Health Consultation

PUBLIC COMMENT VERSION

Residential Soil Contamination

RED PANTHER CHEMICAL COMPANY NPL SITE

CLARKSDALE, MISSISSIPPI

EPA FACILITY ID: MSD000272385

JUNE 8, 2017

COMMENT PERIOD ENDS: JULY 7, 2017

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

A health consultation is a verbal or written response from ATSDR or ATSDR's Cooperative Agreement Partners 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 or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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Prepared By:

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ATSDR Public Health Consultation – Red Panther, MS

Executive Summary

Introduction

The Agency for Toxic Substances and Disease Registry (ATSDR) is charged with reducing harm to humans caused by chemicals in our environment. While ATSDR's main focus is current exposures and solutions to reduce or end those exposures, the Agency is also concerned about past exposures and any health consequences those past exposures may have caused. This health assessment focuses on past and current exposures to soil contamination in neighborhoods near the Red Panther Chemical site in Clarksdale, Mississippi.

To evaluate possible and current exposures at and around Red Panther Chemical Site, the agency evaluated the available data and information on contamination of household yards near the site, Chemicals evaluated in this health consultation include toxaphene and dieldrin, both organochlorine pesticides, and historical information regarding other pesticides. This document describes ATSDR's evaluation and conclusions and where needed suggests ways to identify and reduce any potential hazards.

Background

The Red Panther Chemical National Priorities List (NPL) site is located at 1201 Normandy in Clarksdale, Mississippi. Red Panther operated as a pesticide plant between 1949 and 1996, producing both liquid and dry herbicides, insecticides, and fungicides, Various pesticides were produced including, but not limited to toxaphene, heptachlor, heptachlor epoxide, and dieldrin. Beginning in the 1970's, a number of actions by the company, state, and US Environmental Agency (EPA) took place in response to regulatory requirements and environmental concerns. Of most concern was possible exposures in the surrounding neighborhoods. The closest home is located approximately 250 feet from the site boundary to the west and the nearest school is an elementary school located about 1700 feet to the west.

Following ATSDR's evaluation of exposures to pesticides in the neighborhood surrounding the Red Panther Chemical NPL site, ATSDR concludes the following:

Conclusion 1:

ATSDR finds that exposure to toxaphene, heptachlor, heptachlor epoxide, and dieldrin in the residential soils in the 18th Street neighborhood would not be expected to harm human health under current exposure conditions.

Basis:

The concentrations detected in the residential soils during the 2010 Air Deposition Study and the 2005 Removal Assessment, while elevated above background levels, are well below levels believed to be associated with non-cancer health effects. The concentrations detected in these studies are well below EPA's upper acceptable risk.

Conclusion 2:	ATSDR is unable to determine to what extent past exposures to Red Panther pesticides occurred in the 18th Street community.
Basis:	Several community residents have provided independent anecdotal evidence of past exposure events that appear to be consistent with the current environmental data. However, over the course of years, the addition of clean topsoil or other activities affecting the soil in residential yards has likely lowered soil contaminant levels making it impossible to determine former soil levels. Previous actions by environmental authorities indicate potential exposure pathways have existed.
Recommendations	ATSDR recommends that, while environmental data does not indicate a health hazard under current exposure conditions, additional sampling should be performed to ascertain the extent of potential contamination from the south and west of the site and on-site near the septic field. Detailed sampling recommendations are provided in Section 4.
For More Information	You can call ATSDR at 1-800-CDC-INFO for more information on the Red Panther Chemical NPL Site.

