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1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	06/00/81	

4. TITLE AND SUBTITLE
AMBIENT AIR QUALITY ASSESSMENT 43-21-0170-81 ROCKY MOUNTAIN ARSENAL, DENVER, COLORADO

5. FUNDING NUMBERS

6. AUTHOR(S)
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MD

8. PERFORMING ORGANIZATION REPORT NUMBER
81293R04

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

94-32321

12a. DISTRIBUTION/AVAILABILITY STATEMENT

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED

13. ABSTRACT *(Maximum 200 words)*
THE AIR QUALITY ASSESSMENT WAS CONDUCTED TO EVALUATE THE HEALTH HAZARD POSED BY LOW LEVEL CONTAMINATION OF FUGITIVE DUSTS FROM RMA. THE CONTAMINANTS STUDIED WERE ARSENIC, MERCURY, CADMIUM, COPPER, LEAD, ALDRIN, DIELDRIN, AND ENDRIN. IT WAS FOUND THAT THE CONCENTRATIONS OF THE VARIOUS CONTAMINANTS MONITORED IN THE FUGITIVE DUST FROM RMA DO NOT APPEAR TO POSE A SIGNIFICANT HAZARD TO MEMBERS OF THE GENERAL POPULATION IN OR AROUND RMA, OR TO INDIVIDUALS OCCUPATIONALLY EXPOSED TO WINDBLOWN DUST EMANATING FROM DISPOSAL BASINS AT RMA.

94

14. SUBJECT TERMS
CONTAMINANTS, TOXICITY, DISPOSAL, ARSENIC, MERCURY, CADMIUM, COPPER, LEAD, ALDRIN, DIELDRIN, ENDRIN, SAMPLING

15. NUMBER OF PAGES

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED			

81293R04
ORIGINAL

DEPARTMENT OF THE ARMY
U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY Mr. Bond/ss/AUTOVON 584-3500
ABERDEEN PROVING GROUND, MARYLAND 21010

REPLY TO
ATTENTION OF
HSE-EA-A

1 JUN 1981

SUBJECT: Ambient Air Quality Assessment No. 43-21-0170-81, Rocky Mountain Arsenal, Denver, Colorado

Commander
US Army Toxic and Hazardous
Materiels Agency
ATTN: DRXTH-IS
Aberdeen Proving Ground, MD 21010

A summary of the pertinent findings of the inclosed report follows:

The Air Quality Assessment was conducted to evaluate the health hazard posed by low level contamination of fugitive dusts from Rocky Mountain Arsenal (RMA). The contaminants studied were arsenic, mercury, cadmium, copper, lead, aldrin, dieldrin, and endrin. It was found that the concentrations of the various contaminants monitored in the fugitive dust from RMA do not appear to pose a significant hazard to members of the general population in or around RMA, or to individuals occupationally exposed to windblown dust emanating from disposal basins at RMA.

FOR THE COMMANDER:

1 Incl
as

ROBERT L. HANSON, P.E.
COL, MSC
Director, Environmental Quality

CF:
HQDA (DASG-PSP)
Cdr, HSC (HSPA-P)
Cdr, DARCOM (DRCSG/DRCIS-A)
Cdr, ARRCOM (DRSAR-SG/DRSAR-ISE)
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DEPARTMENT OF THE ARMY
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ABERDEEN PROVING GROUND, MARYLAND 21010

REPLY TO
ATTENTION OF

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AMBIENT AIR QUALITY ASSESSMENT NO. 43-21-0170-81
ROCKY MOUNTAIN ARSENAL,
DENVER, COLORADO

1. AUTHORITY. AR 200-1, Environmental Protection and Enhancement.

2. REFERENCES. See Appendix A for a listing of references.

3. PURPOSE. To determine if a health hazard is posed by low level contamination of fugitive dusts from Rocky Mountain Arsenal (RMA).

4. GENERAL.

a. Abbreviations. A glossary of abbreviations used in this report is provided in Appendix B.

b. Background. Various personnel stationed at RMA have expressed a concern about possible adverse health effects caused by wind blown dust emanating from disposal basins at the Arsenal. In response to these complaints meetings were held on 3-4 October 1979 to establish a procedure to determine if a health hazard due to fugitive dust existed. Based on USATHAMA identification of contaminants in the disposal basin, the following materials were selected for sample analysis.

(1) Arsenic
(2) Mercury
(3) Cadmium
(4) Copper
(5) Lead
(6) Aldrin
(7) Dieldrin
(8) Endrin
(9) Nemagon

Nemagon was subsequently dropped due to the likelihood of it being stripped off the sample because of its low vapor pressure.

c. Sampling Methodology. Although methodology exists for determining total suspended particulates in ambient air, a standard method for ambient sampling of airborne organochlorine and organophosphate pesticides has not been established. Procedures for analysis were found[1], yet no study was found to specifically address

[1] Lewis, R. G. and Jackson, M. D., Evaluation of Polyurethane Foam for Sampling of Pesticides, Polychlorinated Biphenyls and Polychlorinated Naphthalenes in Ambient Air, Analytical Chemisty, October 1977.

the problem of pesticide contaminated fugitive dust. The standard EPA high volume sampler method was selected for sample collection. This presented a problem with filter selection, namely finding one that was suitable for both metal and pesticide analysis. The normal high volume filter selected for metal analysis because of its low metals background content proved to interfer with analysis done by gas chromatography because of its high organic background content. This noncompatability of filter media required the study to be divided into two phases. Phase one from 11 April - 18 September 1980 included the sampling of arsenic, mercury, cadmium, copper, and lead. Concentrations of these compounds were determined by atomic absorption analysis of the high volume filters at APG. Results were reported as total compound per filter and by dividing the mass by the computed flow through the high volume sampler, final results were reported in micrograms per cubic meter of air. The second phase from 26 September - 3 December 1980 included sampling for aldrin, dieldrin, and endrin. Concentrations of these compounds were determined by gas chromatographic analysis of the high volume filters at APG (Appendix C). Results were reported as total compound per filter and by dividing the mass by the computed flow through the high volume sampler, final results were reported in micrograms per cubic meter of air. Appendix C also contains a limited evaluation of the sampling methodology. Sampling was initiated prior to a complete evaluation of the methodology and results are therefore constrained by the following unknowns:

(1) Recovery of pesticides from weathered samples.

(2) Effects of velocity and large volumes of air drawn through the sampler possibly stripping the pesticide from the dust.

(3) Determination of Sample Integrity (possible loss of pesticide from the dust between collection of the sample and its extraction in the laboratory).

High volume sampler flows were calibrated at RMA using a orifice calibration unit which had been calibrated at APG by a positive displacement meter. A 4 day sampling cycle was selected to correspond with the high volume sampling cycle used by the State of Colorado.

d. Sampling Locations. Figure 1 shows the location of RMA in relation to the metropolitan Denver area. Figure 2 shows the location of the sampling sites on the Arsenal. Station 1 and 5 provide entry and exit levels of contamination of fugitive dust. Stations 2, 3, and 4 provided information on emissions from basin A through F. An additional sampler was located on building 373 when power became available. The prevelant wind direction during a 24 hour period was used as a basis to establish the likely source of dust.

e. Meteorological Support. The Atmospheric Science Laboratory Meteorological Team collected and reduced all meteorological data.

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SUBJECT: Ambient Air Quality Assessment No. 43-21-0170-81, Rocky Mountain Arsenal, Denver, CO

