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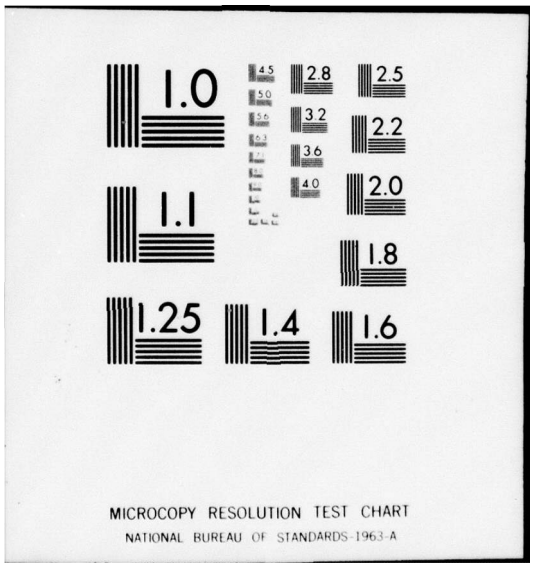
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PESTICIDE MONITORING SPECIAL STUDY NO. 44-0100-77
DEPARTMENT OF THE ARMY PESTICIDE MONITORING PROGRAM
INTERIM EVALUATION OF SOIL AND SEDIMENT SAMPLES COLLECTED IN CY 1975 FROM FOURTEEN INSTALLATIONS
JANUARY - DECEMBER 1976

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US ARMY
ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MD 21010

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This is an interim report evaluating limited soil and sediment pesticide residue data derived from samples collected during calendar year 1975 from 14 installations under the DA Pesticide Monitoring Program to provide a basis for tentative decisions regarding scheduling of environmental sample collections for calendar year 1977. Residue data from a total of 283 soil samples and 123 sediment samples collected according to stratified installation sampling plans were evaluated. Evaluation of these data →

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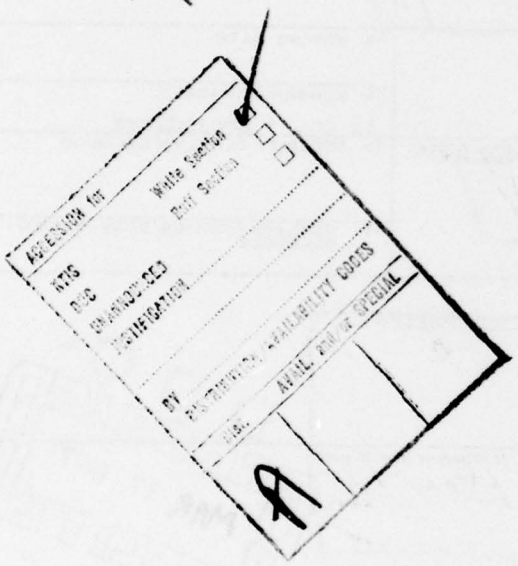

DEPARTMENT OF THE ARMY
U. S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010

15 MAR 1977

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PESTICIDE MONITORING SPECIAL STUDY NO. 44-0100-77
DEPARTMENT OF THE ARMY PESTICIDE MONITORING PROGRAM
INTERIM EVALUATION OF SOIL AND SEDIMENT SAMPLES
COLLECTED IN CY 1975 FROM FOURTEEN INSTALLATIONS
JANURAY - DECEMBER 1976

ABSTRACT

This is an interim report evaluating limited soil and sediment pesticide residue data derived from samples collected during calendar year 1975 from 14 installations under the DA Pesticide Monitoring Program to provide a basis for tentative decisions regarding scheduling of environmental sample collections for calendar year 1977. Residue data from a total of 283 soil samples and 123 sediment samples collected according to stratified installation sampling plans were evaluated. Evaluation of these data supported several tentative conclusions including (1) stratification of installation sampling plans does provide a data base for qualitative and quantitative evaluation of pesticide distribution in a definable environment, (2) environmental data cannot be realistically evaluated without the participation of the analyst, (3) the lag times between sample acquisition, processing, analysis and data evaluation must be reduced to provide more timely corrective feedback information, (4) pesticide residues in soil are more diverse and generally much higher than those detected in sediment samples, (5) pesticide residues in land use areas defined as Range/Training, Agricultural and Grazing contribute little to the overall soil pesticide profile. Recommended changes in field sampling of soil for calendar year 1977 are presented in the report.

