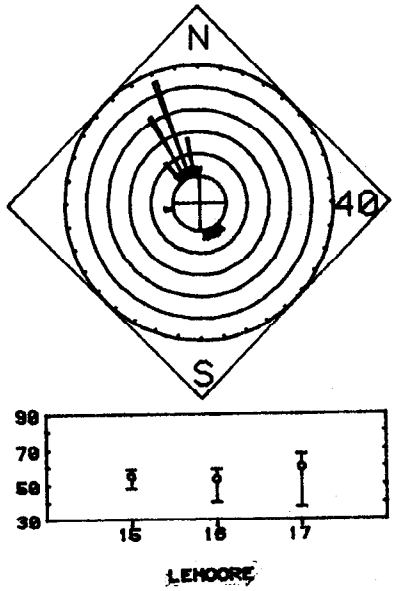
•2,4-D Applications (dots on margin indicate applications within 5 miles)

✪Sampling Sites

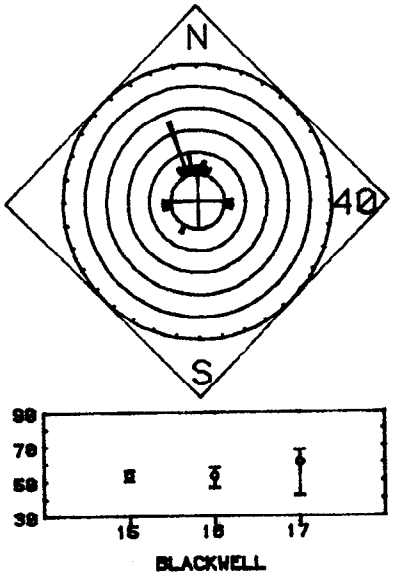
▲Weather Stations



SHANDON



LEMOORE

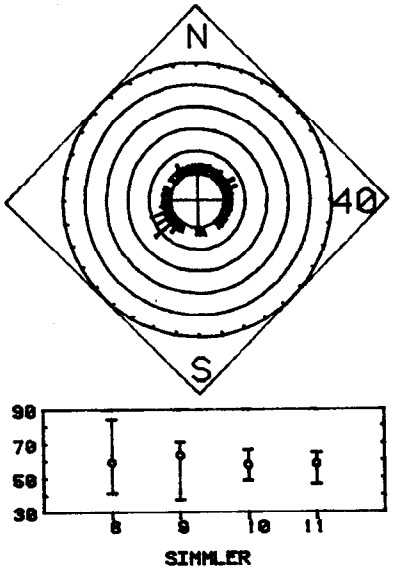


BLACKWELL

Wind Velocity Rose and Temperature Patterns
0600 - 1800 hrs. March 15-17, 1980

Rose Arrows show (velocity x time) in 8mile increments.

Temperatures shown are the high, low and averaged values for the time interval.



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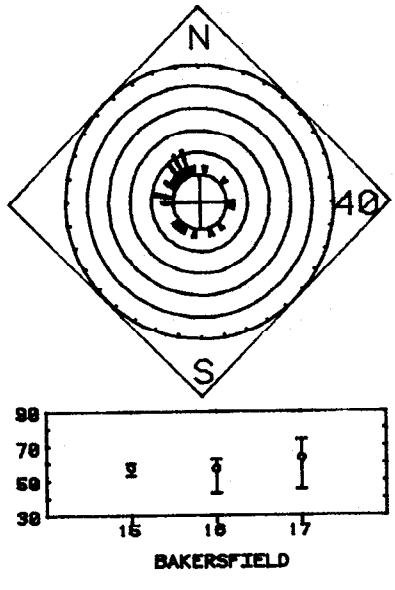

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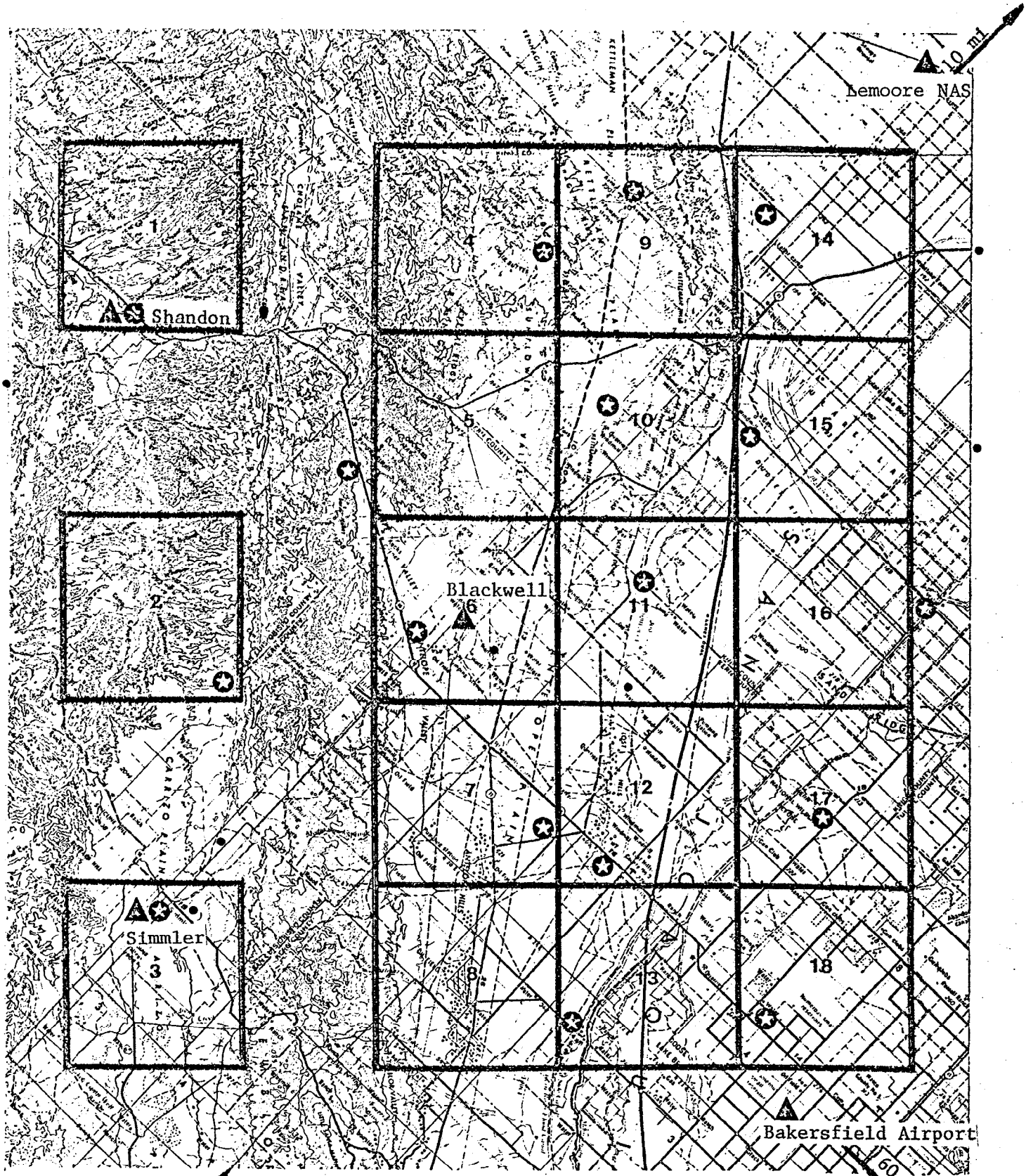
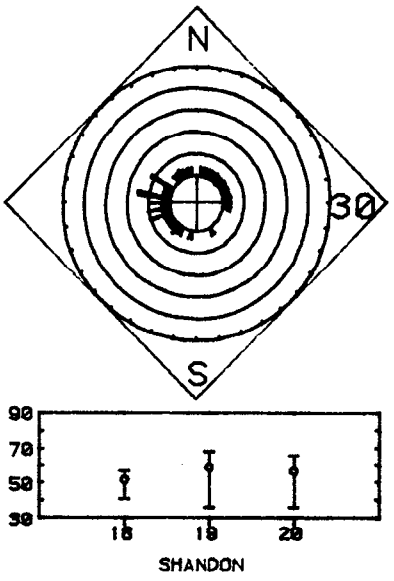


Sampling Period 4, 5 & 6
March 15-23, 1980

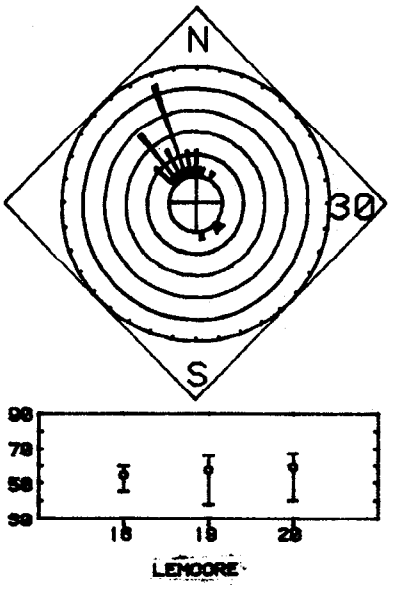
•2,4-D Applications (dots on margin indicate applications within 5 miles)