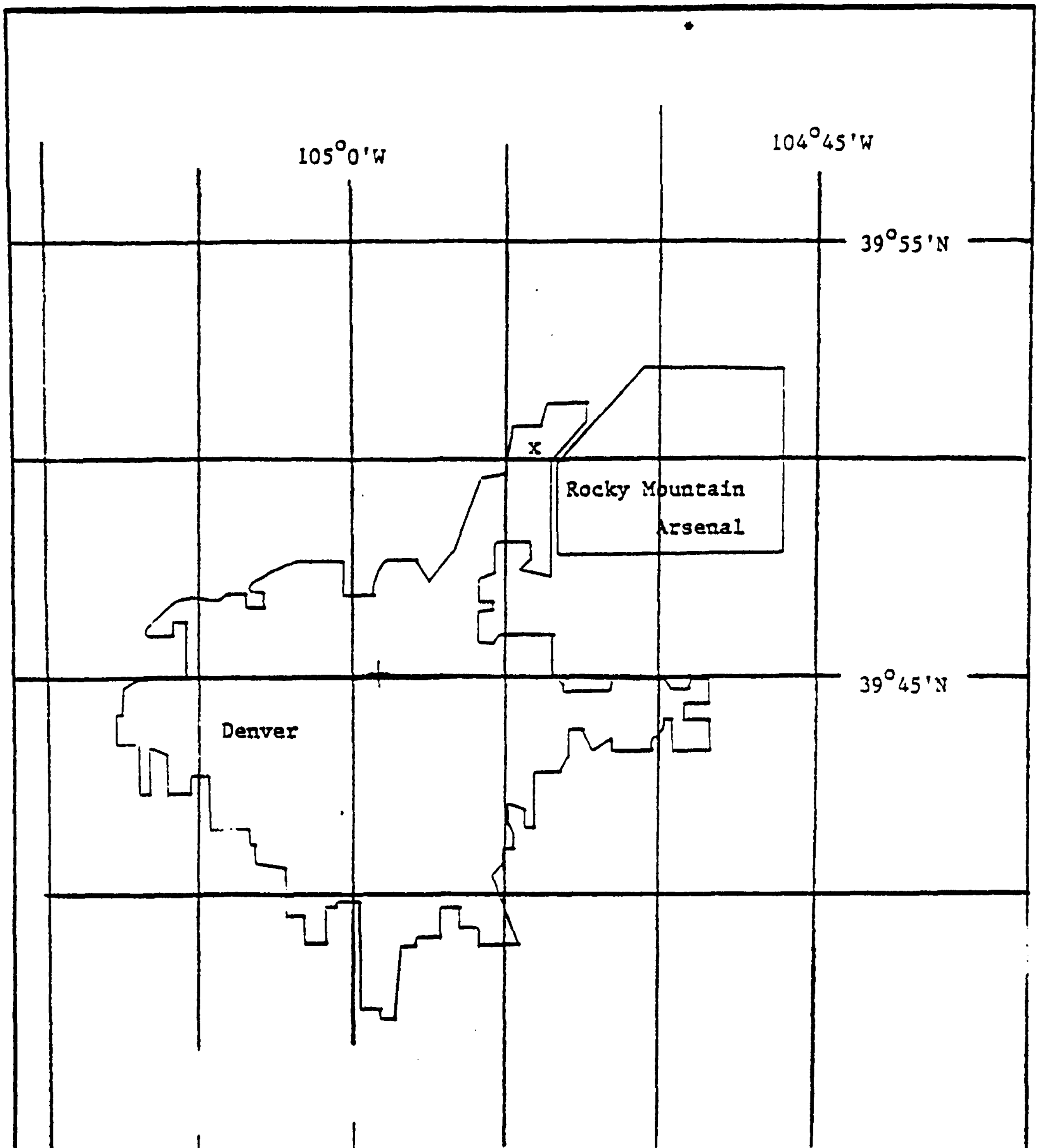

Figure 1 Location of Rocky Mountain Arsenal with respect to Metropolitan Denver

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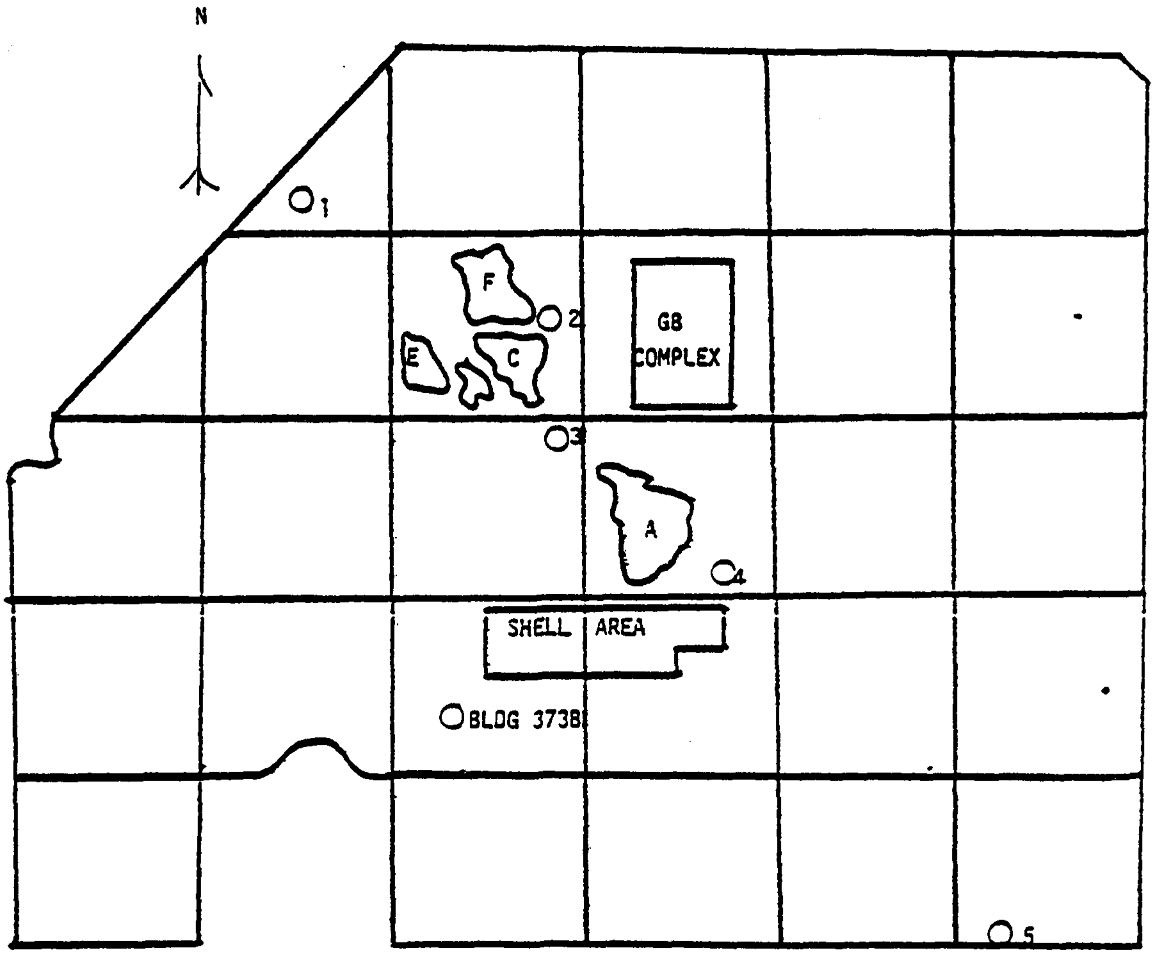

Figure 2. Sampling Sites at Rocky Mountain Arsenal

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f. Ambient Air Concentration Guidelines. Table 1 lists ambient air concentration guidelines used to establish the potential health hazards from low level contamination of fugitive dust at RMA. For the compounds under consideration, lead was the only one to have a national ambient air quality standard. Development of the guidelines for the other compounds were presented in reference 1, Appendix A. The values for aldrin and dieldrin have been modified due to new information published by the EPA concerning these compounds.[2]

TABLE 1: Ambient Air Concentration Guidelines

Compound	Guideline (ug/m^3)
Arsenic	0.008
Mercury	0.87
Cadmium	1.7
Copper	87
Lead	1.5
Aldrin	1.1×10^{-4}
Dieldrin	1×10^{-4}
Endrin	3.0

5. FINDINGS AND DISCUSSION.

a. Treatment of Data.

(1) Several samples at each site were invalidated. Appendix D presents a log of the data collected. Samples were invalidated when:

(a) The sampling time was not within 24 $\pm$ 1 hours.

(b) The sampler malfunctioned.

(c) A filter was torn or had evidence of a flow leak.

(2) Total suspended particulate (TSP) concentrations were recorded to the nearest 1 ug. Table 2 provides the minimum detectable levels (MDL) used in the analysis. The MDL's in ug/m^3, were determined assuming an average total sample air volume of 1500 m^3 and the MDL's of the analytical methods for the compounds measured. For statistical purposes it was assumed that concentrations below the MDL were normally distributed between zero and the MDL. Therefore, each measured value below the MDL was replaced by a value equal to one-half of the minimum detectable limit.

[2] Report, US Environmental Protection Agency (EPA) Research Triangle Park, NC, Ambient Water Quality Criteria for Aldrin/Dieldrin, PB 81-117301 (1980).

TABLE 2: Minimum Detectable Limits (MDL)

Compound	MDL (ug/m^3)
Arsenic	0.008
Mercury	0.00014
Cadmium	0.008
Copper	0.020
Lead	0.160
Aldrin	1.34×10^{-5}
Dieldrin	2×10^{-5}
Endrin	3.4×10^{-5}

b. Meteorological Data. A summary of the meteorological data provided by the Atmospheric Science Laboratory is presented in Appendix E.

c. Pollutant Measurements.

(1) Metals. Table 3 summarizes the metals data for the survey. Figure 3 presents the average concentrations at each sample site. With the exception of Hg, the variability among sites was less than a factor of 10. The average Hg concentrations ranged from a low of 0.0002 ug/m^3 at Stations 3 and 4 to a high of 0.0026 ug/m^3 at building 373. The high average at building 373 was a result of a single value of 0.043 ug/m^3 on 10 June 1981. The prevailing wind direction on 10 June 1981 was from the SSW. The second highest value reported was 0.00071 ug/m^3. Average mercury, cadmium, copper, and lead concentrations were well below the ambient air concentration guidelines shown in Table 1. Three sample days resulted in a detectable amount of arsenic, a suspected carcinogen. Table 4 presents the data for these three days.

TABLE 4: Detectable Arsenic Data Summary

Date	Station No.	As Conc (ug/m^3)	Prevailing WD
27 Apr 80	5	0.007	ESE
9 May 80	5	0.011*	N
		0.018*	N
21 May 80	5	0.008	NE
	Bldg 373	0.012	NE

* Colocated Samples

Average arsenic concentrations at all sites ranged between 0.004 and 0.005 ug/m^3. It should be noted that 90% of the samples contained no detectable arsenic. Therefore, the cancer risk posed by the arsenic contained in the fugitive dust can only be estimated to be somewhere between 0 and approximately 1.7×10^{-5}.

TABLE 3. Metals Data Summary (μg/m³)

Station	Pollutant	No. of Valid Samples	Frequency Distribution (% Less Than) 10	30	50	90	95	Max Obs.	Min Obs.	Arithmetic Mean	Arithmetic Std Dev	Geometric Mean	Geometric Std Dev
#1	As*	28						0.004	0.004	0.004			
	Hg	28		0.00007	0.00027	0.001	0.002	0.011	0.00007	0.0008	0.0021	0.0003	3.2216
	Cd	28			0.004	0.019	0.020	0.036	0.004	0.007	0.007	0.005	1.805
	Cu	28	0.010	0.041	0.053	0.101	0.152	0.164	0.010	0.058	0.037	0.047	2.102
	Pb	28		0.080	0.251	0.461	0.571	0.690	0.080	0.260	0.162	0.210	1.981
#2	As*	29						0.004	0.004	0.004			
	Hg	29		0.00007	0.00025	0.002	0.004	0.005	0.00007	0.0006	0.0011	0.0002	3.6612
	Cd	29			0.004	0.012	0.014	0.017	0.004	0.005	0.004	0.005	1.534
	Cu	29	0.036	0.051	0.056	0.530	0.637	1.241	0.028	0.163	0.264	0.083	2.701
	Pb	29			0.080	0.289	0.290	0.314	0.080	0.148	0.084	0.128	1.712
#3	As*	32						0.004	0.004	0.004			
	Hg	32		0.00007	0.00024	0.00041	0.00044	0.00063	0.00007	0.0002	0.0001	0.0002	1.9387
	Cd	32				0.004	0.010	0.012	0.004	0.005	0.002	0.004	1.331
	Cu	32	0.031	0.036	0.042	0.075	0.077	0.083	0.026	0.046	0.016	0.044	1.372
	Pb	32			0.080	0.251	0.253	0.335	0.080	0.131	0.077	0.114	1.654
#4	As*	38						0.004	0.004	0.004			
	Hg	38		0.00007	0.00015	0.00044	0.001	0.0013	0.00007	0.0002	0.0002	0.0002	2.0610
	Cd	38				0.004	0.010	0.016	0.004	0.005	0.003	0.005	1.419
	Cu	38	0.029	0.036	0.040	0.056	0.064	0.122	0.021	0.040	0.016	0.038	1.345
	Pb	38			0.080	0.246	0.262	0.624	0.080	0.134	0.101	0.114	1.670
#5	As*	29						0.018	0.004	0.005			
	Hg	29	0.00007	0.00015	0.00022	0.00055	0.00071	0.0023	0.00007	0.0003	0.0004	0.0002	2.2158
	Cd	29			0.004	0.007	0.008	0.018	0.004	0.005	0.003	0.005	1.388
	Cu	29	0.019	0.023	0.028	0.049	0.055	0.093	0.010	0.030	0.016	0.027	1.629
	Pb	29			0.080	0.265	0.306	0.357	0.080	0.152	0.081	0.133	1.674
Bldg 373	As*	18						0.012	0.004	0.004			
	Hg	18		0.00007	0.00023	0.00071	0.043	0.043	0.00007	0.0026	0.010	0.0002	4.1676
	Cd	18			0.004	0.012	0.016	0.016	0.004	0.006	0.004	0.005	1.552
	Cu	18	0.035	0.039	0.042	0.064	0.105	0.105	0.030	0.045	0.017	0.043	1.322
	Pb	18		0.080	0.173	0.290	0.337	0.337	0.080	0.169	0.083	0.148	1.682

*No statistics performed since 90% of samples had no detectable arsenic.

GRAPHICAL ILLUSTRATION

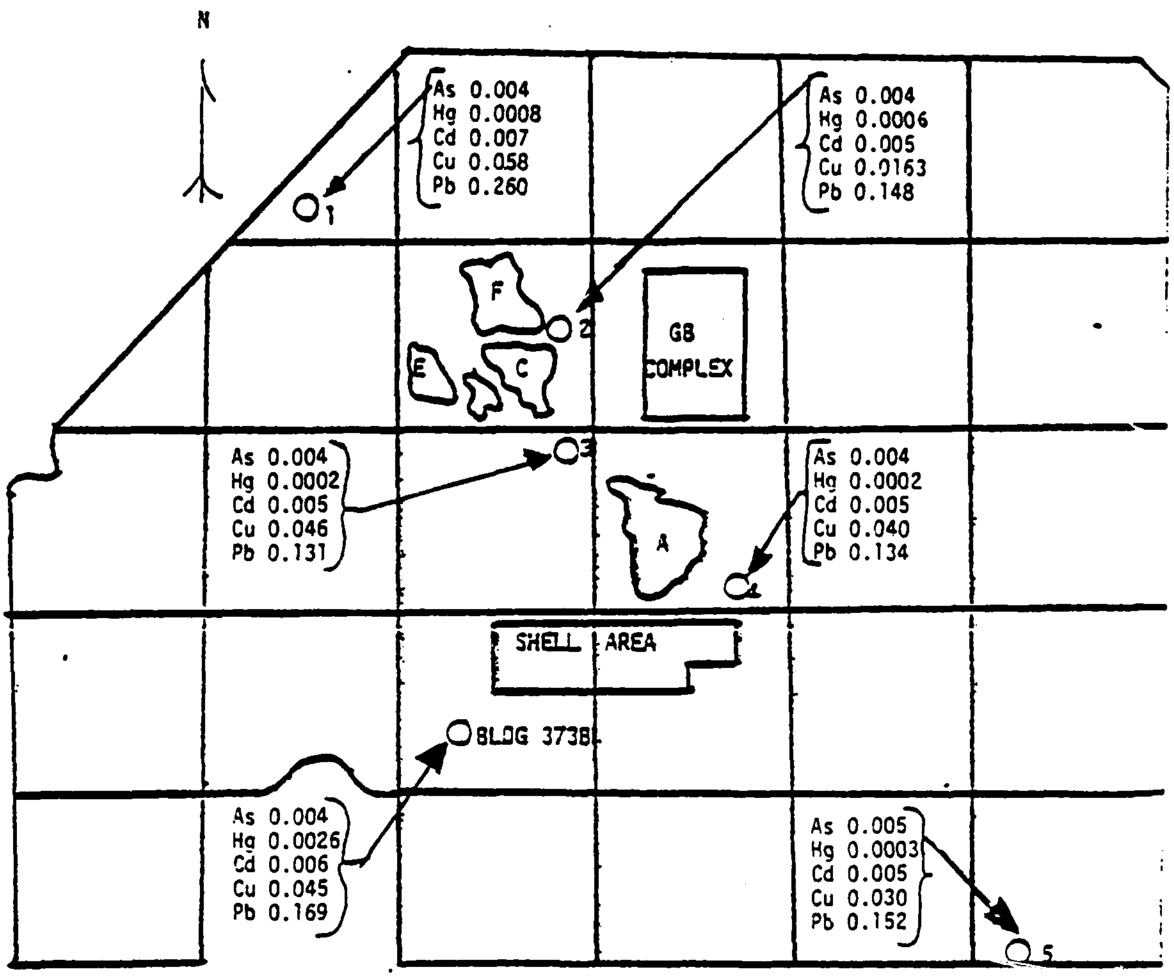

Figure 3. Average Concentrations (μg/m^3)

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(2) Pesticides. Table 5 summarizes the pesticide data for the survey. Figure 4 presents the average concentrations at each sample site. Average concentrations at Station 2, adjacent to the basins, were at least two orders of magnitude greater than any other station while the lowest average concentrations were at the perimeter stations: #1, #5, and Building 373. This indicates that the basins are a definite source of pesticides. The average endrin concentration at each station was below the ambient air quality concentration listed in Table 1. The ambient air quality concentration level of 1.1×10^{-4} ug/m^3 for aldrin, a suspected carcinogen, was exceeded only at Station 2. Thus the estimated cancer risk from aldrin in basin fugitive dust for the populace outside RMA is somewhat less than 1×10^{-6}. The estimated cancer risk from aldrin in basin fugitive dust to personnel inside RMA in the vicinity of the basins is estimated to be no greater than approximately 6.8×10^{-5}. The ambient air quality concentration level of 1×10^{-4} ug/m^3 for dieldrin, a suspected carcinogen, was exceeded at Stations 2 and 3. Thus the estimated cancer risk from dieldrin in basin fugitive dust for the populace outside RMA is also somewhat less than 1×10^{-6}. The estimated cancer risk to personnel inside RMA, in the vicinity of the basins, is estimated to be no greater than approximately 1.5×10^{-4}.

d. Health Significance of Fugitive Dust Contaminant Concentrations. To assess the significance of the concentrations of various contaminants monitored in the fugitive dust at RMA, it is necessary to consider the populations potentially exposed to these contaminants.