DEPARTMENT OF THE ARMY
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PESTICIDE MONITORING SPECIAL STUDY NO. 44-0100-77

DEPARTMENT OF THE ARMY PESTICIDE MONITORING PROGRAM INTERIM EVALUATION OF SOIL AND SEDIMENT SAMPLES COLLECTED IN CY 1975 FROM FOURTEEN INSTALLATIONS JANUARY - DECEMBER 1976

1. AUTHORITY.

a. AR 40-5, Health and Environment, 25 September 1974.

b. AR 200-1, Environmental Protection and Enhancement, 7 December 1973.

2. REFERENCES.

a. Entomological Special Study No. 44-004-74/75, Revised Department of the Army Pesticide Monitoring Program, 1 April 1975. Natl. Tech. Inform. Serv., ADA 044 030, 1975, 38 p.

b. Entomological Special Study No. 44-011-75/76, Department of the Army Pesticide Monitoring Program, January-December 1974. Natl. Tech. Inform. Serv., ADA 017 778, 1975, 14 p.

c. Entomological Special Study No. 44-019-75/76, Pesticide Analysis of Surface Water Samples Collected in the Department of the Army Pesticide Monitoring Program, 1 September 1972 - 31 December 1974. Natl. Tech. Inform. Serv., ADA 030 880, 1975, 20 p.

d. Pesticide Monitoring Special Study No. 44-111-76, Pesticide Monitoring Guidelines, Scheduled Monitoring (Effective 1 April 1976). Natl. Tech. Inform. Serv., ADA 029 983, 1976, 29 p.

3. PURPOSE. The evaluation of limited data subsets is essential to provide a basis for tentative decisions regarding scheduling of environmental sample collections for the calendar year 1977.

4. BACKGROUND.

a. Changes in sampling designs are classically regarded as statistical heresy. Recognition of design errors or fluctuations in available resources dictate such changes from time to time.[1] Initial planning for this program,

[1] Guidelines on Sampling and Statistical Methodologies for Ambient Pesticide Monitoring. 1974. Monitoring Panel of the Federal Working Group on Pest Management.

reference 2a, recognized these potential problems and included provisions for initial oversampling so that irretrievable time would not be lost by a necessity to add new sampling parameters. The desirability and efficiency of stratified sampling designs were recognized in early planning stages. The following factors have produced unavoidable delays in full implementation and timely completion of the laboratory evaluation process.

(1) Logistical problems of sample acquisition, shipment, storage and processing.

(2) Reductions in actual available resources below the level used in planning stages.

(3) Necessity for the concurrent design of data management and statistical programs.

(4) Unanticipated requirements for laboratory support in diverse "pesticide problem" situations.

b. Informal and concurrent evaluation of the data formally reported in reference 2c contributed significantly to the decision to eliminate surface water samples from the scheduled program.

c. Analysis of field samples for certain heavy metals, presumably relatable to pesticide use, has also been terminated since such relationships could not be established.

d. Field experiences in late CY 1974 and early CY 1975 together with informal evaluation of incomplete data subsets produced the changes initiated by reference 2d.

e. Soil and sediment data from 14 installations representing 61 percent of the scheduled data for 1975 is regarded as a subsample which must support early tentative decisions regarding field and laboratory operations.

5. RESULTS AND DISCUSSION. The pesticides routinely analyzed for in the DA Pesticide Monitoring Program and the lower limits of detectability for these pesticides in soil and sediment are presented in Appendix A.

a. Consolidated Data. An alphabetical listing of the 14 installations represented in the present report is shown in Appendix B. The soil data are derived from 283 soil samples collected from sites in all three soil groups and the sediment data from 123 samples from all five sediment site groups.

(1) The soil data indicate the detection of 20 pesticides which in the aggregate produce an overall mean pesticide residue level equal to 28.57 ppm or pounds per acre. (For a 3-inch soil core the values in ppm are equal to pounds per acre.)

(2) The sediment data indicate the detection of only 11 pesticides producing an overall mean pesticide residue level of 0.89 ppm or pounds/acre.

b. Soil Data. The usefulness of these types of data is enhanced by a sequential evaluation progressing from general to specific sample classifications.

(1) The data in Table 1 represent the means of all samples from all soil groups and sites. The data for the isomers of DDT and its common degradation products are included in view of their possible contribution to the estimation of residue age. Emphasis must be placed on the fact that these data include all soil groups and sites indicated in the stratified sampling plan of reference 2d.

(2) Comparisons of selected soil residue data from samples collected in CY73, 74 and consolidated 75 appear in Table 2. Such a comparison is of value only in that it makes very apparent the difficulty of employing a single sample for an entire military installation that has the diversity of an industrial area, an urban area, a suburban area and an agricultural area included within its boundaries.