List of Acronyms

ATSDR	Agency for Toxic Substances and Disease Registry
CDC	Centers for Disease Control and Prevention
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CREG	Cancer risk evaluation guide
CV	Comparison value
EMEG	Environmental media evaluation guide
EPA	U.S. Environmental Protection Agency
HHS	U.S. Department of Health and Human Services
mg/kg/day	Milligram per kilogram bodyweight per day
MRL	Minimal risk level
MsDEQ	Mississippi Department of Environmental Quality
NIOSH	National Institute for Occupational Safety and Health
NPL	National Priority List
ppm	Parts per million
Ppb	Parts per billion
RCRA	Resource Conservation and Recovery Act
RfD	Reference dose
RI	Remedial Investigation
RMEG	Reference dose media evaluation guide
SI	Site Investigation or Site Inspection
µg/kg	Microgram per kilogram of soil
µg/kg/day	Microgram per kilogram bodyweight per day
USGS	U.S. Geological Survey
VOC	Volatile organic compound

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1.0 Background

The Red Panther Chemical Company National Priority List (NPL) site is located at 1201 Normandy Avenue in Clarksdale, MS. After referral by the State and a number of site related activities, the site was proposed for the National Priorities List in March 2011 [1]. This prompted a legislative mandate requiring the Agency for Toxic Substances and Disease Registry (ATSDR) to conduct a Public Health Assessment or such other public health activities as deemed appropriate under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended [42 USC 9604(i)(6)]. This Public Health Consultation was prepared partially to fulfill that mandate. If additional information on the site (including possibly other environmental media) becomes available, ATSDR may conduct additional Consultations addressing public health issues related to this site.

1.1 Site History

Red Panther Chemical Company (referred to in this document as Red Panther) operated as a pesticides plant between 1949 and 1996. The plant produced liquid and dry herbicides, insecticides, and fungicides from raw materials. The site consists of approximately 6.5 acres between East Tallahatchie Street and Normandy Avenue and between Sasse Street and Ardennes Street. A warehouse across the street from the main production facility at the corner of Sasse and Normandy is also included in the site [2,3]. In conducting the 2010 Air Deposition Study, the US Environmental Protection Agency (EPA) discovered that Red Panther owned another adjacent lot at the corner of Sasse and Tallahatchie Streets near the railroad tracks that was not included in the original site boundary [3]. The area between DeSoto Avenue (MS Highway 322) and West Tallahatchie St. north of 18th Street is predominantly commercial and industrial sites. Beyond these businesses are residential areas. The closest home is approximately 250 feet from the site boundary across the railroads tracks to the west along 18th Street. The nearest school is the Booker T. Washington Elementary School located about 1700 feet from the site along 18th Street [4]. (See Figure 1 in Appendix A.) Table 1 summarizes what ATSDR considers the more significant events in the site's history. Complete details can be found in the Administrative Record maintained by the U.S. Environmental Protection Agency (EPA) [1,2,3,5,6,7,8,9,10,11].

Table 1. Significant Events

Year	Event
1949	Site begins operations as a pesticide formulator.
1971	Coahoma Chemical (previous owner) submits an application for a wastewater permit.
1975	Wastewater Permit issued by the state for coolant/wash water discharge into an on-site septic system.
1980	Red Panther submits application for a Hazardous Waste Permit under the Resource Conservation and Recovery Act (RCRA).
1984	Mississippi (MS) issues hazardous waste permit and conducts a RCRA Site Inspection.
1984	National Institute for Occupational Safety and Health (NIOSH) Industrial Hygiene Survey conducted.
1985	Building 16 (Product Warehouse) located on the liquid formulation side of the plant catches fire. 5,000 people evacuated from their homes.
1985	Red Panther advises MS during site inspection that toxaphene production ceased.

Year	Event
1986	State supervised removal of fiber drums found buried under warehouse debris from 1985 fire. It was noted that most did not appear to be used while others had residue of what the Company believed was dieldrin.
1989	MS conducts a sampling visit as part of a Preliminary Assessment to evaluate groundwater contamination near the site.
1990	MS conducts a site investigation.
1991	MS conducts a screening site investigation.
1996	Red Panther ceases all production; site is still used for warehouse and distribution by current operator (Coahoma Chemical).
1999	EPA conducts a site investigation.
2001	Potentially Responsible Parties (PRP) enter into a consent order with EPA to conduct investigations and cleanup activities.
2003	PRP removal action of contaminants found in drainage ditches to the east of the plant; overseen by EPA.
2004	Second removal action by PRP overseen by EPA removes soil contamination and storage tanks from the main plant.
2005	EPA conducts a removal assessment in the areas west of the plant.
2008	EPA conducts another site investigation focused on groundwater contamination.
2010	EPA conducts an air deposition study.

