

Health Consultation

PESTICIDE CONTAMINATION OF RESIDENTIAL SOIL

DES MOINES, POLK COUNTY, IOWA

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

PESTICIDE CONTAMINATION OF RESIDENTIAL SOIL
DES MOINES, POLK COUNTY, IOWA

Prepared by:

Iowa Department of Public Health
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Table of Contents

Purpose.....	1
Background.....	1
Site Evaluation.....	1
Contaminants of Concern	3
Discussion.....	3
Lethal Dose of Endrin for Dog.....	3
Levels of Endrin in Soil and within Dog’s Stomach Contents.....	3
Toxicological Evaluation.....	4
Children’s Health Concerns.....	7
Community Health Concerns.....	7
Conclusions.....	7
Recommendations.....	8
Public Health Action Plan.....	8
References.....	9
Preparers of the Report	11
Certification	12

Purpose

The Iowa Department of Natural Resources (IDNR) has requested the Iowa Department of Public Health (IDPH) Hazardous Waste Site Health Assessment Program to evaluate the health impacts of exposures to residential soil contaminated with pesticides. The residence is located in Des Moines, Iowa. This health consultation addresses potential health risks to people from exposure to the soil within the property. The information in this health consultation was current at the time of writing. Data that emerges later could alter this document’s conclusions and recommendations.

Background

In August 2004, the Iowa Department of Agriculture and Land Stewardship (IDALS) were notified of a dog poisoning in Des Moines, Iowa. According to testimony received by IDALS, the resident of a home in Des Moines, Iowa, reported their 97-pound Siberian Husky died from ingesting a lethal dose of endrin. The poisoning occurred on July 27th or 28th, 2004. It was reported the dog had tremors turning into massive seizures sometime after 4:30 pm. The dog was immediately taken to the local veterinarian and subsequently died at 5:30 pm the same day. The contents of the dog’s stomach were preserved and delivered to the Iowa State University (ISU) Veterinary Diagnostic Laboratory (1). Laboratory analysis revealed the presence of endrin in the dog’s stomach contents at 250 parts per million (ppm). According to the analysis by the veterinary toxicologist at ISU, the dog died from ingestion of a lethal dose of endrin (2).

Site Evaluation

On September 1, 2004, personnel from IDALS visited the site to conduct an evaluation of the premises of the property and to collect soil samples in locations where it was reported the dogs had been digging (the family owns two dogs in addition to the dog that died). According to the IDALS pesticide inspector, there was nothing unusual on the property that would indicate a poison had been placed somewhere in the yard. The garage located on the property was also examined. No chemicals were being stored in the garage at the time of the site visit (1).

Soil samples were collected by the IDALS pesticide inspector in four areas where there was evidence of the dogs digging. Soil samples were collected from the top 3-inches of soil at the edges of the dug out areas and analyzed for endrin. Table 1 includes summary of the laboratory evaluation of the soil samples.

Table 1 – September 2004 Soil Sampling Results (1)

Analyte	Sample Number			
	IA 010231 (ppm)	IA 010232 (ppm)	IA 010233 (ppm)	IA 010234 (ppm)
DDT	1	Not Detected	Not Detected	2
Endrin	<0.1	10-20	<0.1	<0.1
Chlordane	100	10	Not Detected	1

<0.1 means endrin was not detected at or above the laboratory method detection limit of 0.1 ppm.

In October 2004, the IDNR collected additional samples in the area where IDALS collected their samples. Several types of samples were collected by the IDNR and analyzed for chlorohydrocarbon insecticides. Composite surface soil samples were collected from 0-3 inches below ground surface within approximately 2-foot square areas. Composite probe samples were collected at discrete locations 0-12 inches below ground surface. An additional composite deep probe sample was collected near the large hole dug by the dogs at 3-4 feet below ground surface. Table 2 includes a summary of the laboratory evaluation of the soil samples collected by the IDNR within the surface soils (0-3 and 0-12 inches below ground surface). Results from only surface soils are shown in Table 2 since human exposure is likely only to soil very close to the surface.