(3) The value of employing stratified sampling designs is apparent from the data in Table 3. These data have been selected from Table 1 and reorganized to facilitate comparison.

(a) The contribution of land use areas where pesticide contamination may be expected to be excessive is clear in comparing lines 1 and 2 of Table 3. Such highly contaminated areas require specific identification to avoid a bias in general profile data. Their identification also permits corrective action to be initiated. Their location may also indicate the possibility of their contribution to contamination of other environmental components.

(b) Contrasts between lines 3 and 4 of this table indicate the general tendency of range and training areas and outleased agricultural areas to dilute the suburban and urban areas of rather intense pest control operations.

c. Sediment Data.

(1) The data in Table 4 represent the means of all samples from all the types of sediment collection sites.

(2) The overall sediment data are contrasted with comparable soil data from the 14 installations in Table 5. The soil data subset employed in this table represents land use areas of the installations that may have contributed in whole or in part to the pesticide residues in these sediments.

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TABLE 1. THE OVERALL MEAN VALUES AND PERCENT OF POSITIVE SAMPLES FOR PESTICIDE RESIDUES FOUND IN VARIOUS SOIL SAMPLING SITES COLLECTED DURING CY 1975 FROM 14 OF 33 SCHEDULED INSTALLATIONS

Number of Samples	All Sites* 283		Sites 400, 403, 404 23		Sites 410, 411, 412, 413 162		All Sites But 400, 403, 404 257	
Pesticide	Percent Positive	Mean ppm	Percent Positive	Mean ppm	Percent Positive	Mean ppm	Percent Positive	Mean ppm
p,p'-DDT	48	5.21	83	58.63	54	.70	45	.49
o,p'-DDT	25	1.42	61	16.60	27	.11	22	.08
p,p'-DDE	47	.38	78	2.92	55	.208	44	.16
o,p'-DDE	1	.003	4	.03	2	.001	4	.004
p,p'-DDD	19	1.24	56	14.98	20	.03	16	.02
o,p'-DDD	6	.17	30	2.00	6	.006	1	.0007
DDTR†	52	8.62	83	97.42	61	1.09	50	.78
Chlordane	22	18.47	70	223.14	23	.55	18	.37
Trans-chlordane	5	.002	4	.009	9	.003	6	.002
Cis-chlordane	2	.001		nr	3	.002	2	.012
Heptachlor epoxide	6	.008		nr	11	.015	7	.009
Dieldrin	25	.70	56	5.93	32	.37	23	.24
Aldrin	1	.004	4	.002	1	.006	1	.004
Endrin	1	.011	9	.13	1	.0002		nr
Lindane	1	.001	8	.016		nr	<1	.0002
Methoxychlor	1	.340	4	3.9	2	.04	1	.024
Toxaphene	<1	.076	4	.94		nr		nr
Mirex	2	.0006		nr	3	.0010	2	.003
Malathion	4	.008	39	.096		nr	<1	.0004
Diazinon	2	.044	22	.54		nr		nr
Chlorpyrifos	1	.049	13	.60		nr		nr

* Soil Group I - Site 400 (Pesticide Disposal Area), Site 401 (Sewage Treatment Area), Site 402 (Landfill Area), Site 403 (Pesticide Storage Area), Site 404 (Pesticide Shop), Site 405 (Combined Pesticide Storage and Shop Area)
Soil Group II - Site 410 (Residential Area), Site 411 (Contonment Area), Site 412 (Recreation Area), Site 413 (Golf Courses)
Soil Group III - Site 421 (Grazing, Forests and Agricultural Areas), Site 422 (Range and Training Areas)
Random Samples - Site 460 - Only three of the 283 samples collected (1%) were listed as random, unstratified samples. These three samples had little effect on data tabulations presented in Tables 1, 2, 3, and 5.

† DDTR = [DDT + 1.114(DDD + DDE)]

TABLE 2. COMPARISON OF SELECTED PESTICIDE RESIDUES IN SOILS FOR CY73, 74 AND 75

	Number of Samples	DDT	DDE	DDD	Dieldrin	Chlordane	Lindane
				ppm			
CY73*	151	.99	.42	.07	.06	.10	.0005
CY74†	48	20.87	.95	.92	.21	2.81	.0001
CY75‡	283	6.63	.38	1.41	.70	18.47	.001

* Unstratified sampling with one soil sample representing one entire installation
† Partial stratification. Feasibility of data evaluation by stratum difficult
‡ Stratified soil sampling. Data evaluation by soil groups or subsets of groups feasible

TABLE 3. SELECTED RESIDUE DATA FROM TABLE 1 BY LAND USE AREAS (CY75 SAMPLES)