(1) Concerning the general population living and/or working outside RMA, it appears that none of the contaminants monitored pose a significant health hazard.

(a) Concentration of contaminants not suspected of carcinogenicity are well below levels that are known to have an adverse impact on health.

(b) As for those contaminants suspected of carcinogenicity, the estimated life-time risks of cancer (based on an extremely conservative model) are fairly small. For aldrin and dieldrin, the risks are below 1×10^{-6} (one additional case of cancer per 1,000,000 individuals exposed), a value which is well within the range of life-time cancer risks (i.e., $1 \times 10^{-5} - 1 \times 10^{-7}$) the EPA is considering as target values in situations where it is infeasible at this time to reduce exposures to zero.[3] In the case of arsenic the risk maybe slightly higher (i.e., 1.7×10^{-5}) than the upper end of this range. However, even this risk is of a magnitude comparable to, or smaller than risks most people accept on a daily basis for ordinary activities. The risk posed to the population inhaling the fugitive dust can be put into perspective by comparing the average loss of life expectancy of populations engaged in

[3] EPA, Federal Register Vol. 44, No. 52, Thursday, 15 March 1979, pg. 15930

TABLE 5. Pesticide Data Summary ($\mu g/m^3$)

Station	Pollutant	No. of Valid Samples	Frequency Distribution (% Less Than) 10	30	50	90	95	Max Obs.	Min Obs.	Arith. Mean
#1	Aldrin	22			6.7×10^{-6}	2.0×10^{-5}	2.3×10^{-5}	4.1×10^{-5}	6.7×10^{-6}	1×10^{-5}
	Dieldrin	22		1×10^{-5}	3×10^{-5}	2.1×10^{-4}	2.9×10^{-4}	3.6×10^{-4}	1×10^{-5}	7×10^{-5}
	Endrin	22			1.7×10^{-5}	3.0×10^{-5}	3.4×10^{-5}	3.7×10^{-5}	1.7×10^{-5}	1.9×10^{-5}
#2	Aldrin	16	5.7×10^{-5}	1.5×10^{-4}	2.9×10^{-4}	9.0×10^{-3}	2.1×10^{-2}	6.8×10^{-2}	5.1×10^{-5}	7.6×10^{-3}
	Dieldrin	16	3.3×10^{-4}	5.3×10^{-4}	1.4×10^{-3}	2.49×10^{-2}	3.2×10^{-2}	1.023×10^{-1}	3.3×10^{-4}	1.46×10^{-2}
	Endrin	16	4.5×10^{-5}	1.2×10^{-4}	5.3×10^{-4}	7.6×10^{-3}	8.4×10^{-3}	2.86×10^{-2}	4.5×10^{-5}	3.96×10^{-2}
#3	Aldrin	22		6.7×10^{-6}	1.1×10^{-5}	2.0×10^{-4}	2.7×10^{-4}	3.3×10^{-4}	6.7×10^{-6}	6.2×10^{-5}
	Dieldrin	22		5.0×10^{-5}	9.0×10^{-5}	6.1×10^{-4}	7.1×10^{-4}	8.2×10^{-4}	1×10^{-5}	2.1×10^{-4}
	Endrin	22			1.7×10^{-5}	1.1×10^{-4}	1.3×10^{-4}	2.3×10^{-4}	1.7×10^{-5}	4.6×10^{-5}
#4	Aldrin	18			6.7×10^{-5}	2.7×10^{-5}	4.9×10^{-5}	6.7×10^{-5}	6.7×10^{-6}	2×10^{-5}
	Dieldrin	18		6×10^{-5}	1×10^{-4}	1.8×10^{-4}	2.2×10^{-4}	2.4×10^{-4}	1.2×10^{-5}	7.1×10^{-5}
	Endrin	18				1.7×10^{-5}	2.8×10^{-5}	5.5×10^{-5}	1.7×10^{-5}	2×10^{-5}
#5	Aldrin	22				6.7×10^{-5}	1.5×10^{-5}	2.1×10^{-5}	6.7×10^{-6}	7.7×10^{-6}
	Dieldrin	22			1.0×10^{-5}	1.5×10^{-5}	2.0×10^{-5}	5.8×10^{-5}	1×10^{-5}	1.5×10^{-5}
	Endrin	22					1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}
Bldg 373	Aldrin	15			5.7×10^{-5}	1.2×10^{-5}	2.3×10^{-5}	4.2×10^{-5}	6.7×10^{-6}	1.07×10^{-5}
	Dieldrin	15			1.0×10^{-5}	3.0×10^{-5}	1.1×10^{-4}	1.1×10^{-4}	1.0×10^{-5}	2×10^{-5}
	Endrin	15				1.7×10^{-5}	3.6×10^{-5}	3.6×10^{-5}	1.7×10^{-5}	1.8×10^{-5}

GRAPHICAL ILLUSTRATION

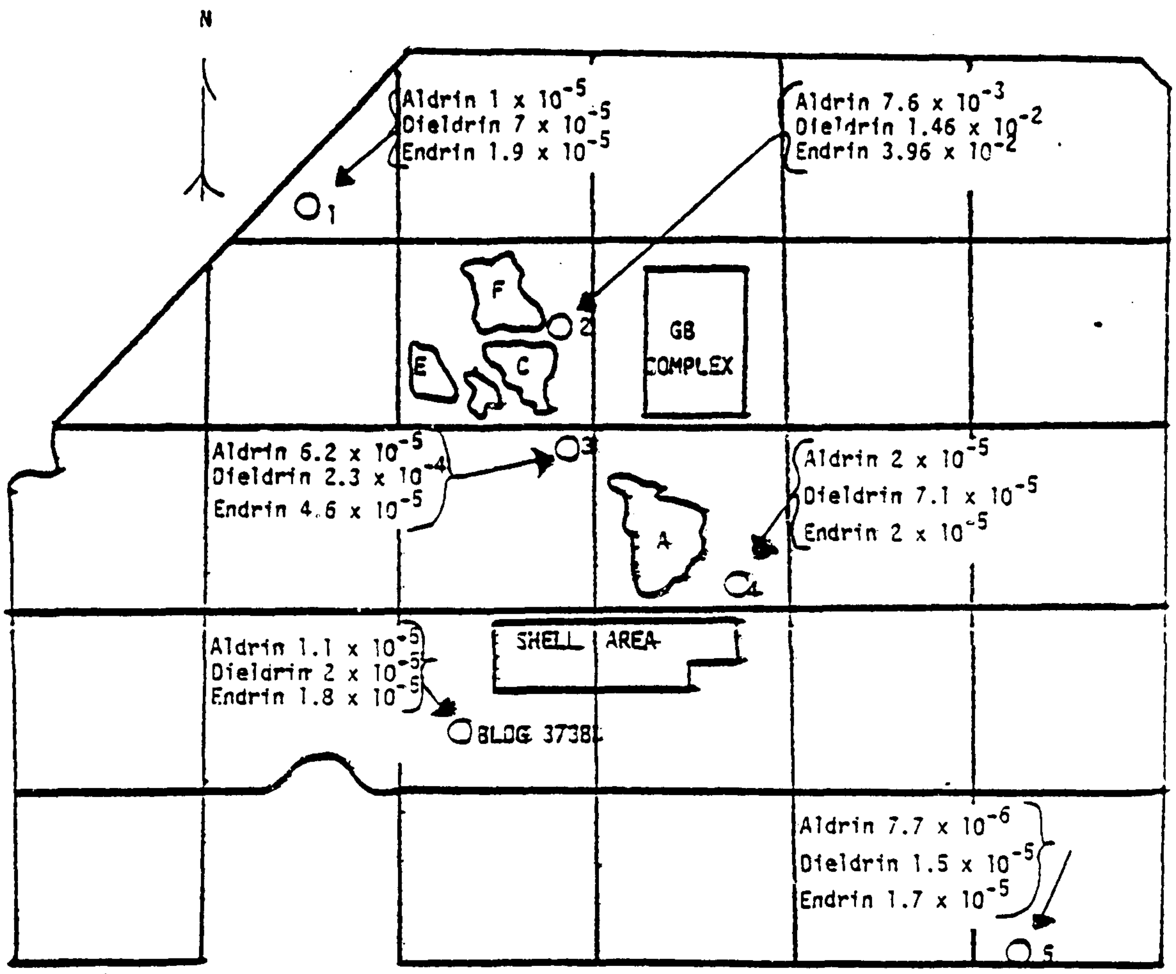

Figure 4. Average Pesticide Concentrations ($\mu g/m^3$)	DATE May 1981
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everyday activities and exposed to hazards these activities involve. It has been estimated that accidents in the home reduce the average life expectancy of the general population by 95 days, falls by 39 days, firearms accidents by 11 days, natural background radiation by 8 days, regular coffee drinking by 6 days, and daily consumption of one 12 ounce bottle of saccharin containing soft drink by 2 days. If it is assumed that all cancers potentially caused by inhaling this dust result in death (an overestimate as all cancers do not result in fatal outcomes) and that a fatal cancer will, on the average, produce 20 years of lost life expectancy in the affected individual, the estimated life-time risk of cancer from inhalation of the fugitive dust (approximately 1.9×10^{-5}, summing the risk for arsenic (1.7×10^{-5}), the risk for aldrin (taken as 1×10^{-6} for the purpose of this calculation, though it is somewhat lower), and the risk for dieldrin (taken as 1×10^{-6} for the purpose of this calculation, though it is somewhat lower)) corresponds to an estimated average loss of life expectancy in the general population of 3 1/3 hours.[4,5] It should be further noted that the risk may in fact be considerably lower (due to the large number of samples in which no arsenic was detected), that an individual would have to be exposed for a lifetime to realize this risk (which may be unrealistic given shifting winds and the mobile nature of our society), and that some authorities consider that this model of carcenogenisis may overestimate risk by one to several orders of magnitude.[6,7] These points considered, the risk posed by inhalation of this dust would appear to be of low order and less consequence than other risks encountered daily, and accepted by most people, in everyday life. Finally, it should be noted that the EPA has estimated that the mean annual average concentration of arsenic for 267 locations in the United States in 1974 was 3 ng/m^3.[8] The average arsenic levels observed in this study are reported as 4-5 ng/m^3, but could actually be lower due to the large number of samples reported as non detectable. It would thus appear that the levels observed in this study are about the same as/(or possibly lower than) average concentrations found in the United States. Therefore, the population around RMA would not appear to be at any greater risk than a large segment of the general United States population.

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7 Ramsey, J. C., et al, Carcinogenic Risk Assessment: Ethylene Dibromide, Tox. and Appl. Pharm. 47: 411-414, 1979.

8 Suta, B. E., Human Exposures to Atmospheric Arsenic, SRI Project E60-5794, Cress Report No. 50., EPA, 1978.

(2) Concerning individuals living and/or working at RMA, but not exposed to the dust as a result of operations conducted in the immediate vicinity of the basins it also appears that none of the contaminants monitored pose a significant health hazard. Concentrations of those contaminants not suspected of carcinogenicity were well below levels that are known to have an adverse impact on health when monitored at all sampling sites. As for the contaminants suspected of carcinogenicity, the estimated lifetime risk of cancer posed by inhalation of dust at sampling sites other than sites 2 and 3 (i.e., in close proximity to the basins) is essentially the same as the risk discussed above. When it is further considered that these individuals are even less likely than the general polulation around RMA to have lifetime exposure to the dusts,it appears that the risk to those individuals is also low order and of less consequence than risks encountered daily, and accepted by most people, in everyday life.