Sampling Sites

Weather Stations



SHANDON



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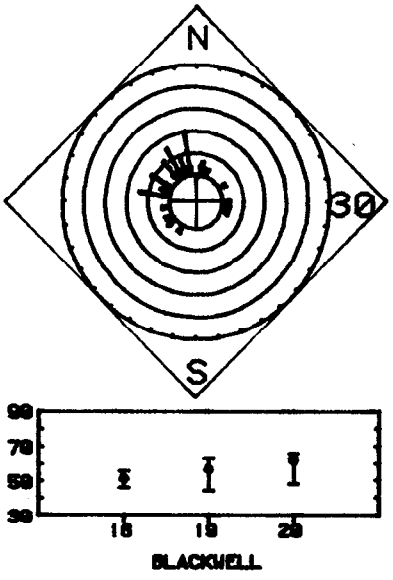
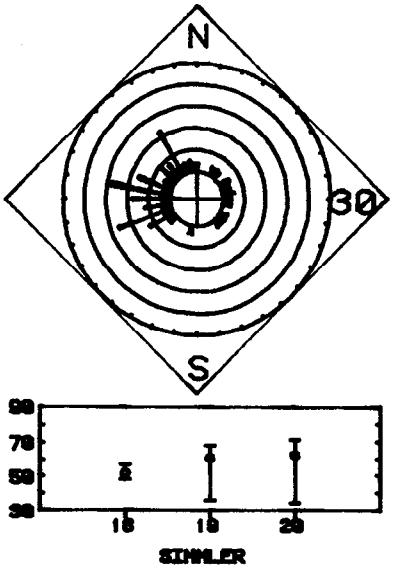


BLACKWELL

Wind Velocity Rose and Temperature Patterns
0600 - 1800 hrs. March 18-20, 1980

Rose Arrows show (velocity x time) in 6mile increments.

Temperatures shown are the high, low and averaged values for the time interval.



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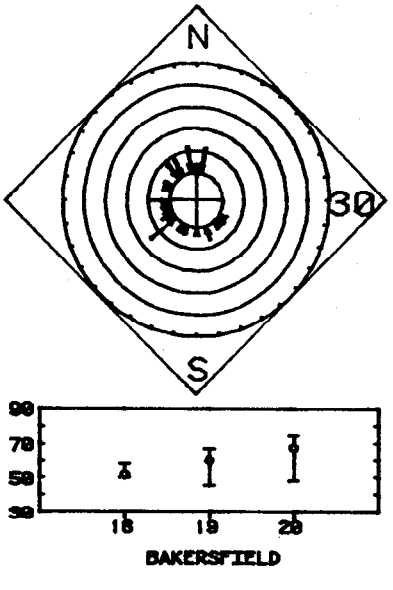

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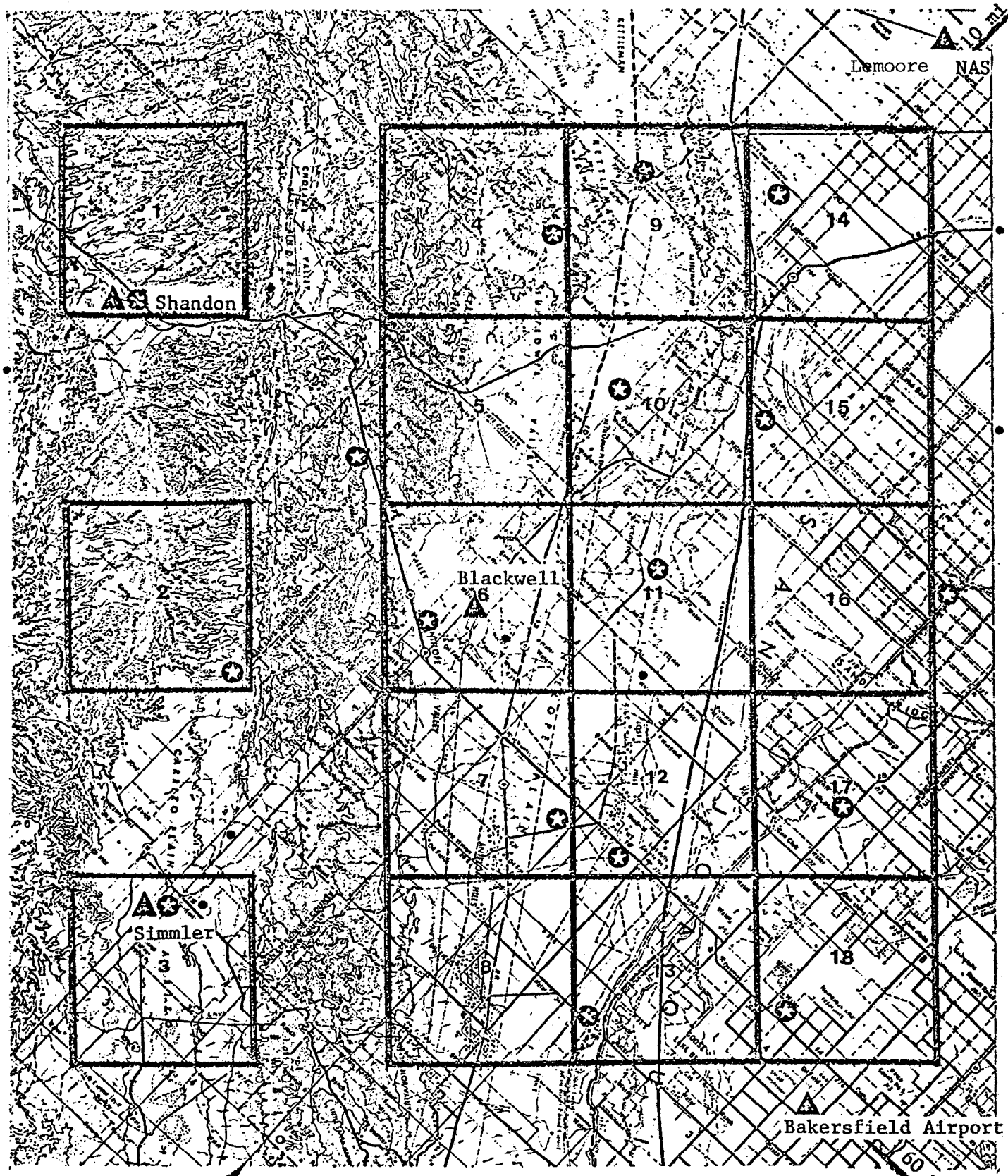
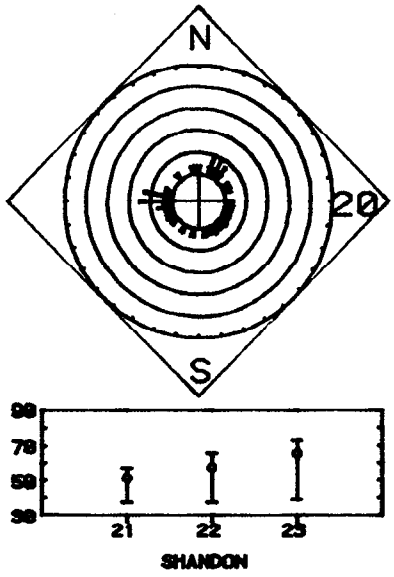


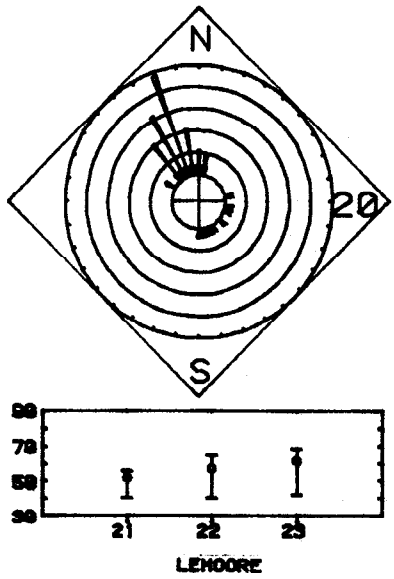
Sampling Period 4, 5 & 6
March 15-23, 1980