	Number of Samples	ppm						
		DDT	DDE	DDD	Chlordane	Dieldrin	Methoxychlor	Malathion
All Sites	283	6.63	.38	1.41	18.47	.70	.34	.008
Pesticide shop, storage and disposal areas	23	75.2	2.95	16.98	223.14	5.93	3.9	.096
Suburban and urban type sites	162	.81	.21	.036	.55	.37	.04	nr
All sites excluding only line 2	257	.57	.16	.021	.37	.24	.024	.0004

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TABLE 4. MEAN VALUES AND PERCENT OF POSITIVE SAMPLES FOR PESTICIDE RESIDUES FOUND IN ALL TYPES OF SEDIMENT COLLECTION SITES FROM 14 OF 33 SCHEDULED INSTALLATIONS IN CY75

	All Sites*		Site 101*		Site 102		Site 200		Site 201		Site 202	
No. of Samples	123		24		50		23		11		15	
	Percent Positive	Mean ppm	Percent Positive	Mean ppm	Percent Positive	Mean ppm	Percent Positive	Mean ppm	Percent Positive	Mean ppm	Percent Positive	Mean ppm
p,p'-DDT	2	.06	4	.002	4	.14		nr		nr		nr
o,p'-DDT	2	.006		nr	4	.016		nr		nr		nr
p,p'-DDE	16	.065	12	.007	10	.136	4	.016	18	.01	33	.037
o,p'-DDE	2	.014		nr	2	.03	4	.003		nr		nr
p,p'-DDD	15	.56	13	.012	12	1.35	13	.021	18	.026	33	.05
o,p'-DDD	5	.15	4	.001	2	.365	4	.002	18	.004	6	.003
Chlordane	7	.029	8	.01	6	.007		nr		nr	27	.192
Trans-chlordane	4	.002	13	.01		nr		nr		nr	7	.0007
Cis-chlordane	2	.002	13	.008		nr		nr		nr		nr
Dieldrin	4	.002	8	.002	4	.0008		nr		nr	6	.007
Aldrin	3	.0007	8	.001		nr		nr		nr	13	.004
Sum of all pesticides		.89		.053		2.045		.042		.04		.294
No. of pesticides	11		9		8		4		3		7	

*Site 101 - Stream entrance to installation
Site 102 - Stream exit from installation
Site 200 - Impounded body of water
Site 201 - Lake or pond - no well defined influent and effluent
Site 202 - Lake or pond - well defined influent and effluent

TABLE 5. CONTRASTS IN PESTICIDE RESIDUE DATA FOR 123 SEDIMENT SAMPLES AND 257 SOIL SAMPLES COLLECTED FROM 14 INSTALLATIONS IN CY75

Pesticide*	Percent Positive		Mean ppm	
	Sediment (all sites)	Soil (all sites but 400, 403,404)	Sediment (all sites)	Soil (all sites but 400, 403, 404)
p,p'-DDT	2	45	.06	.49
o,p'-DDT	2	22	.006	.08
p,p'-DDE	16	44	.065	.16
o,p'-DDE	2	4	.014	.004
p,p'-DDD	15	16	.56	.02
o,p'-DDD	5	1	.15	.0007
Chlordane	7	18	.029	.37
Trans-chlordane	4	6	.002	.002
Cis-chlordane	2	2	.002	.012
Dieldrin	4	23	.002	.24
Aldrin	3	1	.0007	.004

* No other pesticides were reportable in these sediment samples

(a) Frequency of Occurrence. With the exception of o,p'-DDD and aldrin, the residues listed in Table 5 occur in soil more frequently than in sediments. These differences in the percent of positive (reportable value) samples suggest that material in soil is potentially available for transport into the aquatic environment but does not always arrive there in detectable amounts. The o,p'-DDD preponderance in sediment over soil may be explained by the metabolic pathways prevelant in sediment. The aldrin data cannot be logically explained from the present data.

(b) Mean Residue Values. The pesticide residues in sediment substantially exceed those found in soil only in the case of p,p'-DDD and o,p'-DDD. These relatively high concentrations may be the result of combinations of two circumstances: the control of certain aquatic dipterous pests was, in the past, accomplished by the use of DDD; and the environmental metabolic pathways for DDT involve the production of significant amounts of DDD in an anaerobic environment (such as bottom sediment).[2]

(3) The sediment collection sites were also stratified as indicated in Table 4. Although the concentrations of pesticides found are relatively low these data suggest that more pesticide exits the installation via the aquatic environment than comes on to the installation from other sources.