Table 2 – October 2004 Soil Sampling Results (2)

Sample	Analyte Concentration (ppm)						
	DDD	DDE	DDT	Endrin	Endrin aldehyde	Endrin keytone	Chlordane
SS-1	<0.01	0.025	0.070	0.24	0.012	0.030	1.0
SS-2	0.056	0.31	0.58	0.63	0.051	0.074	4.0
SS-3	<0.01	0.032	0.024	0.17	<0.01	0.028	0.42
SS-4	0.028	0.076	0.079	0.76	0.026	0.080	0.92
A-1	0.027	0.23	0.22	0.11	<0.01	0.013	0.64
A-3	0.034	0.42	0.21	0.076	<0.01	<0.01	1.2
B-2	<0.01	0.017	0.015	<0.01	<0.01	<0.01	0.063
B-3	0.028	0.24	0.28	0.029	<0.01	<0.01	0.47
C-2	0.027	0.065	0.054	0.054	<0.01	<0.01	0.13
C-3	0.021	0.079	0.034	0.037	<0.01	<0.01	0.062
Confirmation	0.014	0.053	0.027	0.39	0.022	0.037	0.19

<0.01 means the analyte was not detected at or above the laboratory method detection limit of 0.01 ppm.

SS denotes surface sampling (top 3 inches of soil).

A, B, C, and Confirmation samples all collected with probe (top 12 inches of soil).

Confirmation sample was collected from location near where IDALS obtained highest result for endrin concentration.

During their sampling, the IDNR observed what appeared to be a foundation of former storage area located in the area where some of the samples were collected. According to IDNR staff, the current owners of the property indicated that one of the former owners of the home might have stored pesticides at the residence since the former owner operated a pest control company.

In April 2005, the U.S. Environmental Protection Agency (EPA) collected additional samples of the soil. Composite soil samples were collected at various locations throughout the property at depths ranging from 0-6 inches below ground surface, 6-12 inches below ground surface, and 12-24 inches below ground surface. Table 3, on the following page, is a summary of the laboratory evaluation of the soil samples collected by the EPA within the surface soils (0-6 inches below ground surface). Only chemicals that were detected in more than two surface soil samples are shown in Table 3.

Table 3 – April 2005 Soil Sampling Results (3)

Sample	Analyte Concentration (ppm)					
	Chlordane	DDE	DDT	Endrin	Endrin keytone	Heptachlor Epoxide
10	0.19	0.18	0.20	0.015	ND	ND
13	7.50	0.75	1.30	0.680	0.070 J	0.044
16	16.0 J	0.40	0.63	0.077	0.0051 J	0.100
19	0.086	0.089	0.092	0.860	0.056 J	0.0024
22	0.130	0.021 J	0.024 J	0.040	0.025 J	ND
23	0.100	0.046 J	0.049 J	0.021	0.010 J	ND
26	0.120	0.017	0.032 J	0.024	0.012 J	ND
29	0.590	0.360	0.310	0.520	0.044 J	0.014 J
32	0.180	0.087	0.057	0.030	0.016 J	0.13
35	0.210 J	0.065 J	0.044 J	0.039	0.012 J	0.0019

ND means the analyte was not detected at or above the laboratory method detection limit.

J means the identification of the analyte is acceptable; the report value is any estimate.

Contaminants of Concern

The contaminants of concern at the site further discussed in this health consultation are the pesticides detected throughout the site within the surface soil samples. These pesticides are DDD, DDE, DDT, endrin, chlordane, and heptachlor expoxide. Although detected in the soil, endrin aldehyde and endrin keytone will not be discussed further since these chemicals result from the breakdown of endrin and there is limited toxicological information available for these chemicals.