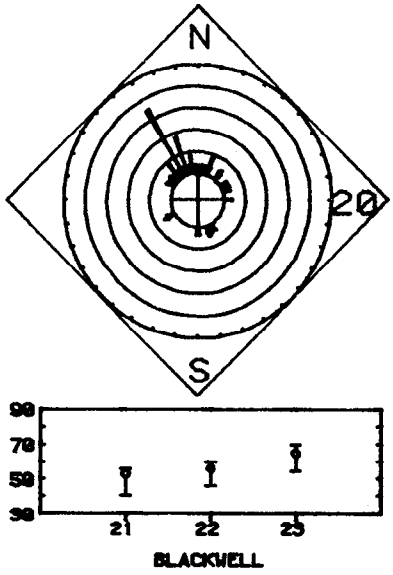
•2,4-D Applications (dots on margin indicate applications within 5 miles)

✪Sampling Sites

▲Weather Stations



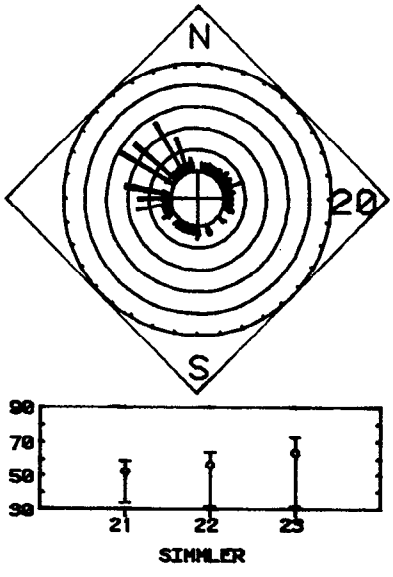


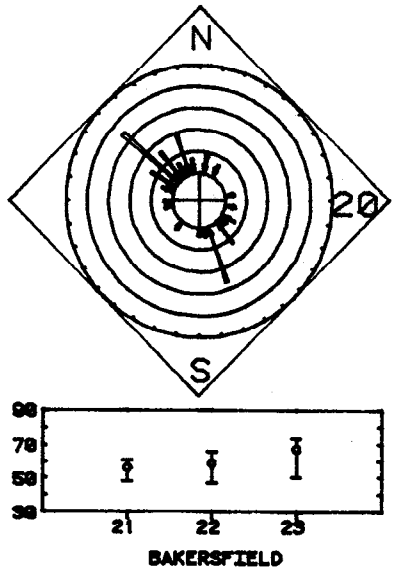


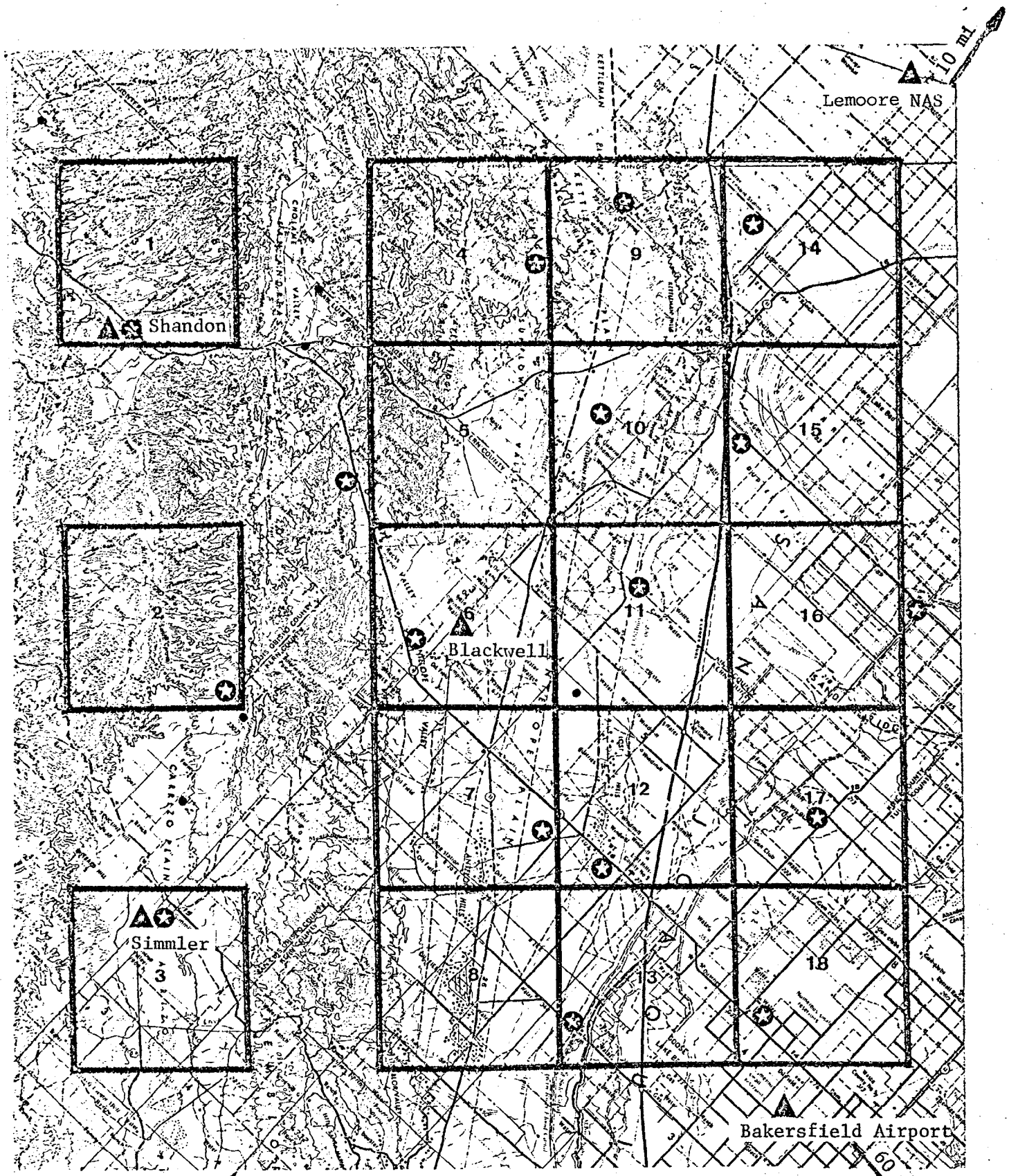
Wind Velocity Rose and Temperature Patterns
0600 - 1800 hrs. March 21-23, 1980

Rose Arrows show (velocity x time) in 4mile increments.

Temperatures shown are the high, low and averaged values for the time interval.

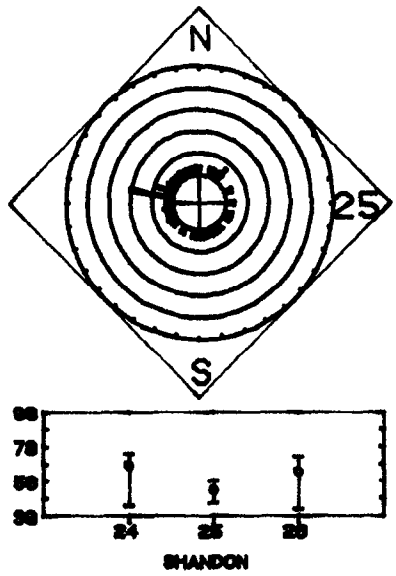


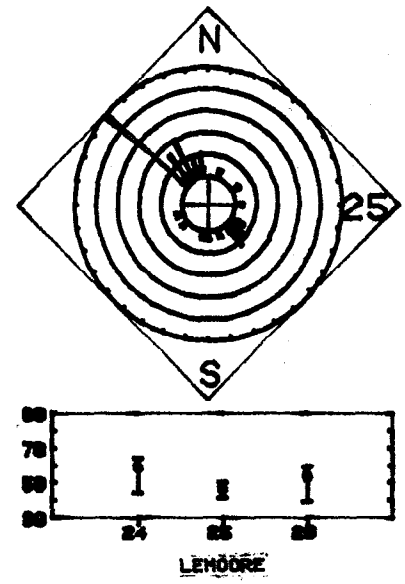


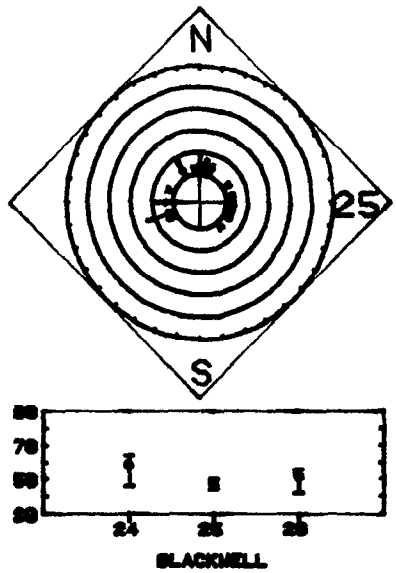


Sampling Period 7
March 24-26, 1980

- 2,4-D Applications (dots on margin indicate applications within 5 miles)
- Sampling Sites
- Weather Stations