(3) Concerning individuals occupationally exposed to the dust as a result of operations conducted in the immediate vicinity of the basins, levels of contaminants monitored are well below occupational exposure guidelines for all of those substances. It should be noted that the current Federal Standard for arsenic takes its potential carcinogenicity into account and is a time weighted average of 10 ug/m^3.[9] Average arsenic concentrations at sites 2 and 3 were 4 orders of magnitude lower than this. As for aldrin and dieldrin, the current Federal Standards are time weighted averages of 250 ug/m^3.[10] It can be seen that average levels of aldrin and dieldrin measured at sites 2 and 3 are 5-6 orders of magnitude lower than the Federal Standards. Furthermore, at site 2 the estimated lifetime risk of cancer would be no greater than approximately 2.4×10^{-4} (summing the risks for arsenic, dieldrin and aldrin) and is probably considerably less due to the large number of samples in which no arsenic was detected and the fact that workers are not likely to spend a lifetime or even a large portion of their lifetimes in the near vicinity of the basins.[11] This corresponds to an average loss of life expectancy of approximately 1 3/4 days.[11] In terms of risks posed by known occupational carcinogens, the risk appears to be acceptably low. The International Commission on Radiological Protection (ICRP) has estimated that workers exposed to the well known occupational carcinogen, ionizing radiation, at 5 REM/yr (the federal occupational exposure limit) have a risk of cancer of 5×10^{-4}.[12] Thi is twice

[9] OSHA, Title 29, Code of Federal Regulations Part 1910.1018.

[10] OSHA, Title 29, Code of Federal Regulations Part 1910.1000.

[11] Op. Cit., (4), (5).

[12] ICRP No. 26, Recommendations of the International Commission on Radiological Protections, Pergomon Press, New York, p. 12, 1977.

the risk estimated in this situation using exagerated exposure conditions in terms of duration (probably less than a lifetime) and concentrations (considering the large number of samples in which no contaminant was detected), and a model believed by several authors to overestimate the actual risk in the industrial setting by one to several orders of magnitude.[13] It therefore appears that occupational exposure to the fugitive dust does not pose a significant health hazard when compared to occupational exposure guidelines or risk estimates for this setting.

6. CONCLUSION. The concentrations of the various contaminants monitored in fugitive dust from RMA do not appear to pose a significant hazard to members of the general population in or around RMA or to individuals occupationally exposed to windblown dust emanating from disposal basins at RMA.

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13 Op. Cit., (6), (7).

HSE-EA-A
SUBJECT: Ambient Air Quality Assessment No. 43-21-0170-81, Rocky Mountain Arsenal, Denver, Colorado

APPENDIX A

REFERENCES

1. Letter, HSE-EA-A, this Agency, 2 November 1979, subject: Proposed Particulate Ambient Air Monitoring Program at Rocky Mountain Arsenal.

2. Report, HSE-EA-A, this Agency, Air Pollution Engineering Study, Analysis of Impact of GB Demilitarization Operations on Ambient Air Quality Rocky Mountain Arsenal, December 1973 - October 1976.

3. Letter, SARRM-TOE-C, Rocky Mountain Arsenal, 12 October 1979, subject: Identification of Airborne Pollutants from Waste Basins on RMA, w/1st Ind., DRXTH-IS, US Army Toxic and Hazardous Materiels Agency, 8 November 1979.

4. Letter, SARRM-TOE-C, Rocky Mountain Arsenal, 3 January 1980, subject: Monitoring of Fugitive Dust at RMA.

5. Letter, HSE-EA-A, this Agency, 12 September 1980, subject: Status of Particulate Ambient Air Monitoring Program at Rocky Mountian Arsenal.

6. MFR, SARRM-TOE-C, Rocky Mountain Arsenal, 30 August 1978, subject: Basin A Dust Sample.

7. MFR, SARRM-TOE-C, Rocky Mountain Arsenal, 18 December 1979, subject: Wind Blown Transport Study.

APPENDIX B

GLOSSARY

AAC	Ambient Air Concentration
AS	Arsenic
^oC	Degrees Centigrade
Cd	Cadmium
Cu	Copper
Cm	Centimeter
^oF	Degree Fahrenheit
gm	Gram
Hg	Mercury
Km	Kilometer
m	Meter (m^3 denotes cubic meter)
mm	Millimeter
MDL	Minimum Detectable Level
mg	Milligram
mph	Miles Per Hour
OSHA	Occupational Safety and Health Administration
Pb	Lead
ppm	Parts Per Million
RMA	Rocky Mountain Arsenal
sec	Second
TSP	Total Suspended Particulate Matter
ug	Microgram
ug/m^3	Microgram Per Cubic Meter
USAEHA	US Army Environmental Hygiene Agency
USATHAMA	US Army Toxic and Hazardous Materiels Agency
EPA	US Environmental Protection Agency

APPENDIX C

PESTICIDE SAMPLING METHODOLOGY

I. METHODOLOGY

A. EXTRACTION AND CLEAN-UP

Filters used in this study were determined to be contaminant free prior to sampling. Each sample filter was folded up and extracted in a one quart mason jar with 400 ml of 5% ethyl ether in hexane. The extraction was carried out for 2 hours on a mechanical shaker and extracts were let stand overnight (the shaker had been adjusted to provide slightly more than a gentle sloshing motion). Each extract was decanted into a Kaderna-Danish apparatus and the filter in the jar rinsed with 50 ml hexane. The rinse was added to the sample extract and the extracts were then concentrated on a hot water bath (100 C) to 10 ml. The extracts were transferred to 15 ml culture tubes with Teflon® lined caps and taken to GLC. No clean-up was performed on these samples.

B. Analysis

Results of the analysis of samples in this study may be found in Table 1. Analysis of the samples was performed by gas-liquid chromatography using a Tracor MT-220 equipped with glass lines injection ports and a Ni^{63} electron capture detector in the pulse mode. Instrument parameters were as follows:

detector temperature:	315°C
injector temperature:	220°C
column temperature:	195°C
electrometer sensitivity:	0.8 X 10 amps full scale (input - 10^2; output-8)
carrier gas flow:	60 ml/min 5% Methane in Argon

GLC column used: 6 ft U shaped, 1/4" O.D., 4 mm I.D., packed with 1.5% SP-2250 + 1.95% SP-2401 on 100/120 Supelcoport

Confirmation of residues in selected samples was performed by alternate column GLC on a Tracor MT-560 equipped with a Ni^{63} linear electron capture detector. Instrument parameters were as follows:

detector temperature:	325°C
injector temperature:	225°C
column temperature:	180°C
detector saturation current:	8×10^{-9}A
recorder attenuation:	- 2
carrier gas flow:	55 ml/min 5% Methane in Argon

GLC column used: 6 ft coiled, 1/4" O.D. 4 mm I.D. packed with 5% OV 210 on 80/100 Gas Chrom Q.

® Teflon is a registered trademark of E. I. DuPont de Nemours and Co., Inc., Wilmington, DE.

C. Sample Spiking Procedure.

Before actual air sampling began at Rocky Mountain Arsenal representative soil was obtained from the Installation. This soil was determined to be free of the pesticides of interest by GLC prior to its use in any recovery study. The soil was ground up using a mortar and pestle, sifted through a 40 mesh sieve, and mixed thoroughly. Two 10 gram aliquots of this soil were weighed into separate 4 oz. bottles and then spiked with known concentrations of pesticide standards in 10 ml acetone. The spiked soil was let equilibrate for 1 hour and then the acetone was evaporated under Nitrogen (The soil was stirred periodically to enhance even distribution of the pesticides onto the soil particles). After the soil was dry it was then frozen for 24 hours. The concentration of pesticides spiked were: aldrin - 1.25 and 12.5 ug/g, dieldrin - 2.5 and 25 ug/g, and endrin - 5.0 and 50 ug/g.

Six aliquots of soil ranging from 96.7 to 103 milligrams in weight were taken from each spiking level, placed on air filters, and carried through the extraction procedure described earlier. The weight of the spiked soil used here was based on an average figure of 100 milligrams of dust that we estimated would be collected on a filter during a 24 hour sampling period.

D. Summary of Results of The Recovery Study.

As can be seen from the table the average recovery was fair to good ranging from 81.7% for aldrin to 91.3% for dieldrin, however, the variability was high especially for aldrin. The recovery of pesticides in one replicate was extremely poor, was regarded as an outlier, and the data not used. The high variability may be attributable to the nature and size of the soil particles as well as the small size of the aliquots used for the recovery determination.

TABLE 2. **SUMMARY OF RECOVERY DATA FOR ALDRIN, DIELDRIN, AND ENDRIN**

PROJECT NO. 43-21-0170-80

COMPOUND	Spiking Range (ug/g)	Number Experiments	$\bar{X}$	S	S $\bar{X}$	CV
Aldrin	1.25-12.5	11	81.7	15.82	4.77	19.36
Dieldrin	2.5 - 25	11	91.3	10.21	3.08	11.18
Endrin	5.0 - 50	11	88.4	9.25	2.79	10.46

APPENDIX D

TESTING RESULTS

Total Suspended Particulate (μg/m³)

Date		Station 1	Station 2	Station 3	Station 4	Station 5	Bldg 373
Apr	11	6	25	9	9	10	
	15	77	26	49	57	53	
	19	88	94	79	58	56	
	22(A)*	64	156	110	90	75	
	(B)*	-	205	115	117	82	
	27	35	41	43	24	38	
May	5	101	34	31	36	15	
	9(A)	-	47	-	21	29	
	(B)	-	55	29	33	18	
	13	-	48	23	10	3	
	17	-	25	-	22	6	
	21	129	194	135	145	232	255
	23(A)	49	66	70	176	-	205
	(B)	-	103	83	143	-	-
	29	64	102	41	86	64	165
	30	64	58	-	64	116	48
Jun	6	160	271	-	94	159	95
	10(A)	88	72	78	64	106	66
	(B)	-	70	73	68	100	-
	14	110	83	90	81	225	76
Jul	18	67	-	65	64	49	53
	23	-	204	106	315	131	172
	28(A)	-	-	105	74	-	61
	(B)	-	-	-	72	-	-
	31	66	-	-	72	-	-
Aug	4	108	-	121	143	-	98
	8	102	-	-	89	-	73
	12(A)	121	-	106	73	-	81
	(B)	231	-	88	63	-	-
	15	34	-	42	59	-	31
	20	-	164	71	-	-	-
	24	88	-	68	44	53	-
	28(A)	91	47	52	158	46	58
	(B)	138	54	51	41	103	-
Sep	2	47	53	67	48	58	51
	6	64	57	65	67	58	54
	10	63	49	44	66	35	-
	14(A)	48	28	55	56	48	-
	(B)	88	56	46	51	50	-
	18	55	-	52	53	143	55
	26	256	197	86	156	162	340
	30(A)	217	301	263	322	306	423
	(B)	330	11	7	-	384	-
Oct	4	313	-	698	108	82	276
	8	397	-	467	151	95	105
	12	205	-	607	169	29	116
	16(A)	146	239	521	259	36	184
	(B)	107	-	93	-	-	-
	20	325	301	133	473	507	456
	24	259	112	414	418	174	219
	28	430	156	-	194	282	485
Nov	1(A)	250	209	392	110	374	279
	(B)	276	412	-	79	40	-
	5	-	204	-	-	-	-
	9	272	226	526	43	310	-
	13	409	389	159	-	-	-
	17(A)	549	7	488	-	-	337
	(B)	198	-	359	-	-	-
	21	-	252	455	549	137	315
	25	310	235	24	-	303	-
	29	493	161	136	-	373	18
Dec	3(A)	84	-	60	-	65	155
	(B)	686	-	604	-	111	-