Discussion

Lethal Dose of Endrin for Dog

The dose that is lethal to fifty percent (LD_{50}) of animals of similar size to a dog ranges from 3 to 16 mg/kg-body weight (4). According to the veterinary toxicologist at ISU, a dog the size of the one that died could have easily ingested about 1 kg of soil. One kg of soil at 250 ppm endrin (the concentration of endrin in the stomach of the dog) would be about 250 mg of endrin. Therefore the dog would have received a dose of 250 mg / 44 kg (weight of dog), or 5.7 mg/kg endrin. This most likely was enough endrin to produce a one-time lethal dose to this dog. Information in the literature indicates that a diet of food that contains 8 ppm endrin can be lethal to dogs when ingested over time (5).

Levels of Endrin in Soil and within Dog's Stomach Contents

The data collected so far at this site indicates the levels endrin detected in the soils analyzed by the IDALS and the IDNR are much less than the level of endin detected in the stomach contents of the dog that died. This highest level of endrin in site surface soils is 10-20 ppm in the soil collected by IDALS. The highest level of endrin in site surface soils collected by the IDNR is

0.76 ppm. The highest level of endrin in site surface soils collected by EPA is 0.86 ppm. In order for the dog to ingest the lethal dose of endrin, it would have had to ingest material much more concentrated with endrin than the surface soil that has been tested by the IDALS, IDNR, and EPA.

There are several explanations for the difference between the level of endrin in the stomach of the dog and the levels found in the soil. One explanation is that the areas sampled by the IDALS and the IDNR were not the area in which the dog ingested the fatal amount of endrin. Another explanation is that in receiving the fatal dose of endrin, the dog removed the heavily contaminated soil, possibly some pure endrin formulation, and the soil left was contaminated at the levels determined by the IDALS, IDNR, or EPA. Another possibility is that the dog ingested pure endrin formulation from a non-soil location on or off the site property.

It is concluded that the dog did not die from ingesting soil at the concentrations determined by the IDALS, IDNR, or EPA. The concentration of endrin in the soil samples were less than the concentration of endrin in the stomach of the dog, and endrin would not concentrate over time in the stomach of a dog.

Toxicological Evaluation

The following information has been prepared as a toxicological evaluation of exposure to surface soil containing pesticides at the concentrations detected on-site by the IDALS, IDNR, and EPA. The greatest potential for health impacts from the contaminated soil would be from incidental ingestion of surface soil by children that may be living or playing vicinity of soil contaminated with pesticides. Children tend to be more sensitive to exposures to soil, and incidentally ingest more soil than adults. The chemicals of concern have a high affinity for soil and do not pose an inhalation hazard. In order to evaluate the potential health impacts, Table 4 has been developed that indicates the average level of the chemicals of concern that were detected in the on-site surface soils that were sampled.

Table 4 – Average Level of Chemicals of Concern in On-Site Soils

Chemical of Concern	Average Detected Concentration (ppm)
DDD	0.029
DDE	0.17
DDT	0.32
Endrin	0.94
Chlordane	6.27
Heptachlor epoxide	0.049

ppm - means part per million and is equivalent to mg/kg or milligrams per kilogram

An average estimate of incidental ingestion of soil by children is 100 mg soil per day (6). An incidental ingestion rate for soil ingestion is an estimate of the amount of soil that is ingested due to normal hand-to-mouth activities during each day. For the purposes of this toxicological evaluation it is assumed that a child would obtain all of the soil for incidental ingestion from the soils within the yard of the site. This is a conservative assumption, since incidental ingestion

would result from exposure to dirt and soils from various locations a child may be exposed to throughout the day. Table 5 includes the amount of contaminant that would be ingested if a child received all their incidentally ingested soil from the yard areas for each chemical of concern. The numbers in the table assume that the child weighs 15 kg.