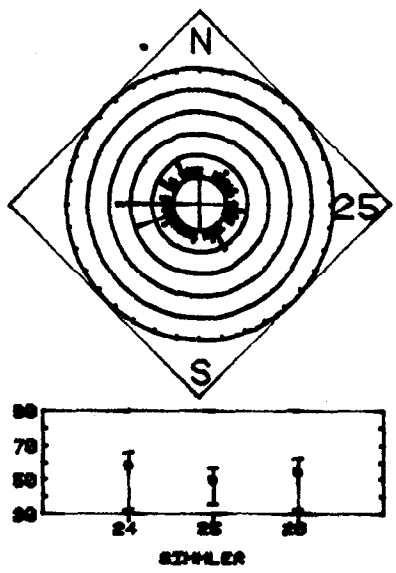


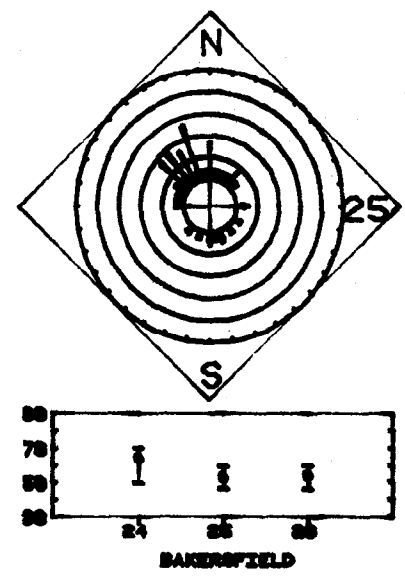


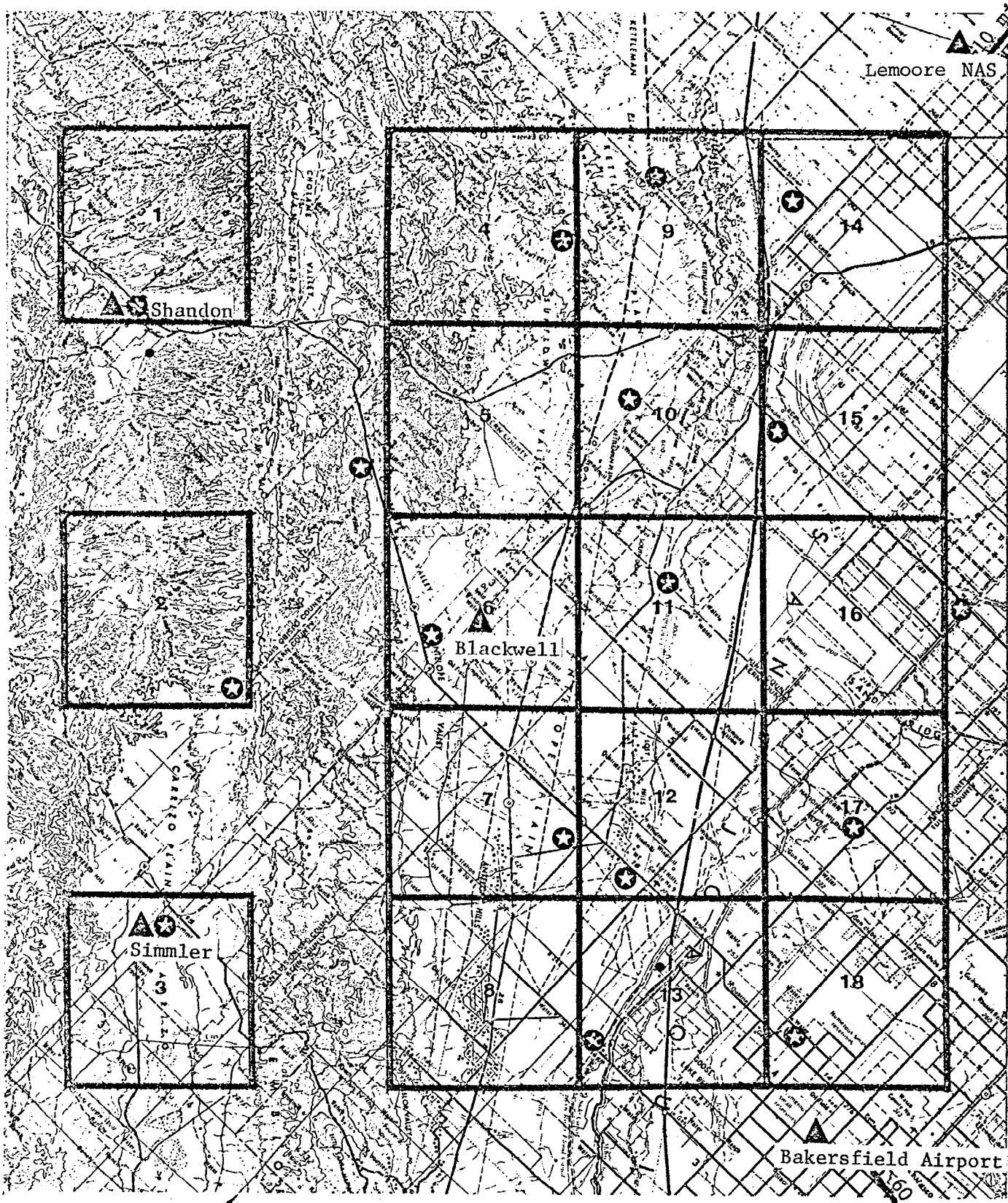
Wind Velocity Rose and Temperature Patterns
0600 - 1800 hrs. March 24-26, 1980

Rose Arrows show (velocity x time) in 5mile increments.

Temperatures shown are the high, low and averaged values for the time interval.

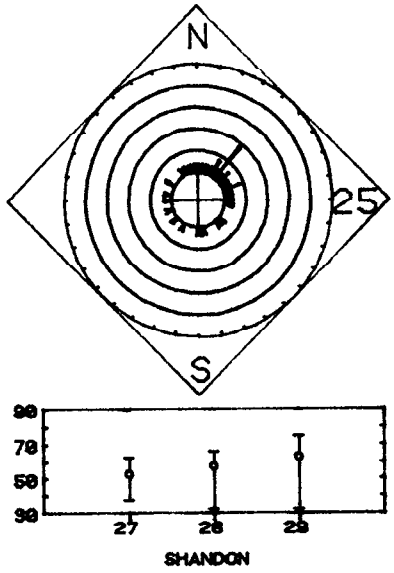




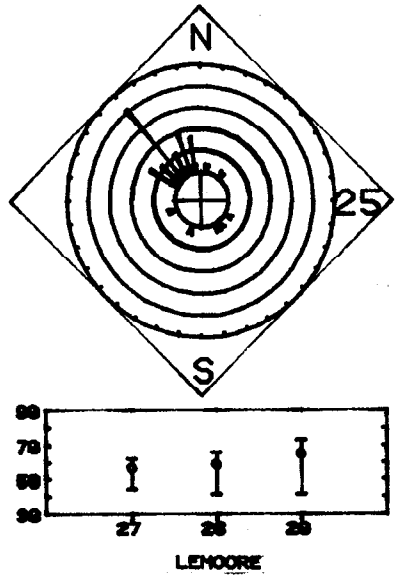


Sampling Period 8 & 9
March 27-April 2, 1980

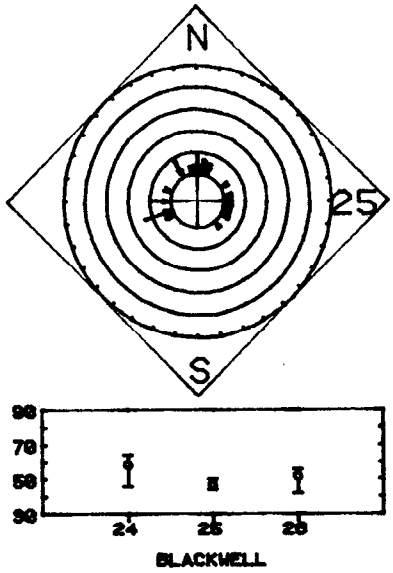
- 2,4-D Applications (dots on margin indicate applications within 5 miles
- Sampling Sites
- Weather Stations