*(A) - Primary Sampler, (B) - Colocated Sampler

Arsenic Concentrations ($\mu g/m^3$)*

.e		Station 1	Station 2	Station 3	Station 4	Station 5	Bldg 373
pr	11	0.004	0.004	0.004	0.004	0.004	
	15	0.004	0.004	0.004	0.004	0.004	
	19	0.004	0.004	0.004	0.004	0.004	
	22(A)**	0.004	0.004	0.004	0.004	0.004	
	(B)**	0.004	0.004	0.004	0.004	0.004	
	27	0.004	0.004	0.004	0.004	0.007	
ay	5	0.004	0.004	0.004	0.004	0.004	
	9(A)	-	0.004	-	0.004	0.011	
	(B)	-	0.004	0.004	0.004	0.018	
	13	-	0.004	0.004	0.004	0.004	
	17	-	0.004	-	0.004	0.004	
	21	0.004	0.004	0.004	0.004	0.008	0.012
	23(A)	0.004	0.004	0.004	0.004	-	0.004
	(B)	-	0.004	0.004	0.004	-	-
	29	0.004	0.004	0.004	0.004	0.004	0.004
	30	-	0.004	-	0.004	0.004	0.004
un	6	0.004	0.004	-	0.004	0.004	0.004
	10(A)	0.004	0.004	0.004	0.004	0.004	0.004
	(B)	-	0.004	0.004	0.004	0.004	-
	14	0.004	0.004	-	-	0.004	0.004
	18	0.004	-	0.004	0.004	0.004	0.004
	23	-	0.004	0.004	0.004	0.004	0.004
	28(A)	-	0.004	0.004	0.004	-	0.004
	(B)	-	-	-	0.004	-	-
	31	0.004	-	-	0.004	-	-
ug	4	0.004	-	0.004	0.004	-	0.004
	8	0.004	-	-	0.004	-	0.004
	12(A)	0.004	-	0.004	0.004	-	0.004
	(B)	0.004	-	0.004	0.004	-	-
	15	0.004	-	0.004	0.004	-	0.004
	20	-	0.004	0.004	-	-	-
	24	0.004	-	0.004	0.004	0.004	-
	28(A)	0.004	0.004	0.004	0.004	0.004	0.004
	(B)	-	0.004	0.004	0.004	0.004	-
p	2	0.004	0.004	0.004	0.004	0.004	0.004
	6	0.004	0.004	0.004	0.004	0.004	0.004
	10	0.004	0.004	0.004	0.004	0.004	-
	14(A)	0.004	0.004	0.004	0.004	0.004	-
	(B)	0.004	0.004	0.004	0.004	0.004	-
	18	0.004	-	0.004	0.004	0.004	0.004

* 1/2 MDL = 0.004 $\mu g/m^3$

** (A) - Primary Sampler, (B) - Colocated Sampler

Mercury Concentrations ($\mu g/m^3$)*

.e		Station 1	Station 2	Station 3	Station 4	Station 5	Bldg 373
›r	11	0.00033	0.00007	0.00033	0.00023	0.00043	
	15	0.00044	0.00007	0.00042	0.0013	0.00022	
	19	0.00227	0.00030	0.00044	0.00007	0.00071	
	22(A)**	0.00007	0.00007	0.00007	0.00007	0.00007	
	(B)**	-	0.00144	0.00017	0.00007	0.00007	
	27	0.00007	0.00007	0.00007	0.00007	0.00007	
ıy	5	0.00007	0.00007	0.00024	0.00007	0.00023	
	9(A)	-	0.00007	-	0.00044	0.00055	
	(B)	-	0.00038	0.00007	0.00007	0.00007	
	13	-	0.00007	0.00041	0.00030	0.00007	
	17	-	0.00007	-	0.00007	0.00007	
	21	0.00007	0.00007	0.00007	0.00007	0.00028	0.00007
	23(A)	0.00007	0.00007	0.00007	0.00007	-	-
	(B)	-	0.00042	0.00007	0.00007	-	0.00007
	29	0.00026	0.00007	0.00007	0.00022	0.00022	0.00007
	30	-	0.00007	-	0.00007	0.00029	0.00007
ın	6	0.00055	0.00074	-	0.00060	0.00042	0.00071
	10(A)	0.011	0.00170	0.00027	0.00045	0.00021	0.0425
	(B)	-	0.00370	0.00063	0.00044	0.00043	-
	14	0.00036	0.00025	-	-	0.00022	0.00023
.	18	0.00027	-	0.00019	0.00015	0.00016	0.00024
	23	-	0.00025	0.00019	0.00035	0.00015	0.00041
	28(A)	-	-	0.00030	0.00016	-	0.00025
	(B)	-	-	-	0.00032	-	-
	31	0.00041	-	-	0.00030	-	-
ıg	4	0.00007	-	0.00029	0.00031	-	0.00033
	8	0.00027	0.00007	-	0.00023	-	0.00032
	12(A)	0.00017	-	0.00020	0.00015	-	-
	(B)	0.00038	-	0.00028	0.00015	-	0.00032
	15	0.00025	-	0.00029	0.00015	-	0.00007
	20	-	0.00007	0.00029	-	-	-
	24	0.00027	-	0.00007	0.00015	0.00015	-
	28(A)	0.00028	0.00035	0.00028	0.00015	0.00037	-
	(B)	0.00025	0.00016	0.00028	0.00030	0.00042	0.00023
p	2	0.00035	0.00017	0.00030	0.00022	0.00022	0.00016
	6	0.00018	0.00017	0.00019	0.00016	0.00022	0.00016
	10	0.00007	0.00025	0.00028	0.00015	0.00029	-
	14(A)	0.00141	0.00488	0.00020	0.00015	0.00022	-
	(B)	0.00078	0.00152	0.00036	0.00015	0.00020	-
	18	0.00007	-	0.00018	0.00015	0.00015	0.00016

* 1/2 MDL = 0.00007 $\mu g/m^3$

** (A) - Primary Sampler, (B) - Colocated Sampler

Cadmium Concentrations ($\mu g/m^3$)*

Date		Station 1	Station 2	Station 3	Station 4	Station 5	Bldg 373
Apr	11	0.004	0.004	0.004	0.004	0.004	
	15	0.004	0.004	0.004	0.004	0.004	
	19	0.004	0.004	0.004	0.004	0.004	
	22(A)	0.004	0.004	0.004	0.004	0.004	
	(B)	-	0.004	0.004	0.004	0.004	
	27	0.010	0.012	0.010	0.010	0.007	
May	5	0.004	0.011	0.004	0.004	0.018	
	9(A)	-	0.004	-	0.004	0.004	
	(B)	-	0.004	0.004	0.004	0.004	
	13	-	0.004	0.004	0.004	0.006	
	17	-	0.004	-	0.004	0.004	
	21	0.004	0.004	0.004	0.004	0.006	0.004
	23(A)	0.004	0.004	0.004	0.004	-	0.004
	(B)	-	0.004	0.004	0.004	-	-
	29	0.019	0.017	0.012	0.010	0.004	0.012
	30	-	0.004	-	0.004	0.004	0.004
Jun	6	0.036	0.008	-	0.004	0.008	0.004
	10(A)	0.004	0.004	0.004	0.004	0.004	0.004
	(B)	-	0.004	0.004	0.004	0.004	-
	14	0.004	0.004	-	-	0.004	0.004
Jul	18	0.004	-	0.004	0.004	0.004	0.004
	23	-	0.004	0.004	0.004	0.004	0.004
	28(A)	-	-	0.004	0.004	-	0.004
	(B)	-	-	-	0.004	-	-
	31	0.004	-	-	0.004	-	-
Aug	4	0.009	-	0.004	0.004	-	0.004
	8	0.004	-	-	0.004	-	0.004
	12(A)	0.004	-	0.004	0.016	-	0.016
	(B)	0.004	-	0.004	0.014	-	-
	15	0.004	-	0.004	0.004	-	0.004
	20	-	0.004	0.004	-	-	-
	24	0.004	-	0.010	0.004	0.007	-
	28(A)	0.020	0.004	0.004	0.004	0.004	0.004
	(B)	0.004	0.004	0.004	0.004	0.004	-
Sep	2	0.004	0.004	0.004	0.004	0.004	0.004
	6	0.009	0.004	0.004	0.004	0.004	0.011
	10	0.004	0.004	0.004	0.004	0.004	-
	14(A)	0.004	0.004	0.004	0.004	0.004	-
	(B)	0.004	0.004	0.004	0.004	0.004	-
	18	0.004	0.0139	0.004	0.004	0.004	0.004

* 1/2 MDL = 0.004 $\mu g/m^3$

** (A) - Primary Sampler, (B) - Colocated Sampler

Copper Concentrations ($\mu g/m^3$)*

Date		Station 1	Station 2	Station 3	Station 4	Station 5	Bldg 373
Apr	11	0.010	0.060	0.044	0.034	0.038	
	15	0.034	0.051	0.075	0.039	0.028	
	19	0.041	0.069	0.056	0.032	0.029	
	22(A)**	0.010	0.053	0.083	0.021	0.041	
	(B)**	-	0.065	0.077	0.038	0.010	
	27	0.010	0.036	0.032	0.029	0.025	
May	5	0.010	0.056	0.066	0.041	0.030	
	9(A)	-	0.066	-	0.044	0.037	
	(B)	-	0.413	0.059	0.044	0.045	
	13	-	0.028	0.026	0.032	0.049	
	17	-	0.054	-	0.056	0.030	
	21	0.083	0.047	0.026	0.036	0.093	0.041
	23(A)	0.074	0.046	0.031	0.036	-	0.045
	(B)	-	0.295	0.037	0.029	-	-
	29	0.051	0.062	0.064	0.045	0.033	0.105
	30	-	0.061	-	0.042	0.019	0.036
Jun	6	0.036	1.241	-	0.041	0.022	0.054
	10(A)	0.087	0.065	0.041	0.045	0.036	0.064
	(B)	-	0.530	0.044	0.030	0.055	-
	14	0.069	0.051	-	-	0.026	0.048
Jul	18	0.033	-	0.026	0.023	0.010	0.030
	23	-	0.087	0.052	0.047	0.028	0.042
	28(A)	-	-	0.040	0.042	-	0.039
	(B)	-	-	-	0.036	-	-
	31	0.069	-	-	0.043	-	-
Aug	4	0.052	-	0.067	0.064	-	0.040
	8	0.038	-	-	0.040	-	0.038
	12(A)	0.041	-	0.040	0.027	-	0.033
	(B)	0.164	-	0.053	0.025	-	-
	15	0.046	-	0.042	0.034	-	0.033
	20	-	0.049	0.033	-	-	-
	24	0.032	-	0.035	0.031	0.010	-
	28(A)	0.057	0.410	0.052	0.122	0.023	0.042
	(B)	0.152	0.053	0.042	0.037	0.038	-
Sep	2	0.053	0.033	0.038	0.040	0.019	0.042
	6	0.050	0.036	0.036	0.045	0.024	0.045
	10	0.061	0.044	0.042	0.047	0.021	-
	14(A)	0.059	0.041	0.038	0.042	0.023	-
	(B)	0.093	0.637	0.035	0.039	0.020	-
	18	0.055	-	0.032	0.031	0.019	0.035

* 1/2 MDL = 0.010 $\mu g/m^3$

** (A) - Primary Sampler, (B) - Colocation Sampler

Lead Concentrations (µg/m³)*

Date		Station 1	Station 2	Station 3	Station 4	Station 5	Bldg 373
Apr	11	0.080	0.080	0.080	0.080	0.080	
	15	0.080	0.080	0.080	0.080	0.080	
	19	0.239	0.202	0.080	0.080	0.080	
	22(A)	0.080	0.080	0.080	0.080	0.080	
	(B)	-	0.080	0.080	0.080	0.080	
	27	0.080	0.080	0.080	0.080	0.080	
May	5	0.080	0.080	0.171	0.080	0.174	
	9(A)	-	0.289	-	0.214	0.234	
	(B)	-	0.287	0.181	0.214	0.207	
	13	-	0.080	0.080	0.080	0.080	
	17	-	0.080	-	0.080	0.080	
	21	0.181	0.080	0.080	0.080	0.306	0.169
	23(A)	0.080	0.080	0.080	0.080	-	0.080
	(B)	-	0.080	0.080	0.080	-	-
	29	0.223	0.080	0.080	0.157	0.188	0.193
	30	-	0.080	-	0.080	0.080	0.080
Jun	6	0.571	0.314	-	0.246	0.162	0.290
	10(A)	0.080	0.080	0.080	0.080	0.080	0.080
	(B)	-	0.080	0.080	0.080	0.080	-
	14	0.305	0.194	-	-	0.146	0.171
Jul	18	0.080	-	0.080	0.080	0.080	0.080
	23	-	0.242	0.080	0.198	0.265	0.237
	28(A)	-	-	0.080	0.080	-	0.225
	(B)	-	-	-	0.161	-	-
	31	0.407	-	-	0.080	-	-
Aug	4	0.274	-	0.244	0.192	-	0.237
	8	0.195	-	-	0.080	-	0.080
	12(A)	0.206	-	0.080	0.080	-	0.080
	(B)	0.435	-	0.080	0.080	-	-
	15	0.253	-	0.080	0.080	-	0.080
	20	-	0.211	0.253	-	-	-
	24	0.350	-	0.241	0.196	0.243	-
	28(A)	0.461	0.247	0.251	0.262	0.212	0.241
	(B)	0.690	0.209	0.249	0.624	0.222	-
Sep	2	0.371	0.290	0.335	0.246	0.357	0.337
	6	0.251	0.192	0.193	0.157	0.205	0.201
	10	0.312	0.189	0.217	0.169	0.080	-
	14(A)	0.258	0.080	0.080	0.080	0.177	-
	(B)	0.429	0.152	0.080	0.080	0.080	-
	18	0.223	-	0.185	0.148	0.177	0.173