Table 5 – Estimated Daily Ingested Amount of Chemical of Concern

Chemical of Concern	Ingested Amount for Child (mg/kg)/day
DDD	1.9×10^{-7}
DDE	1.1×10^{-6}
DDT	2.1×10^{-6}
Endrin	6.3×10^{-6}
Chlordane	4.2×10^{-5}
Heptachlor epoxide	3.6×10^{-7}

This toxicological evaluation will compare these estimated daily ingestion amounts to the following comparison values: Agency for Toxic Substances and Disease Registry (ATSDR) Oral Minimum Risk Levels (MRLs), the U.S. Environmental Protection Agency (EPA) Chronic Reference Dose (RfD), and the level of exposure that translates to a one-in-ten-thousand (10^{-4}) increased risk of cancer utilizing an EPA oral slope factor. A one in 10,000 increased risk of cancer is considered acceptable by EPA.

Minimum Risk Levels

Minimum risk levels (MRLs) are established by the Agency for Toxic Substances and Disease Registry (ATSDR). The MRL is defined as, “an estimate of daily exposure to a human being to a chemical that is likely to be without an appreciable risk of deleterious effects (non-carcinogenic) over a specified period of time (7).” MRLs are based upon human and animal studies, include several safety factors, and are reported for acute exposure (≤ 14 days), intermediate exposure (15 – 364 days), and chronic exposure (≥ 365 days). Table 6 includes oral MRLs that have been developed for the chemicals of concern:

Table 6 – Oral MRLs for Chemicals of Concern (8, 9, 10, 11)

Chemical	Acute MRL (mg/kg)/day	Intermediate MRL (mg/kg)/day	Chronic MRL (mg/kg)/day
DDD	Not Available	Not Available	Not Available
DDE	Not Available	Not Available	Not Available
DDT	5×10^{-4}	5×10^{-4}	Not Available
Endrin	Not Available	2×10^{-3}	3×10^{-4}
Chlordane	1×10^{-3}	6×10^{-4}	6×10^{-4}
Heptachlor epoxide	Not Available	Not Available	Not Available

Chronic Oral Reference Dose

The EPA chronic oral RfD is defined as “an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime (12).” The chronic oral RfDs are based upon human and animal studies, include safety factors, and are reported for lifetime exposures. Table 7 includes RfDs that have been developed for the chemicals of concern:

Table 7 – RfDs for Chemicals of Concern (13, 14, 15, 16)

Chemical	RfD (mg/kg)/day
DDD	Not Available
DDE	Not Available
DDT	5×10^{-4}
Endrin	3×10^{-4}
Chlordane	5×10^{-4}
Heptachlor epoxide	1.3×10^{-5}

Increased Risk of Cancer

The EPA has developed oral slope factors for evaluating increased risk of cancer from a lifetime of exposure to certain chemicals. The slope factor is defined as “an upper bound, approximating a 95% confidence limit, on the increased cancer risk from a lifetime exposure to an agent. This estimate, usually expressed in units of proportion (of a population) affected per mg/kg/day (13).” The interpretation of slope factor would be as follows: if slope factor = $1.5 \times 10^{-2} \text{ (mg/kg/day)}^{-1}$, 1.5 excess tumors are expected to develop per 100 people if exposed daily for a lifetime to 1 mg of the chemical per kg of body weight. Table 8 includes slope factors that have been developed for chemicals of concern and the daily ingestion rate that would equate to an excess cancer incidence risk of one-in-ten-thousand.

Table 8 – Slope Factors and Concentration Equating to 10^{-4} Cancer Risk

Chemical	Slope Factor ((mg/kg)/day) ⁻¹ (12, 14)	10^{-4} Cancer Risk (mg/kg)/day
DDD	Not Available	-
DDE	Not Available	-
DDT	0.34	2.94×10^{-4}
Endrin	Not Available	-
Chlordane	0.35	2.86×10^{-4}
Heptachlor epoxide	9.1	1.10×10^{-5}

Evaluation of Highest Oral Exposure Levels

For all chemicals of concern, the level of the estimated amount ingested daily for each chemical of concern shown in Table 5 is below the health effect levels included in Tables 6 through 8. The health effect levels shown in Tables 6 through 8 consider both cancer and non-cancerous end points. The conclusion of the toxicological evaluation is that individuals, even if daily exposed to the levels of chemicals detected in the soil during the September 2004, October 2004, and April 2005 sampling events, would not be expected to have any adverse health effects.