SHANDON



LEMOORE

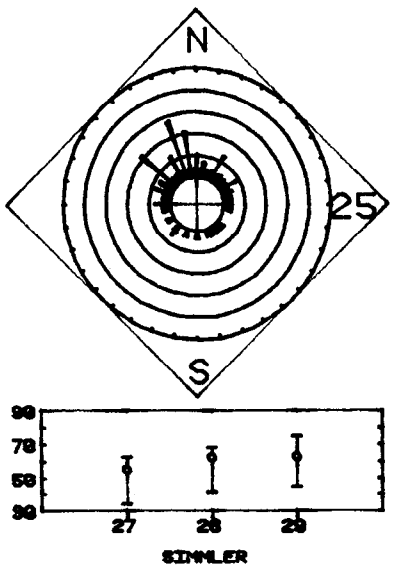


BLACKWELL

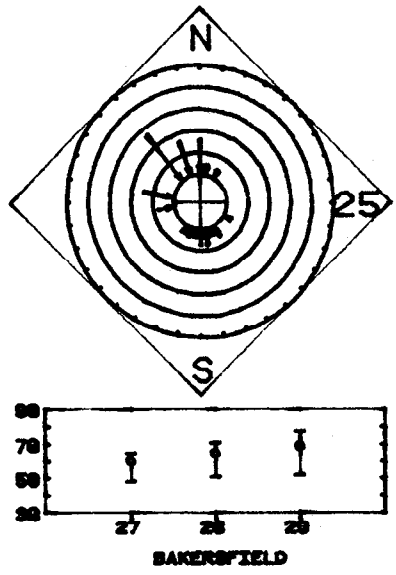
Wind Velocity Rose and Temperature Patterns
0600 - 1800 hrs. March 27-29, 1980

Rose Arrows show (velocity x time) in 5mile increments.

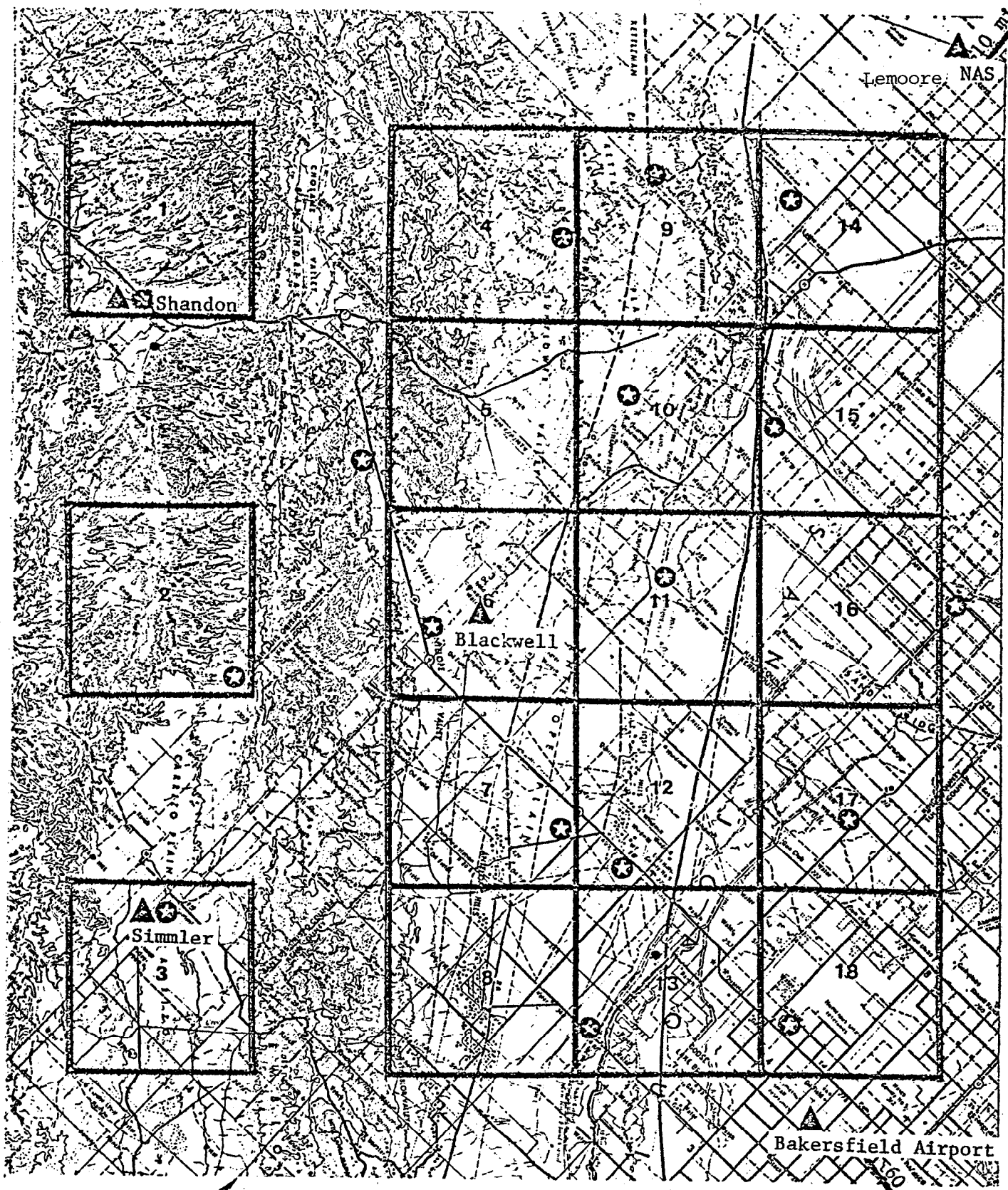
Temperatures shown are the high, low and averaged values for the time interval.



SINNLER

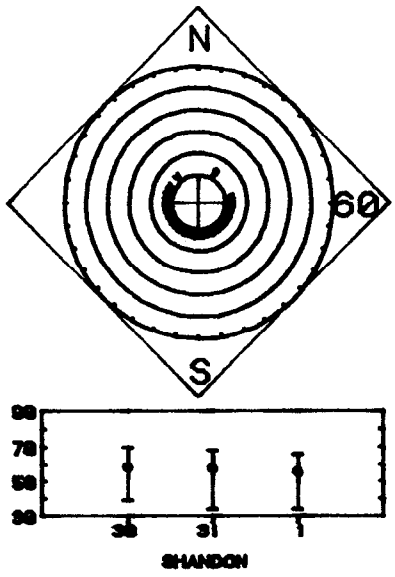


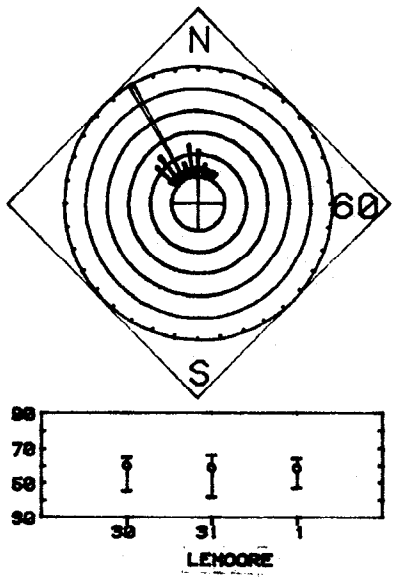
BAKERSFIELD

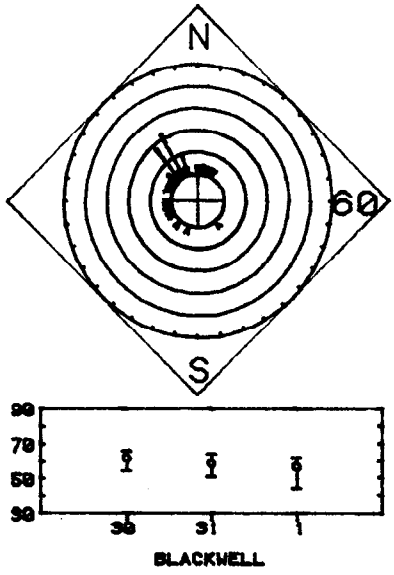


Sampling Period 8 & 9
March 27-April 2, 1980

- 2,4-D Applications (dots on margin indicate applications within 5 miles
- Sampling Sites
- Weather Stations



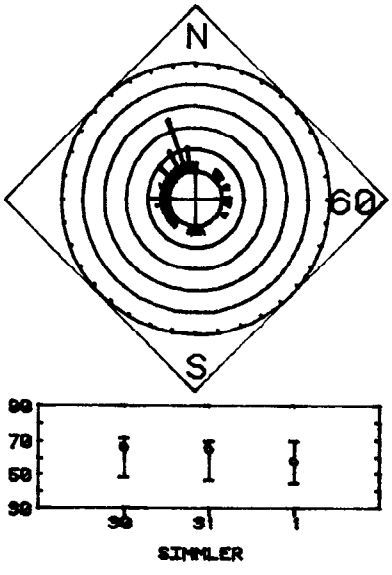


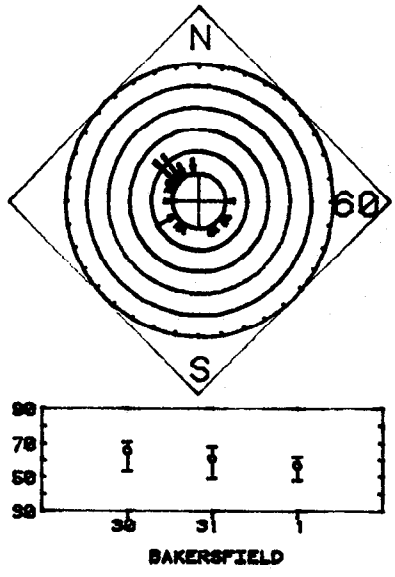


Wind Velocity Rose and Temperature Patterns
0600 - 1800 hrs. March 30-April 1, 1980

Rose Arrows show (velocity x time) in 12mile increments.