* 1/2 MDL = 0.080 µg/m³

** (A) - Primary Sampler, (B) - Colocated Sampler

Aldrin Concentrations (μg/m³)*

Date		Station 1	Station 2	Station 3	Station 4	Station 5	Bldg 373
Sep	26	6.7×10^{-6}	1.59×10^{-4}	6.7×10^{-6}	1.65×10^{-5}	6.7×10^{-6}	6.7×10^{-6}
	30(A)**	6.7×10^{-6}	7.8×10^{-5}	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}
	(B)**	6.7×10^{-6}	5.14×10^{-5}	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}	-
Oct	4	6.7×10^{-6}	-	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}
	8	6.7×10^{-6}	-	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}
	12	6.7×10^{-6}	-	3.31×10^{-4}	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}
	16(A)	6.7×10^{-6}	1.51×10^{-5}	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}
	(B)	6.7×10^{-6}	-	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}	-
	20	6.7×10^{-6}	0.021	2.02×10^{-4}	1.69×10^{-5}	6.7×10^{-6}	1.16×10^{-5}
	24	1.96×10^{-5}	0.068	3.53×10^{-5}	2.42×10^{-5}	6.7×10^{-6}	6.7×10^{-6}
	28	6.7×10^{-6}	4.86×10^{-4}	-	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}
Nov	1(A)	6.7×10^{-6}	0.008	3.65×10^{-5}	2.73×10^{-5}	6.7×10^{-6}	6.7×10^{-6}
	(B)	6.7×10^{-6}	0.0036	7.28×10^{-5}	4.85×10^{-5}	2.1×10^{-5}	-
	5	6.7×10^{-6}	0.0089	5.39×10^{-5}	-	6.7×10^{-6}	4.2×10^{-5}
	9	6.7×10^{-6}	0.009	9.59×10^{-5}	6.68×10^{-5}	6.7×10^{-6}	1.08×10^{-5}
	13	4.14×10^{-5}	9.45×10^{-4}	2.73×10^{-4}	-	-	-
	17(A)	6.7×10^{-6}	2.92×10^{-4}	1.10×10^{-4}	-	6.7×10^{-6}	-
	(B)	6.7×10^{-6}	-	3.08×10^{-5}	-	6.7×10^{-6}	-
	21	-	2.09×10^{-4}	5.14×10^{-5}	2.26×10^{-5}	1.51×10^{-5}	2.26×10^{-5}
	25	2.28×10^{-5}	8.51×10^{-5}	1.11×10^{-5}	6.7×10^{-6}	6.7×10^{-6}	-
	29	6.7×10^{-6}	5.74×10^{-5}	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}
Dec	3(A)	6.7×10^{-6}	-	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}	6.7×10^{-6}
	(B)	1.79×10^{-5}	-	6.7×10^{-6}	-	6.7×10^{-6}	-

* 1/2 MDL = 6.7×10^{-6} μg/m³

** (A) - Primary Sampler, (B) - Colocated Sampler

Dieldrin Concentrations ($\mu g/m^3$)*

Da		Station 1	Station 2	Station 3	Station 4	Station 5	Bldg 373
Sep	26	5.92×10^{-5}	7.34×10^{-4}	5.15×10^{-5}	1.66×10^{-4}	1×10^{-5}	1×10^{-5}
	30(A)*	1×10^{-5}	5.31×10^{-4}	5.32×10^{-5}	1.15×10^{-5}	1×10^{-5}	1×10^{-5}
	(B)**	1×10^{-5}	3.34×10^{-4}	5.04×10^{-5}	-	1×10^{-5}	-
Oct	4	4.95×10^{-5}	-	1×10^{-5}	6.06×10^{-5}	1×10^{-5}	3.05×10^{-5}
	8	1×10^{-5}	-	4.69×10^{-5}	7.34×10^{-5}	1×10^{-5}	2.4×10^{-5}
	12	6.93×10^{-5}	-	8.21×10^{-4}	1.13×10^{-4}	1×10^{-5}	1×10^{-5}
	16(A)	1.96×10^{-5}	4.23×10^{-4}	5.32×10^{-5}	5.08×10^{-5}	1×10^{-5}	1×10^{-5}
	(B)	2.46×10^{-5}	-	6.99×10^{-5}	4.51×10^{-5}	1×10^{-5}	-
	20	3.32×10^{-5}	0.032	5.32×10^{-4}	1.13×10^{-4}	1×10^{-5}	3.49×10^{-5}
	24	1.96×10^{-5}	0.1023	2.06×10^{-4}	1.82×10^{-4}	1×10^{-5}	1×10^{-5}
	28	1×10^{-5}	0.0021	-	4.64×10^{-5}	1×10^{-5}	1.11×10^{-4}
Nov	1(A)	1×10^{-5}	0.0249	1.04×10^{-4}	9.82×10^{-5}	1×10^{-5}	1×10^{-5}
	(B)	1×10^{-5}	0.0165	9.27×10^{-5}	6.67×10^{-5}	5.79×10^{-5}	-
	5	2.97×10^{-5}	0.0089	1.32×10^{-4}	-	1×10^{-5}	1.14×10^{-4}
	9	1×10^{-5}	0.009	2.88×10^{-4}	2.39×10^{-4}	1×10^{-5}	3.23×10^{-5}
	13	2.07×10^{-4}	9.45×10^{-4}	7.13×10^{-4}	-	-	-
	17(A)	9.64×10^{-5}	2.92×10^{-4}	6.10×10^{-4}	-	1×10^{-5}	-
	(B)	3.57×10^{-4}	-	5.78×10^{-4}	-	1×10^{-5}	-
	21	-	2.09×10^{-4}	2.06×10^{-4}	1.52×10^{-4}	1.51×10^{-5}	3.4×10^{-5}
	25	2.9×10^{-4}	8.51×10^{-4}	7.2×10^{-5}	-	1×10^{-5}	-
	29	3.59×10^{-5}	5.74×10^{-4}	1.94×10^{-4}	-	5.62×10^{-5}	1×10^{-5}
Dec	3(A)	5.39×10^{-5}	-	5.14×10^{-5}	-	1×10^{-5}	1×10^{-5}
	(B)	7.15×10^{-5}	-	8.97×10^{-5}	-	1×10^{-5}	-

* 1/2 MDL = 1×10^{-5} $\mu g/m^3$

** (A) - Primary Sampler, (B) - Colocated Sampler

Endrin Concentrations ($\mu g/m^3$)*

Date		Station 1	Station 2	Station 3	Station 4	Station 5	Bldg 373
Sep	26	1.7×10^{-5}	1.15×10^{-4}	1.7×10^{-5}	5.52×10^{-5}	1.7×10^{-5}	1.7×10^{-5}
	30(A)**	1.7×10^{-5}	8.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}
	(B)**	1.7×10^{-5}	4.5×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	-
Oct	4	3.71×10^{-5}	-	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}
	8	1.7×10^{-5}	-	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}
	12	1.7×10^{-5}	-	2.35×10^{-4}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}
	16(A)	1.7×10^{-5}	2.83×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}
	(B)	1.7×10^{-5}	-	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	-
	20	1.7×10^{-5}	0.0084	1.31×10^{-4}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}
	24	1.7×10^{-5}	0.0286	4.71×10^{-4}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}
	28	1.7×10^{-5}	5.33×10^{-4}	-	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}
Nov	1(A)	1.7×10^{-5}	0.0065	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}
	(B)	1.7×10^{-5}	0.0042	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	-
	5	1.7×10^{-5}	0.0076	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	3.6×10^{-5}
	9	1.7×10^{-5}	0.0051	5.99×10^{-5}	2.78×10^{-5}	1.7×10^{-5}	ND
	13	2.96×10^{-5}	6.16×10^{-4}	1.07×10^{-4}	-	-	-
	17(A)	1.7×10^{-5}	3.76×10^{-4}	7.15×10^{-5}	-	1.7×10^{-5}	-
	(B)	1.7×10^{-5}	-	9.87×10^{-5}	-	1.7×10^{-5}	-
	21	-	2.25×10^{-4}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}
	25	3.41×10^{-5}	4.51×10^{-4}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	-
	29	1.7×10^{-5}	6.27×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}
Dec	3(A)	1.7×10^{-5}	-	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}	1.7×10^{-5}
	(B)	1.7×10^{-5}	-	-	-	1.7×10^{-5}	-

* 1/2 MDL = 1.7×10^{-5} $\mu g/m^3$

** (A) - Primary Sampler, (B) - Colocated Sampler

APPENDIX E

METEOROLOGICAL DATA

HSE-EA-A
SUBJECT: Ambient Air Quality Assessment No. 43-21-0170-81, RMA, Denver, CO

METEOROLOGICAL DATA

1. The operation, maintenance, calibration and quality assurance aspects of the wind analyzers were performed by the Atmospheric Science Laboratory (ASL) Meteorology Team at Rocky Mountain Arsenal. In addition, this team reduced the strip chart records into mean hourly wind speeds and directions and provided the encoded data to this Agency. The encoded data were keypunched into cards and entered into a computer storage file from which the wind roses in Figures 1 through 5 for the five stations were produced.

2. Percentages of data recovery for the five stations are presented in the following table.

DATA RECOVERY RATES

Station	Percentage
1	63.8
2	80.3
3	81.3
4	70.9
5	88.6

HSE-EA-A
SUBJECT: Ambient Air Quality Assessment No. 43-21-0170-81, RMA, Denver, CO

METEOROLOGICAL DATA REPRESENTATIVE OF ALL FIVE STATIONS

DATE	AUG WS	PREV WD	PEAK WS	PEAK WD	GRD COND
11 Apr 81	13	NW	30	NNE	Very damp
15	8	SSE	36	NW	Dry
19	7	SSE	20	WNW	Dry
22	8	NE	29	NE	Dry
27	5	ESE	18	NNE	Dry
5 May 81	6	S	19	ENE	Damp
9	6	N	30	NNW	Damp
13	7	ESE	20	NE	Damp
17	7	ESE	17	ENE	Very damp
21	8	NE	18	ESE	Dry
23	6	NW	21	ENE	Dry
29	8	N	37	ENE	Dry
30	8	SE	28	SE	Dry
6 Jun 81	9	NNW	47	NW	Dry
10	8	SSW	32	NNE	Damp

Meteorological Data For Hi-Vol Monitoring Days From Station #1

DATE	AVG. W/S (MPH)	PREVAILING W/D	PEAK W/S	W/D	STATE OF GROUND
02 Sep 80	Missing	Missing	Missing	Missing	0
06	Missing	Missing	Missing	Missing	0
10	4	NW	9	SW	1
14	6	NW	11	S	1
18	3	SW	12	SSW	0
22	5	SE	7	SE	0
26	4	SE	7	SE	0
30	5	SW	8	SSW	0
04 Oct 80	5	WNW	9	ESE	0
08	4	SW	10	NE	0
12	5	SW	6	SSW	0
16	7	NE	14	NE	0
20	4	SW	4	NE	0
24	9	SW	7	NW	1
28	4	SW	5	SW	0
01 Nov 80	4	SW	6	SW	0
05	4	SW	5	SW	0
09	4	N	6	N	0
13	Missing	Missing	Missing	Missing	0
17	Missing	SW	Missing	Missing	7
21	7	SW	10	SSW	1
25	Missing	SW	Missing	Missing	7
29	8	SW	12	S	6
03 Dec 80	9	SW	13	SSE	5
07	Missing	Missing	Missing	Missing	5
11	7	SE	13	SW	1
15	5	SSE	7	SSE	0
17	Missing	Missing	Missing	Missing	0

Meteorological Data For Hi-Vol Monitoring Days From Lake F, Station #2

DATE	AVG. W/S (MPH)	PREVAILING W/D	PEAK W/S (MPH)	W/D	STATE OF GROUND
02 Sep 80	5	SW	11	SE	0
06	5	SW	11	SE	0
10	5	NW	8	S	1
14	5	NW	13	SSW	1
18	11	SW	13	SSW	0
22	6	SSE	9	ESE	0
26	5	SW	11	SW	0
30	7	SW	12	WSW	0
04 Oct 80	Missing	Missing	Missing	Missing	0
08	5	SE	8	SSE	0
12	Missing	Missing	Missing	Missing	0
16	5	NE	9	NE	0
20	5	SSE	8	SSE	0
24	6	S	16	WNW	0
28	5	SW	9	SSE	1
01 Nov 80	Missing	Missing	Missing	Missing	0
05	8	S	11	S	0
09	Missing	Missing	Missing	Missing	0
13	Missing	Missing	Missing	Missing	0
17	5	S	11	SE	7
21	8	S	16	SSW	1
25	7	SSW	8	SSW	7
29	7	S	14	W	6
03 Dec 80	8	SSW	11	SSE	5
07	Missing	Missing	Missing	Missing	5

Meteorological Data For Hi-Vol Monitoring Days From Lake F, Station #2

DATE	AVG. W/S	PREVAILING W/D	PEAK W/S	W/D	STATE OF GROUND
08 Dec 80	4	S	5	S	Missing
09	6	SE	9	S	Missing
10	13	SW	18	W	Missing
11	11	SW	17	W	1
15	7	SW	9	W	0
17	Missing	Missing	Missing	Missing	0