(a) This tempting generalization, derived from average data, does not stand the scrutiny of statistical evaluation. The biasing data come from one sample. This unique situation was apparent to the analyst and is the subject of specific investigation.

(b) The reporting of a site classification (200) merely designated as an impounded body of water is a field coding error that had not been detected previously. Retrospective correction of this error will be initiated.

(c) Although it appears that impounded bodies of water have more contamination than flowing streams the small numbers of samples make this evaluation difficult. Impoundments would, however, entrap and retain contaminated sediment materials adding support to this generalization.

6. CONCLUSIONS. These conclusions are tentative, based on an incomplete data subset. However, modification of these conclusions of a qualitative nature are unlikely. Quantitative modifications are anticipated to be minor and not requiring major retrospective corrections.

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[2] Menzies, C. M., Metabolism of Pesticides An Update. Special Scientific Report--Wildlife No. 184, United States Department of the Interior (1974)

a. Stratification of sampling plans does provide a data base for both qualitative and quantitative evaluation of pesticide distribution in a definable environment.

b. Environmental data cannot be evaluated realistically without the participation of the analyst who is knowledgeable about the entire process.

c. The lag times between sample acquisition, processing, analysis and data evaluation must be reduced to provide corrective feedback information to initiate corrective actions.

d. Pesticide residues in soil are more diverse and generally much higher than those detected in sediment samples.

e. Pesticide residues in land use areas defined in installation sampling plans as Range/Training, Agricultural and Grazing (Soil Group III) contribute very little to the overall soil pesticide profile. The major part of Soil Group III might be better designated, Rural/Noncrop Land.

7. RECOMMENDATIONS.

a. Soil. Some soil sites can be consolidated and one land use group discontinued for CY77 field sampling.

(1) Land Use Area III (Range/Training, Agricultural, etc.) should be discontinued for CY77 field sampling.

(2) Sites 410 and 411 can be consolidated with three new sites selected at random from this consolidation. One additional sample (composite of the three sites) should be collected for phenoxyherbicide analysis.

b. Sediment. Installation sampling plans will remain basically the same for CY77 as for previous years with no major reduction in samples collected.

c. Installation Sampling Plan Revisions. Detailed revisions to the installation sampling plans will be initiated to conform to the above recommendations.

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APPENDIX A

LISTING OF PESTICIDES ROUTINELY ANALYZED FOR IN THE DA PESTICIDE MONITORING PROGRAM AND LOWER LIMITS OF DETECTABILITY FOR THESE PESTICIDES IN SOIL AND SEDIMENT

Pesticide*	Lower Limits of Detectability in Soil and Sediment (Electron-capture detection, except where otherwise noted)† (ppm)
α-BHC	0.003
β-BHC	0.010
Aldrin	0.008
Chlordane (tech)	0.060
Cis-chlordane	0.008
Trans-chlordane	0.008
Oxychlordane	0.008
o,p'-DDD	0.020
p,p'-DDD	0.016
o,p'-DDE	0.020
p,p'-DDE	0.016
o,p'-DDT	0.020
p,p'-DDT	0.030
Dieldrin	0.012
Endrin	0.021
Heptachlor	0.003
Heptachlor epoxide	0.008
Lindane	0.004
Methoxychlor	0.080
Mirex	0.020
Toxaphene	0.800
Chlorpyrifos	0.012
Diazinon	0.052
Malathion	0.010 (flame photometric detection)
Methyl parathion	0.030
Parathion	0.020
2,4-D and esters‡	0.010
2,4,5-T and esters‡	0.004
Silvex and esters‡	0.004

* Pesticides not appearing on this list are not presently being analyzed for; however, they may or may not have been present in a sample.

† Of the pesticides on this list only those present at or above the concentration listed for the minimum detection limit would have been reported; pesticides not meeting this criteria are designated as nr (not reportable).

‡ Not analyzed for in CY75 sample collections; analyses for phenoxyherbicides in selected soil samples (i.e., 10-20 percent of total) commenced with CY76 sample collections.

APPENDIX B

ALPHABETICAL LISTING OF INSTALLATIONS
REPRESENTED IN PRESENT REPORT

Installation Name	State Where Located
Fort Carson	Colorado
Fort Devens	Massachusetts
Fort Eustis	Virginia
Fort Huachuca	Arizona
Fort Leavenworth	Kansas
Fort Meade	Maryland
Fort McClellan	Alabama
Fort McCoy	Wisconsin
Fort McPherson	Georgia
Fort Ord	California
Presidio of San Francisco	California
Fort Riley	Kansas
Fort Stewart	Georgia
Yuma Proving Ground	Arizona