Temperatures shown are the high, low and averaged values for the time interval.





E. Discussion

The following points can be concluded from the study results:

1. No evidence of drift from San Luis Obispo County into the San Joaquin Valley was seen.
2. Potential area-wide drift from the large numbers of NV 2,4-D applications in the San Joaquin Valley did not occur. 2,4-D was not an air basin pollutant during the monitoring period, 1980.
3. No evidence of any illegal ester applications was detected during the study period.

The weather during this project had a great impact on both aerial applications of 2,4-D and air sampling. Several late season storms forced air applications to be delayed and some growers may have been unable to use 2,4-D herbicides. Use report data indicates short periods of no spray activity (Table 1 and Appendix I). These periods correspond to our records of storm activity and rain damaged samples (Table 3).

County personnel have reported significantly less phenoxy symptoms for this season. During the 1979 season, 19,331 acres were sprayed with LV 2,4-D in eastern San Luis Obispo County. The 1980 use reports (Appendix I) show only 12,143 acres (less than 63% of the 1979 area) were sprayed with LV 2,4-D in San Luis Obispo County. This is a significant reduction in the use of volatile 2,4-D. The decrease in acreage sprayed with volatile 2,4-D in San Luis Obispo may be due to the adverse weather conditions and/or the effect of new San Luis Obispo regulations on PCA recommendations for 1980. It does point out, however, that the results from this study should not be extrapolated beyond those conditions which occurred in 1980. The air monitoring results

might have been very different if the 1979 amounts of 2,4-D were applied or warmer weather had occurred close to the ester applications.

REFERENCES

1. State of California Legislature 1949 Regular Session, Statutes of California, Chapter 1294 (An Act to Add Section 1066.7 to the Agricultural Code) Sec. 2 paragraph 2.

2. State of California Administrative Code, Title 3, Chapter 4, Sub. Chapter 1, Group 2, Article 20, Section 2458.

3. L. M. Rissinger and E. Robinson, "Long Distance Transport of 2,4-D", J. of Applied Meteorology, Vol. 15, No. 8, August 1976.

4. E. Robinson and L. L. Fox, "2,4-D Herbicides in Central Washington", J. APCA Vol. 28, No. 10, October 1978.

5. R. Grover, L. A. Kerr, "Residues of 2,4-D in Air Samples from Saskatchewan: 1966-1975", J. Envir. Sci. Health, B11 (4), 331-347 (1976).

6. S. O. Farwell, W. J. Powell, D. F. Adams, "Survey of Airborne 2,4-D in South-Central Washington", J. Air Poll. Cont. Assoc., V26 (3), 224-230 (1976).

APPENDIX I. 2,4-D USE PERMITS GRANTED WITHIN THREE COUNTY STUDY AREA
FEB 24 - APR 2, 1980

###	DATE OF APPLICATION MON DAY YR	COUNTY	LOCATION	TOTAL GALLONS 2,4-D APPLIED	TOTAL ACRES TREATED	CROP TREATED
1	FEB 24 80	SLO	T.25S,R.15E,S.16	80	760	BARLEY
2	FEB 25 80	KGS	T.20S,R.20E,S.15	12	100	BARLEY
3	FEB 25 80	KGS	T.20S,R.20E,S.15	4	35	BARLEY
4	FEB 25 80	KGS	T.24S,R.18E,S.33	58	154	BARLEY
5	FEB 25 80	KRN	T.25S,R.20E,S.28	60	320	BARLEY
6	FEB 25 80	KRN	T.25S,R.20E,S.34	45	240	BARLEY
7	FEB 25 80	KRN	T.25S,R.21E,S.26	60	320	BARLEY
8	FEB 25 80	KRN	T.25S,R.21E,S.27	30	160	BARLEY
9	FEB 25 80	KRN	T.25S,R.21E,S.28	30	160	BARLEY
10	FEB 25 80	SLO	T.27S,R.14E,S.12	86	860	BARLEY
11	FEB 25 80	SLO	T.30S,R.19E,S.12	80	960	BARLEY
12	FEB 26 80	KGS	T.20S,R.19E,S.01	56	300	BARLEY
13	FEB 26 80	KGS	T.20S,R.19E,S.06	114	610	BARLEY
14	FEB 26 80	KGS	T.20S,R.19E,S.32	37	200	BARLEY
15	FEB 26 80	KGS	T.20S,R.19E,S.31	13	71	BARLEY
16	FEB 26 80	KGS	T.20S,R.20E,S.06	85	677	BARLEY
17	FEB 26 80	KGS	T.20S,R.19E,S.36	48	255	BARLEY
18	FEB 26 80	KGS	T.20S,R.20E,S.31	32	207	BARLEY
19	FEB 26 80	KRN	T.25S,R.21E,S.32	56	300	BARLEY
20	FEB 26 80	KRN	T.25S,R.21E,S.33	13	68	BARLEY
21	FEB 26 80	KRN	T.25S,R.23E,S.26	20	81	WHEAT
22	FEB 26 80	KRN	T.26S,R.21E,S.05	51	270	BARLEY
23	FEB 26 80	KRN	T.26S,R.21E,S.09	56	300	BARLEY
24	FEB 26 80	SLO	T.25S,R.15E,S.26	61	726	BARLEY
25	FEB 26 80	SLO	T.26S,R.14E,S.21	06	65	BARLEY
26	FEB 26 80	SLO	T.26S,R.14E,S.28	83	830	BARLEY
27	FEB 26 80	SLO	T.26S,R.15E,S.19	06	55	BARLEY
28	FEB 26 80	SLO	T.27S,R.14E,S.14	72	723	BARLEY
29	FEB 27 80	KGS	T.21S,R.18E,S.25	19	150	BARLEY
30	FEB 27 80	KGS	T.21S,R.18E,S.22	9	75	BARLEY
31	FEB 27 80	KGS	T.21S,R.18E,S.12	16	100	****
32	FEB 27 80	KGS	T.22S,R.18E,S.01	30	160	BARLEY
33	FEB 27 80	KGS	T.22S,R.21E,S.10	85	543	COTTON
34	FEB 27 80	KGS	T.22S,R.21E,S.12	96	614	COTTON
35	FEB 27 80	KGS	T.22S,R.21E,S.14	97	618	COTTON
36	FEB 27 80	SLO	T.26S,R.24E,S.24	09	110	BARLEY
37	FEB 27 80	SLO	T.27S,R.14E,S.19	48	480	BARLEY
38	FEB 27 80	SLO	T.27S,R.15E,S.26	09	110	BARLEY
39	FEB 28 80	KGS	T.20S,R.20E,S.12	4	32	BARLEY
40	FEB 28 80	KGS	T.20S,R.19E,S.13	49	260	BARLEY
41	FEB 28 80	KGS	T.20S,R.19E,S.24	21	110	BARLEY
42	FEB 28 80	KGS	T.20S,R.19E,S.01	40	320	BARLEY
43	FEB 28 80	KGS	T.20S,R.20E,S.36	27	170	BARLEY
44	FEB 28 80	KGS	T.20S,R.20E,S.19	21	112	BARLEY
45	FEB 28 80	KGS	T.20S,R.20E,S.30	9	47	BARLEY

APPENDIX I. (cont.)