Meteorological Data For Hi-Vol Monitoring Days from Station #3

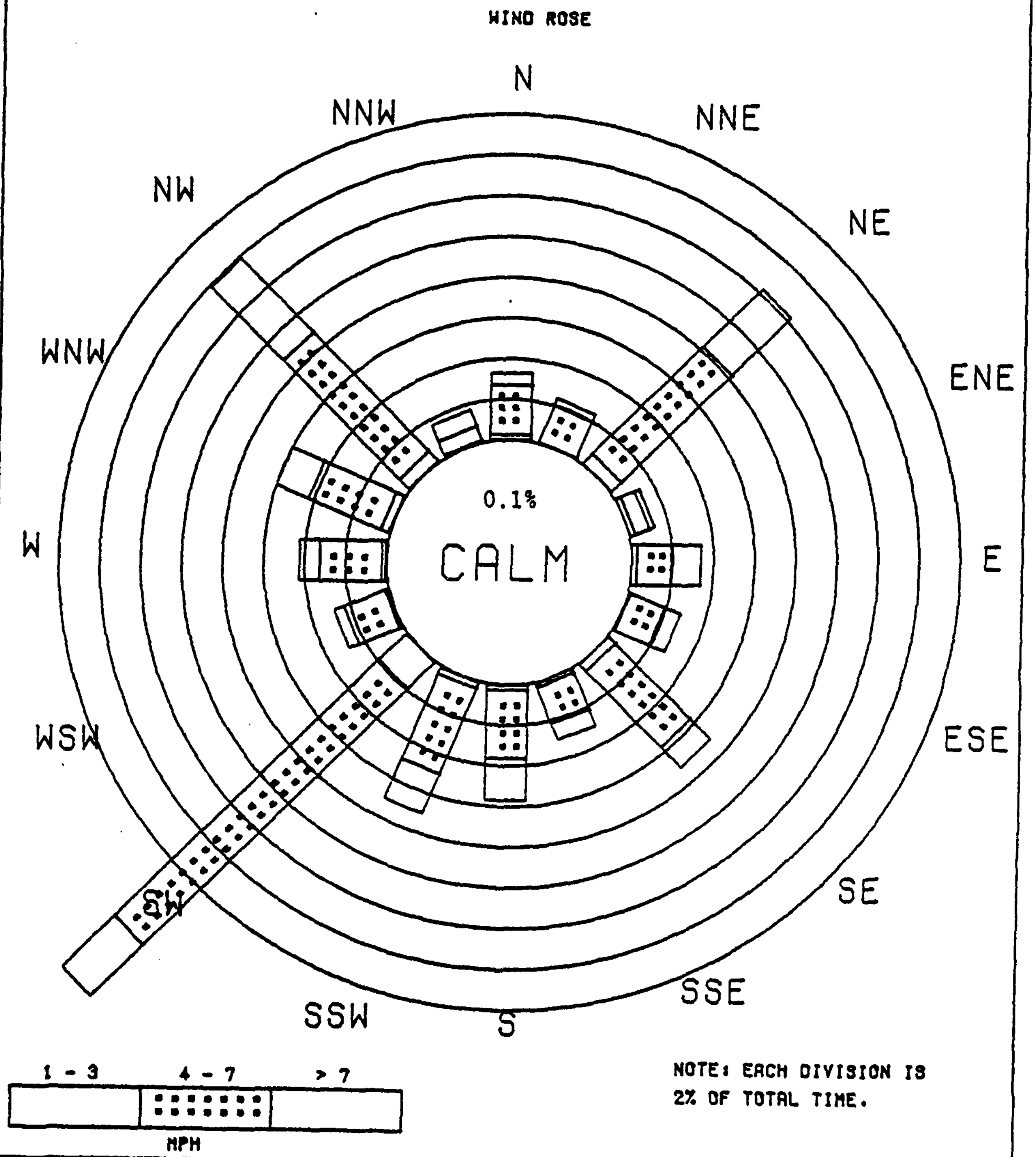
DATE	AVG. W/S (MPH)	PREVAILING W/D	PEAK W/S	W/D	STATE OF GROUND
02 Sep 80	5	SW	12	SE	0
06	5	SE	11	SSE	0
10	5	NE	7	S	1
14	6	SSW	13	SSW	1
18	8	SSW	13	SSW	0
22	7	SE	11	SSW	0
26	5	SE	13	SE	0
30	8	SW	7	SW	0
04 Oct 80	6	SW	7	SW	0
08	Missing	Missing	Missing	Missing	0
12	8	SW	12	SW	0
16	7	ESE	10	ESE	0
20	5	SW	7	SE	0
24	10	SSW	14	NW	0
28	5	SW	7	SW	1
01 Nov 80	7	SW	7	SW	0
05	7	SW	12	SW	0
09	5	NW	7	SW	0
13	Missing	Missing	Missing	Missing	0
17	6	SW	9	SW	7
21	9	SW	14	SW	1
25	5	Missing	7	Missing	7
29	10	Missing	16	Missing	6
03 Dec 80	8	SSW	13	SSE	5
07	4	ENE	5	ENE	5
11	8	SW	12	NW	1
15	6	SSE	8	W	0
17	Missing	Missing	Missing	Missing	0

Meteorological Data For Hi-Vol Monitoring Days From Basin A, Station #4

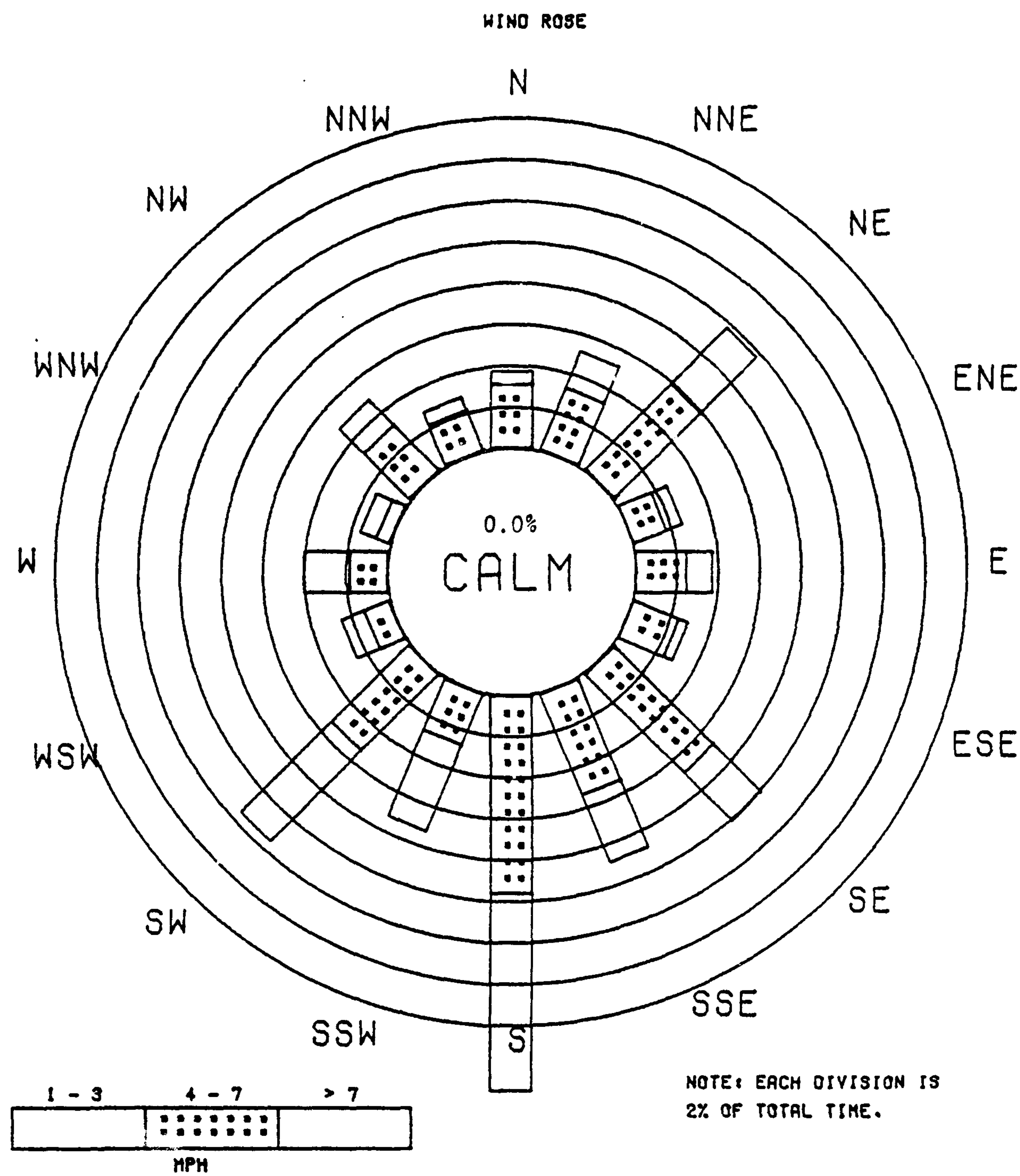
DATE	AVG. W/S (MPH)	PREVAILING W/D	PEAK W/S (MPH)	W/D	STATE OF GROUND
22 Sep 80	4	SSW	7	ESE	Missing
26	4	ESE	6	ESE	0
30	4	SSW	7	SSW	0
04 Oct 80	5	Missing	10	Missing	0
08	7	SSW	9	N	0
12	Missing	Missing	Missing	Missing	0
16	6	E	11	E	0
20	6	SE	7	NE	0
24	7	S	15	W	0
28	4	S	5	S	1
01 Nov 80	5	SSW	8	SSW	0
05	5	SSE	6	SSW	0
09	5	WNW	7	E	0
13	Missing	Missing	Missing	Missing	0
17	6	SSW	8	SSW	7
21	8	SSW	11	SSW	1
25	5	SSE	7	SSE	7
29	6	S	12	WSW	6
03 Dec 80	7	S	Missing	Missing	5
07	Missing	N	10	Missing	5
11	8	S	10	NNW	1
15	6	S	10	SW	0
17	Missing	Missing	Missing	Missing	0

Meteorological Data For Hi-Vol Monitoring Days From Station #5

DATE	AVG. W/S (MPH)	PREVAILING W/D	PEAK W/S (MPH)	W/D	STATE OF GROUND
02 Sep 80	8	SSE	10	SSE	0
06	7	Missing	10	Missing	0
10	8	SE	16	SE	1
14	7	WNW	16	SE	1
18	8	ESE	20	SSE	0
22	8	ESE	12	ESE	0
26	7	SE	9	NE	0
30	7	SSE	10	SSE	0
04 Oct 80	7	SE	13	NNW	0
08	6	SE	8	N	0
12	9	SSE	12	SSE	0
16	8	NNW	13	NNW	0
20	5	SE	7	N	0
24	3	SE	15	WSW	0
28	4	SE	6	SE	1
01 Nov 80	6	SSE	8	SSE	0
05	6	SE	8	SE	0
09	5	W	12	E	0
13	8	NW	12	NW	0
17	6	SE	8	SE	7
21	7	SE	14	SE	1
25	6	SE	7	SE	7
29	12	SE	18	SSW	6
03 Dec 80	6	E	11	E	5
07	Missing	Missing	Missing	Missing	5
11	6	SE	10	SE	1
15	5	SE	7	ESE	0
17	Missing	Missing	Missing	Missing	0