Children's Health Concerns

Children have unique vulnerabilities to some environmental chemicals, and IDPH's Hazardous Waste Site Health Assessment Program evaluated the potential impact of the presence of the chemicals of concern detected in the soil samples during the September 2004, October 2004, and April 2005 sampling event on children's health. The levels of the chemicals of concern were below published comparison values. These comparison values are considered protective, even to the most sensitive individuals including children. It is concluded that children's health would not be negatively impacted by the presence of these chemicals at the levels detected within the soil samples.

Community Health Concerns

The IDPH is aware that there is a concern of the health impacts to the current dogs that are still being exposed to on-site soils. During site investigations completed by the IDALS, IDNR, and the EPA, a more concentrated area of pesticide contamination, similar to what may have poisoned the dog was not located. As discussed previously, the dog may have removed the heavily contaminated soil by ingesting soil that contained the fatal dose of endrin. Since the IDALS, IDNR, and EPA were not able to locate a heavily contaminated area within the soils on the property, it is possible that no areas of heavily contaminated soil remain on the property that would cause serious health impacts to dogs.

On average, the areas that were sampled by IDALS, IDNR, and EPA do not contain concentrations of pesticides that would be toxic to dogs. In order to provide a greater degree of comfort, the property owner may wish to remove the surface soils in the areas where the dogs were digging and replace them with clean soils and additional landscaping to prevent any further digging by animals. This would minimize exposure to soils that contain even small amounts of pesticides.

Conclusions

From the soil sampling and analytical data collected during the September 2004, October 2004, and April 2005 sampling events, it is concluded that:

- Human exposure to the soils through incidental ingestion would not be expected to produce any adverse health effects, even to sensitive portions of the human population including children.

- There is a possibility that areas of heavily contaminated soil no longer exist on the property.

Recommendations

- As part of prudent public health practice, consideration should be given to removal of surface soils in the areas where the dogs were digging and replacement with clean soils and additional landscaping to prevent any further digging by animals.

Public Health Action Plan

- IDPH will provide assistance with community health education as needed and requested.
- IDPH will review any additional sampling data provided by the IDALS, IDNR, or EPA and update health recommendations as necessary.
- IDPH will continue to address and evaluate community concerns.

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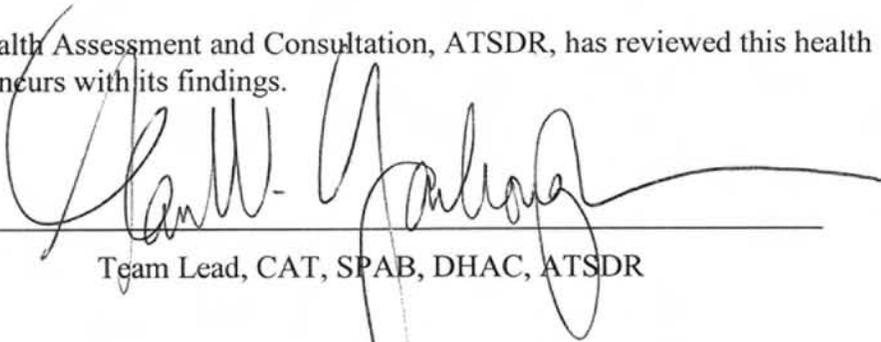
CERTIFICATION

The Iowa Department of Public Health, Hazardous Waste Site Health Assessment Program, has prepared this health consultation evaluating site information and soil sampling data subsequent to a fatal ingestion of Endrin by a dog at a residential property in Des Moines, Iowa under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). The document is in accordance with approved methodology and procedures existing when the health consultation was being prepared. Editorial review was completed by the Cooperative Agreement partner.



Technical Project Officer, CAT, SPAB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with its findings.



Team Lead, CAT, SPAB, DHAC, ATSDR