###	DATE OF APPLICATION MON DAY YR	COUNTY	LOCATION	TOTAL GALLONS 2,4-D APPLIED	TOTAL ACRES TREATED	CROP TREATED
46	FEB 28 80	KGS	T.20S,R.20E,S.23	9	75	BARLEY
47	FEB 28 80	SLO	T.27S,R.16E,S.22	28	330	BARLEY
48	FEB 29 80	KGS	T.23S,R.19E,S.02	25	200	BARLEY
49	FEB 29 80	KGS	T.23S,R.21E,S.35	38	304	BARLEY
50	FEB 29 80	KGS	T.23S,R.21E,S.26	38	302	BARLEY
51	FEB 29 80	KGS	T.23S,R.21E,S.31	4	50	BARLEY
52	FEB 29 80	KGS	T.23S,R.21E,S.30	113	600	BARLEY
53	FEB 29 80	KRN	T.26S,R.21E,S.18	76	303	WHEAT
54	FEB 29 80	KRN	T.26S,R.21E,S.19	18	74	WHEAT
55	FEB 29 80	KRN	T.26S,R.21E,S.20	64	256	WHEAT
56	FEB 29 80	KRN	T.26S,R.21E,S.20	73	293	WHEAT
57	FEB 29 80	KRN	T.26S,R.21E,S.29	19	75	WHEAT
58	FEB 29 80	SLO	T.25S,R.15E,S.33	102	1018	BARLEY
59	FEB 29 80	SLO	T.27S,R.17E,S.19	67	800	BARLEY
60	MAR 1 80	KGS	T.20S,R.20E,S.24	42	225	BARLEY
61	MAR 1 80	KGS	T.20S,R.20E,S.13	29	155	BARLEY
62	MAR 1 80	KGS	T.22S,R.19E,S.23	76	610	BARLEY
63	MAR 1 80	KGS	T.22S,R.19E,S.26	76	610	BARLEY
64	MAR 1 80	KGS	T.22S,R.19E,S.35	76	610	BARLEY
65	MAR 1 80	KGS	T.22S,R.19E,S.13	73	590	BARLEY
66	MAR 1 80	KGS	T.22S,R.19E,S.12	74	595	BARLEY
67	MAR 1 80	KGS	T.22S,R.19E,S.01	43	38	BARLEY
68	MAR 1 80	KGS	T.23S,R.19E,S.02	18	147	BARLEY
69	MAR 1 80	KRN	T.25S,R.23E,S.33	28	150	*****
70	MAR 1 80	KRN	T.26S,R.21E,S.23	12	95	BARLEY
71	MAR 1 80	KRN	T.27S,R.21E,S.24	6	45	BARLEY
72	MAR 1 80	SLO	T.28S,R.18E,S.20	28	330	BARLEY
73	MAR 2 80	KGS	T.21S,R.20E,S.24	74	597	COTTON
74	MAR 3 80	KRN	T.26S,R.21E,S.21	4	30	BARLEY
75	MAR 3 80	KRN	T.27S,R.22E,S.36	1	8	BARLEY
76	MAR 3 80	KRN	T.28S,R.22E,S.06	5	37	BARLEY
77	MAR 4 80	KGS	T.20S,R.20E,S.09	17	93	BARLEY
78	MAR 4 80	KGS	T.20S,R.20E,S.14	10	55	BARLEY
79	MAR 4 80	KGS	T.20S,R.19E,S.07	120	640	BARLEY
80	MAR 4 80	KGS	T.20S,R.19E,S.35	56	300	BARLEY
81	MAR 4 80	KGS	T.20S,R.19E,S.04	60	320	BARLEY
82	MAR 4 80	KGS	T.20S,R.19E,S.30	120	640	BARLEY
83	MAR 4 80	KGS	T.21S,R.19E,S.20	37	295	BARLEY
84	MAR 4 80	KGS	T.21S,R.19E,S.17	38	305	BARLEY
85	MAR 4 80	KGS	T.21S,R.20E,S.28	57	610	COTTON
86	MAR 4 80	KGS	T.22S,R.21E,S.03	6	30	COTTON
87	MAR 4 80	KGS	T.23S,R.21E,S.13	33	270	BARLEY
88	MAR 4 80	KGS	T.23S,R.21E,S.20	19	150	BARLEY
89	MAR 4 80	KGS	T.23S,R.21E,S.36	35	282	BARLEY
90	MAR 4 80	KGS	T.23S,R.21E,S.19	39	308	BARLEY
91	MAR 4 80	KGS	T.23S,R.21E,S.25	44	353	BARLEY
92	MAR 4 80	KGS	T.23S,R.21E,S.36	61	322	BARLEY
93	MAR 4 80	KGS	T.23S,R.21E,S.31	57	304	BARLEY
94	MAR 4 80	KRN	T.25S,R.19E,S.24	4	100	BARLEY

APPENDIX I. (cont.)

###	DATE OF APPLICATION MON	DAY	YR	COUNTY	LOCATION	TOTAL GALLONS 2,4-D APPLIED	TOTAL ACRES TREATED	CROP TREATED
95	MAR	4	80	KRN	T.25S,R.20E,S.30	5	168	BARLEY
96	MAR	4	80	KRN	T.25S,R.20E,S.32	88	429	BARLEY
97	MAR	4	80	KRN	T.26S,R.21E,S.14	2	15	BARLEY
98	MAR	4	80	KRN	T.26S,R.21E,S.26	2	15	BARLEY
99	MAR	4	80	KRN	T.27S,R.21E,S.09	19	150	BARLEY
100	MAR	4	80	KRN	T.27S,R.22E,S.15	26	135	BARLEY
101	MAR	4	80	KRN	T.27S,R.22E,S.30	36	284	BARLEY
102	MAR	4	80	KRN	T.28S,R.22E,S.08	1	12	BARLEY
103	MAR	4	80	SLO	T.26S,R.15E,S.19	100	530	BARLEY
104	MAR	4	80	SLO	T.27S,R.17E,S.05	100	550	BARLEY
105	MAR	5	80	SLO	T.26S,R.17E,S.30	97	519	BARLEY
106	MAR	6	80	KRN	T.27S,R.22E,S.10	22	117	BARLEY
107	MAR	7	80	KGS	T.20S,R.19E,S.28	38	38	BARLEY
108	MAR	7	80	KGS	T.20S,R.20E,S.27	17	95	BARLEY
109	MAR	7	80	KGS	T.20S,R.20E,S.33	143	765	BARLEY
110	MAR	7	80	KGS	T.20S,R.20E,S.29	58	310	BARLEY
111	MAR	7	80	KRN	T.26S,R.24E,S.25	10	60	BARLEY
112	MAR	8	80	KGS	T.20S,R.20E,S.18	40	320	BARLEY
113	MAR	8	80	KGS	T.20S,R.20E,S.04	38	300	BARLEY
114	MAR	8	80	KGS	T.20S,R.20E,S.13	16	84	BARLEY
115	MAR	8	80	KGS	T.24S,R.19E,S.19	35	284	BARLEY
116	MAR	8	80	KGS	T.22S,R.19E,S.22	66	530	BARLEY
117	MAR	8	80	KGS	T.22S,R.19E,S.34	44	350	BARLEY
118	MAR	8	80	KGS	T.22S,R.19E,S.21	33	265	BARLEY
119	MAR	8	80	KGS	T.22S,R.19E,S.01	73	585	BARLEY
120	MAR	8	80	KGS	T.22S,R.19E,S.24	75	600	BARLEY
121	MAR	8	80	KGS	T.22S,R.21E,S.25	6	46	COTTON
122	MAR	8	80	KGS	T.22S,R.21E,S.26	77	614	COTTON
123	MAR	8	80	KGS	T.22S,R.21E,S.33	98	627	COTTON
124	MAR	8	80	KGS	T.22S,R.21E,S.15	66	524	COTTON
125	MAR	8	80	KGS	T.22S,R.21E,S.01	62	495	COTTON
126	MAR	8	80	KRN	T.25S,R.19E,S.07	29	233	BARLEY
127	MAR	8	80	KRN	T.25S,R.19E,S.06	16	128	BARLEY
128	MAR	8	80	KRN	T.25S,R.19E,S.17	26	210	BARLEY
129	MAR	8	80	KRN	T.25S,R.19E,S.19	15	117	BARLEY
130	MAR	8	80	KRN	T.25S,R.20E,S.18	4	119	BARLEY
131	MAR	8	80	KRN	T.25S,R.21E,S.24	112	600	BARLEY
132	MAR	8	80	KRN	T.25S,R.21E,S.25	32	170	BARLEY
133	MAR	8	80	SLO	T.29S,R.18E,S.24	117	1400	BARLEY
134	MAR	9	80	KGS	T.20S,R.20E,S.19	19	100	BARLEY
135	MAR	9	80	KGS	T.24S,R.18E,S.25	15	119	BARLEY
136	MAR	9	80	KGS	T.24S,R.18E,S.16	4	500	BARLEY
137	MAR	9	80	KGS	T.22S,R.17E,S.32	38	200	BARLEY
138	MAR	9	80	KGS	T.22S,R.17E,S.34	13	70	BARLEY
139	MAR	9	80	KGS	T.22S,R.17E,S.29	112	600	BARLEY
140	MAR	9	80	KGS	T.23S,R.17E,S.11	88	469	BARLEY
141	MAR	9	80	KGS	T.23S,R.17E,S.13	93	497	BARLEY
142	MAR	9	80	KGS	T.23S,R.17E,S.12	38	200	BARLEY

APPENDIX I. (cont.)