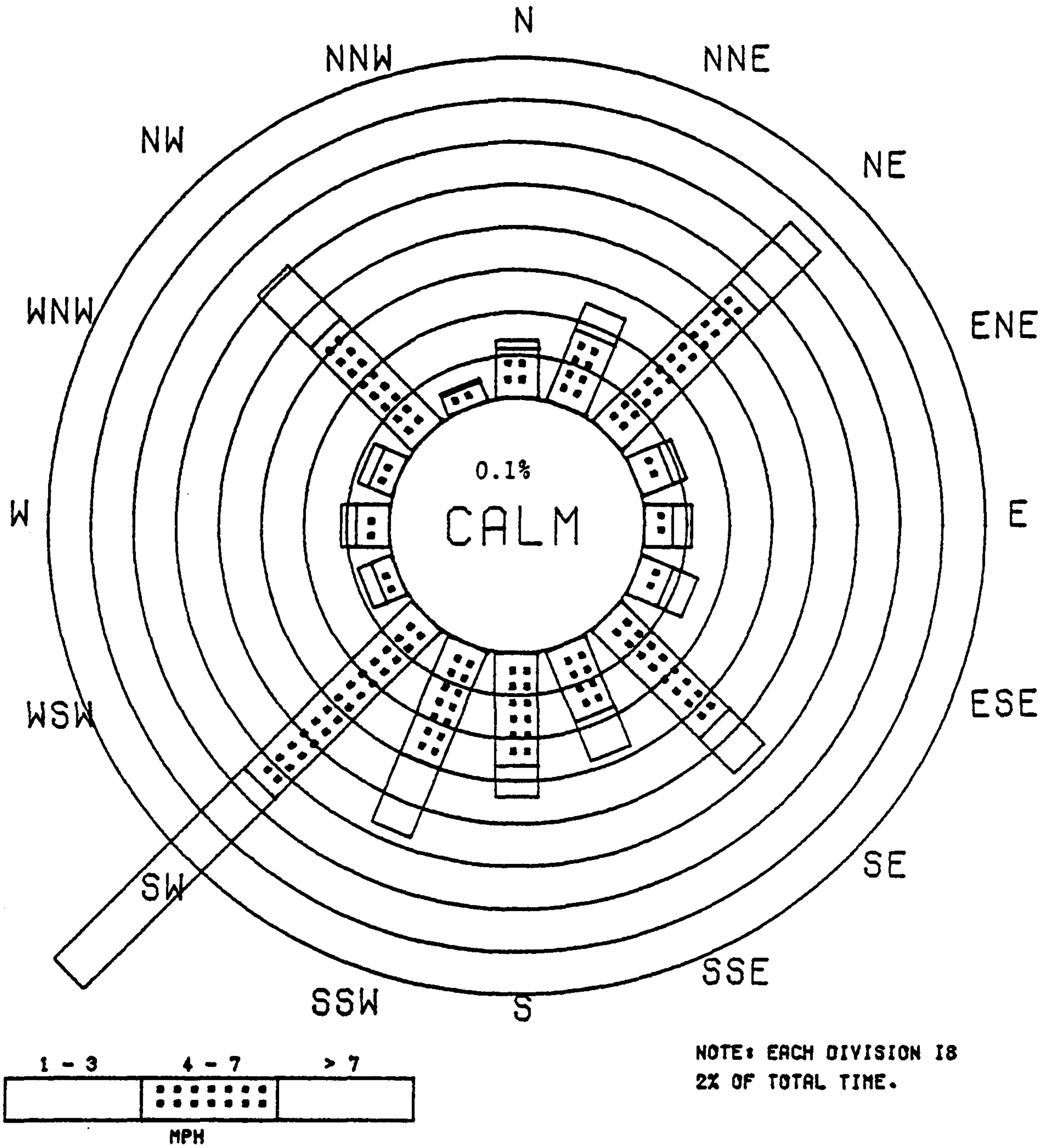


U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY HEALTH SERVICES COMMAND	FIGURE: 1 RMA. STATION 1.
	PERIOD OF RECORD 8 SEPTEMBER - 15 DECEMBER 1980.
	SOURCE OF DATA ASL MET TEAM MONITORING STUDY



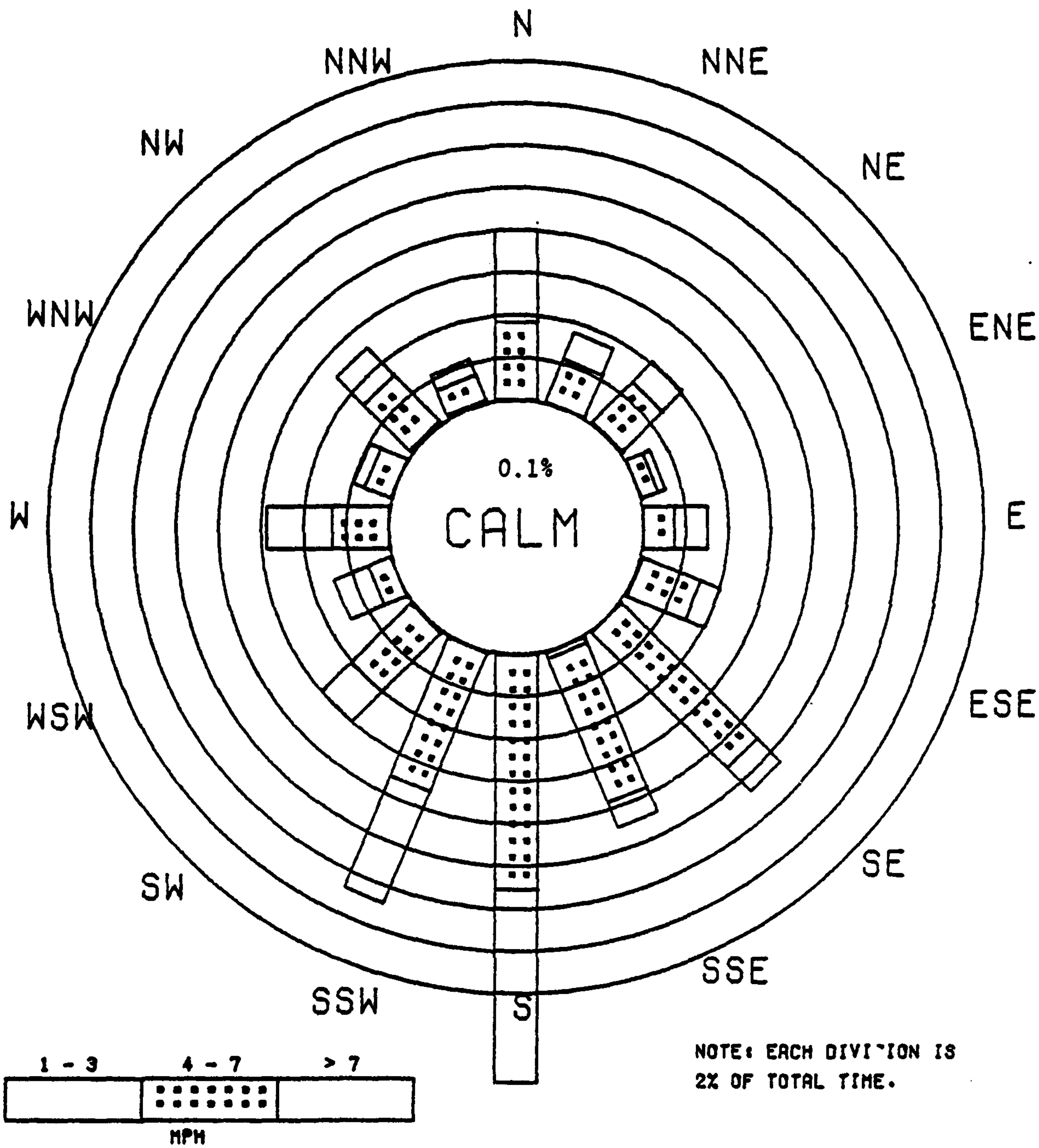
U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY	FIGURE: 2 RMA. LAKE F. STATION 2
HEALTH SERVICES COMMAND	PERIOD OF RECORD 1 SEPTEMBER 1980 - 15 DECEMBER 1980
	SOURCE OF DATA ASL MET TEAM MONITORING STUDY

WIND ROSE



U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY HEALTH SERVICES COMMAND	FIGURE: 3 RMA, STATION 3
	PERIOD OF RECORD 1 SEPTEMBER 1980 - 16 DECEMBER 1980
	SOURCE OF DATA ASL MET TEAM MONITORING STUDY

WIND ROSE



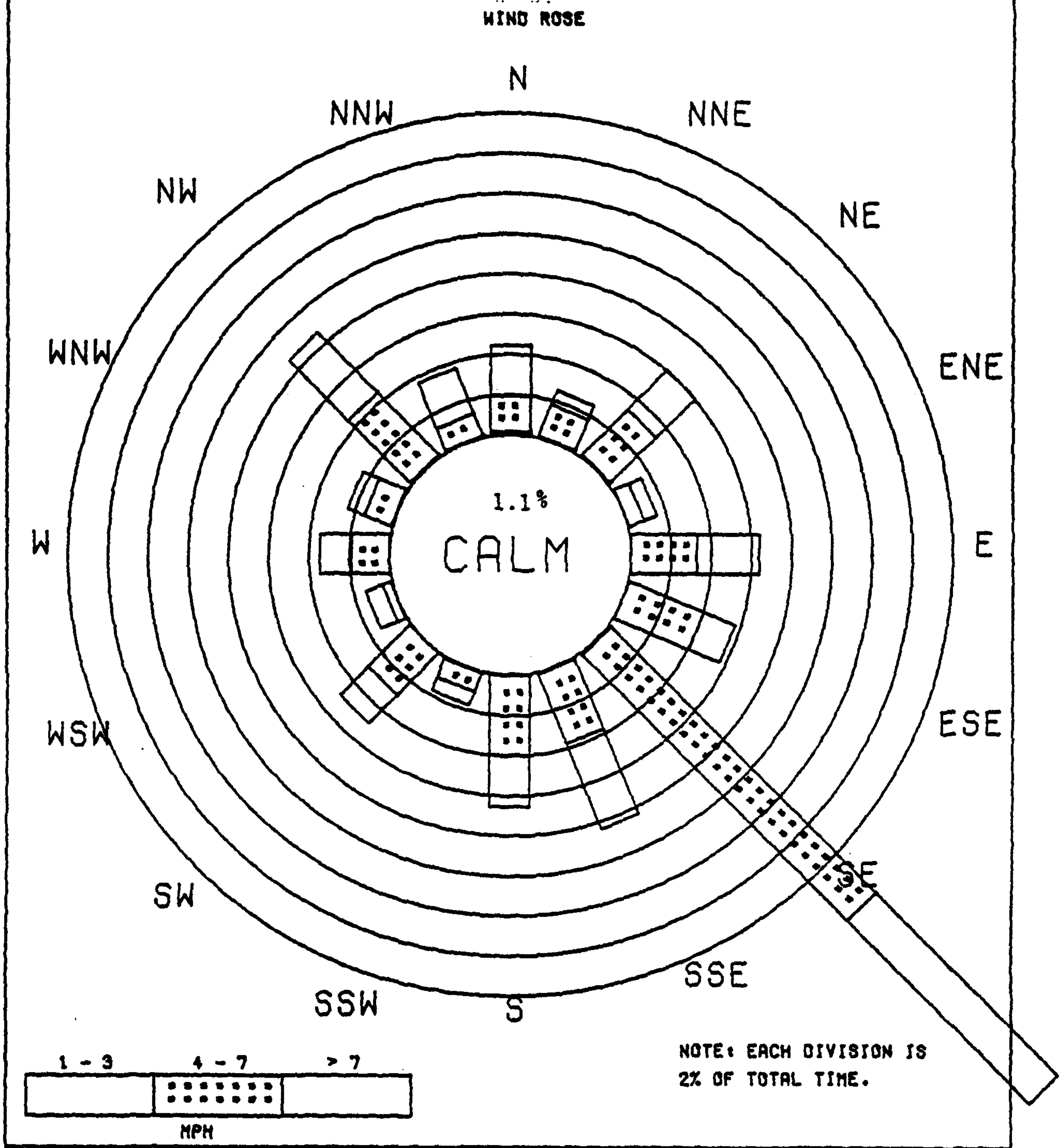
U.S.ARMY ENVIRONMENTAL HYGIENE AGENCY

HEALTH SERVICES COMMAND

FIGURE: 4 RMA. BASIN A. STATION 4

PERIOD OF RECORD
22 SEPTEMBER - 15 DECEMBER 1980.

SOURCE OF DATA
ASL MET TEAM MONITORING STUDY



U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY

HEALTH SERVICES COMMAND

FIGURE: 5 RMA. STATION 5.

PERIOD OF RECORD
1 SEPTEMBER 1980 - 16 DECEMBER 1980

SOURCE OF DATA
ASL MET TEAM MONITORING STUDY

ATMOSPHERIC SCIENCES LABORATORY

METEOROLOGICAL TEAM DATA

ASL ROCKY MOUNTAIN MET TEAM

METEOROLOGICAL SUPPORT DIVISION

WHITE SANDS MISSILE RANGE, NEW MEXICO

11 APRIL 80 - 29 NOV 80

UNITED STATES ARMY

ELECTRONICS RESEARCH & DEVELOPMENT COMMAND

AVERAGE STABILITY INDEX FOR HI-VOL SAMPLING DAYS (Daytime Values)

DATE	STABILITY INDEX	DATE	STABILITY INDEX
11 Apr 81	D	10 Sep 81	D
15	C	14	C
19	B	18	C
23	D	25	C
27	C	26	C
01 May 81	D	30	C
09	C	04 Oct 81	B
13	C	08	C
17	D	12	B
21	B	16	C
25	C	20	C
29	C	24	C
02 Jun 81	B	28	C
06	B	01 Nov 81	C
10	B	05	C
20 Jul 81	B	09	C
24	C	13	D
21 Aug 81	C	17	D
25	D	21	C
29	C	25	D
06 Sep 81	B	29	C

Stability Index: B = Moderate Lapse Rate or Unstable Condition
C = Slight Lapse Rate or Unstable Condition
D = Neutral Condition or Slightly Stable Condition