###	DATE OF APPLICATION MON	DAY	YR	COUNTY	LOCATION	TOTAL GALLONS 2,4-D APPLIED	TOTAL ACRES TREATED	CROP TREATED
143	MAR	9	80	KGS	T.23S,R.18E,S.28	128	617	BARLEY
144	MAR	9	80	KGS	T.23S,R.18E,S.29	13	69	BARLEY
145	MAR	9	80	KGS	T.23S,R.18E,S.21	66	353	BARLEY
146	MAR	9	80	KGS	T.23S,R.18E,S.20	40	216	BARLEY
147	MAR	9	80	KGS	T.23S,R.18E,S.18	30	160	BARLEY
148	MAR	9	80	KRN	T.25S,R.18E,S.25	27	217	BARLEY
149	MAR	9	80	SLO	T.29S,R.18E,S.35	54	640	BARLEY
150	MAR	9	80	SLO	T.32S,R.21E,S.33	40	250	BARLEY
151	MAR	10	80	KGS	T.20S,R.20E,S.23	14	75	BARLEY
152	MAR	10	80	KGS	T.20S,R.20E,S.01	19	100	BARLEY
153	MAR	10	80	KGS	T.20S,R.20E,S.14	15	80	BARLEY
154	MAR	10	80	KGS	T.22S,R.19E,S.21	10	80	BARLEY
155	MAR	10	80	KGS	T.22S,R.19E,S.22	20	162	BARLEY
156	MAR	10	80	KGS	T.22S,R.19E,S.27	77	618	BARLEY
157	MAR	10	80	KGS	T.22S,R.19E,S.28	33	260	BARLEY
158	MAR	10	80	KGS	T.22S,R.19E,S.25	75	600	BARLEY
159	MAR	10	80	KGS	T.22S,R.18E,S.36	75	600	BARLEY
160	MAR	10	80	KGS	T.22S,R.21E,S.33	18	193	COTTON
161	MAR	10	80	KGS	T.23S,R.19E,S.01	62	495	BARLEY
162	MAR	10	80	KRN	T.27S,R.22E,S.14	26	138	BARLEY
163	MAR	10	80	KRN	T.27S,R.22E,S.15	34	190	BARLEY
164	MAR	10	80	SLO	T.29S,R.19E,S.04	100	1200	BARLEY
165	MAR	10	80	SLO	T.30S,R.19E,S.10	43	520	BARLEY
166	MAR	11	80	KGS	T.20S,R.19E,S.23	15	80	BARLEY
167	MAR	11	80	KGS	T.20S,R.20E,S.04	46	250	BARLEY
168	MAR	11	80	KGS	T.22S,R.21E,S.24	29	335	COTTON
169	MAR	11	80	KGS	T.23S,R.21E,S.11	4	32	COTTON
170	MAR	11	80	SLO	T.29S,R.17E,S.13	42	500	BARLEY
171	MAR	11	80	SLO	T.30S,R.19E,S.03	100	1200	BARLEY
172	MAR	12	80	KGS	T.20S,R.20E,S.10	11	60	BARLEY
173	MAR	12	80	KGS	T.20S,R.20E,S.02	4	20	BARLEY
174	MAR	12	80	KGS	T.20S,R.20E,S.35	10	55	BARLEY
175	MAR	12	80	KGS	T.20S,R.20E,S.23	11	60	BARLEY
176	MAR	12	80	KGS	T.20S,R.20E,S.02	13	140	BARLEY
177	MAR	12	80	KGS	T.24S,R.21E,S.27	60	320	BARLEY
178	MAR	12	80	KGS	T.21S,R.20E,S.26	40	317	COTTON
179	MAR	12	80	KRN	T.25S,R.20E,S.23	30	300	BARLEY
180	MAR	12	80	KRN	T.25S,R.20E,S.26	28	220	BARLEY
181	MAR	12	80	KRN	T.25S,R.20E,S.36	28	220	BARLEY
182	MAR	12	80	KRN	T.25S,R.20E,S.36	35	280	BARLEY
183	MAR	12	80	KRN	T.25S,R.21E,S.27	30	160	BARLEY
184	MAR	12	80	KRN	T.25S,R.20E,S.35	13	100	BARLEY
185	MAR	12	80	KRN	T.26S,R.22E,S.23	51	270	BARLEY
186	MAR	12	80	KRN	T.27S,R.22E,S.22	15	80	BARLEY
187	MAR	12	80	SLO	T.30S,R.19E,S.18	27	320	BARLEY
188	MAR	13	80	KGS	T.24S,R.17E,S.29	10	55	BARLEY
189	MAR	13	80	KGS	T.24S,R.17E,S.03	9	70	BARLEY
190	MAR	13	80	KGS	T.24S,R.18E,S.02	13	105	WHEAT
191	MAR	13	80	KGS	T.24S,R.18E,S.11	29	60	WHEAT

APPENDIX I. (cont.)

###	DATE OF APPLICATION MON DAY YR	COUNTY	LOCATION	TOTAL GALLONS 2,4-D APPLIED	TOTAL ACRES TREATED	CROP TREATED
192	MAR 13 80	KRN	T.25S,R.21E,S.34	116	620	BARLEY
193	MAR 13 80	KRN	T.25S,R.22E,S.11	10	80	BARLEY
194	MAR 13 80	KRN	T.25S,R.22E,S.12	10	80	BARLEY
195	MAR 13 80	KRN	T.26S,R.21E,S.02	36	195	BARLEY
196	MAR 13 80	KRN	T.26S,R.21E,S.03	116	620	BARLEY
197	MAR 13 80	KRN	T.26S,R.21E,S.10	28	150	BARLEY
198	MAR 13 80	KRN	T.27S,R.23E,S.20	5	20	BARLEY
199	MAR 13 80	KRN	T.27S,R.24E,S.29	20	80	BARLEY
200	MAR 14 80	KGS	T.21S,R.20E,S.22	40	324	COTTON
201	MAR 14 80	KGS	T.21S,R.20E,S.21	75	600	COTTON
202	MAR 14 80	KGS	T.21S,R.20E,S.13	77	618	COTTON
203	MAR 14 80	KGS	T.23S,R.21E,S.11	16	175	COTTON
204	MAR 14 80	KGS	T.23S,R.21E,S.15	80	430	BARLEY
205	MAR 14 80	KGS	T.23S,R.21E,S.13	40	323	BARLEY
206	MAR 14 80	KGS	T.23S,R.21E,S.14	58	310	BARLEY
207	MAR 14 80	KRN	T.26S,R.23E,S.23	9	75	BARLEY
208	MAR 14 80	KRN	T.25S,R.23E,S.02	25	95	WHEAT
209	MAR 14 80	SLO	T.25S,R.15E,S.35	71	380	BARLEY
210	MAR 14 80	SLO	T.29S,R.19E,S.27	66	800	BARLEY
211	MAR 15 80	KGS	T.20S,R.20E,S.04	10	40	BARLEY
212	MAR 15 80	KGS	T.22S,R.21E,S.04	6	32	BARLEY
213	MAR 17 80	KRN	T.25S,R.20E,S.34	39	314	WHEAT
214	MAR 18 80	KRN	T.26S,R.21E,S.11	52	310	BARLEY
215	MAR 22 80	KRN	T.27S,R.22E,S.16	25	50	ALFALFA
216	MAR 22 80	SLO	T.25S,R.16E,S.30	65	350	BARLEY
217	MAR 22 80	SLO	T.27S,R.14E,S.31	7	35	BARLEY
218	MAR 22 80	SLO	T.29S,R.18E,S.23	58	700	BARLEY
219	MAR 22 80	SLO	T.29S,R.19E,S.33	44	530	BARLEY
220	MAR 23 80	SLO	T.25S,R.14E,S.29	226	1219	BARLEY
221	MAR 23 80	SLO	T.25S,R.16E,S.16	**	250	BARLEY
222	MAR 23 80	SLO	T.26S,R.16E,S.06	55	240	BARLEY
223	MAR 25 80	SLO	T.26S,R.18E,S.17	34	405	BARLEY
224	MAR 25 80	SLO	T.29S,R.18E,S.04	100	1200	BARLEY
225	MAR 25 80	SLO	T.25S,R.14E,S.29	226	1219	BARLEY
226	APR 2 80	KRN	T.32S,R.33E,S.28	15	40	GRASS
227	APR 2 80	SLO	T.26S,R.14E,S.23	24	130	BARLEY
228	APR 2 80	SLO	T.26S,R.15E,S.17	5	28	BARLEY
229	APR 2 80	SLO	T.26S,R.15E,S.19	10	50	BARLEY

KGS = KINGS, KRN = KERN, SLO = SAN LUIS OBISPO