As indicated in Table 1, independent reviews of the site operations (e.g., State or Federal inspections and document reviews, etc.) did not begin until the laws requiring such reviews were passed in the 1970's. Operations at the plant prior to that are not clear. In 1984, the state conducted a site inspection and was provided a map of the plant, dated October 1980, indicating that the southern portion of the plant (roughly from Sasse Street to the plant entrance near Patton Street) was involved in the production of solid pesticide formulations while the northern portion of the plant was involved in liquid formulations [8, 12]. In that 1984 site inspection, the state collected a series of sediment samples in the drainage ditches around the site including a sample on the west side of the facility. Toxaphene at 428 parts per million (ppm) and dieldrin at 47 ppm (milligram per kilogram or mg/kg) were detected in a storm drain by the railroad tracks on the west side of the plant (Sample SD-08; see Figure 1). The removal action later that same year only addressed contamination on the east side of the plant, which had much higher contaminant levels [9]. These concentrations in Sample SD-08 are approximately 4 times and 20 times, respectively, higher than the current non-cancer health guideline values and represent a lifetime cancer risk of roughly 1.0×10^{-3}. While this early sample result is potentially significant for past exposures, this health consultation is based primarily on data from the 2010 air deposition study and from the 2005 removal assessment. (See Figures 2 and 3, respectively, in Appendix A.)

In 1984, the National Institute for Occupational Safety and Health (NIOSH) was conducting a nationwide investigation into the reproductive health effects, primarily for female workers, following exposure to organotin compounds. As part of that investigation, NIOSH conducted industrial hygiene surveys of various facilities that handled these types of chemicals. At the time, Red Panther was formulating, packaging, and distributing a pesticide that included tricyclohexyltin hydroxide as one of the active ingredients. The NIOSH report of their survey provides an excellent summary of the dry or solid pesticides handling at Red Panther. During the course of the survey, NIOSH measured dust conditions on the production line. The reported total particulate concentrations inside the facility ranged

from 0.7 up to 11 mg/m^3 averaged over 8 hour shifts. [13] The average concentration of dust was 2.35 mg/m^3. For comparison, the occupational standards for "particulates not otherwise classified" range from 10 to 15 mg/m^3 [14] and visible dust at construction sites has been reported at ambient concentrations around 2-3 mg/m^3. The average concentration on the second shift (4 pm to midnight) was over 4 times the average on the first shift (8 am to 4pm). [13]

NIOSH indicated in their report that the results may be skewed because of a problem in the production line that may or may not have been a common occurrence. Eliminating that sample, the maximum reading drops to 6.5 mg/m^3; the average concentration falls to 1.73 mg/m^3; and, the second shift concentrations drop to less than 3 times the first shift. NIOSH reported ventilation systems at key locations to capture the dust and workers were required to wear respirators in the plant. It is not clear from the NIOSH report how the ventilation system filtered the dusts and where the system exhausts were located. [It appears that NIOSH did not select Red Panther for the next phase of their investigation; probably because all of the 3 females working at Red Panther at the time were in the administration department and did not handle chemicals.] [13]

1.2 Chemicals Made or Used at Red Panther

Pesticides known to be produced by Red Panther include [3]:

Toxaphene	Aldrin	Arsenicals
DDT	Methyl Parathion	Chlorpyrifos
2,4-D	Malathion	Carbaryl
Diazinon	Methoxychlor	DSMA
MSMA	Chlorothalonil	Parathion

Other chemicals were used in the production process or detected in samples on site. [5, 6, 7, 12, 13, 15] These include:

m-Xylene	Ethylbenzene	Barium
Cyanide	Carbon Disulfide	2-Methylnaphthalene
Dieldrin	Ethylene Glycol	Asana
Vyddate	Caustic Soda	Methanol
Ethanol	"Aromatic 100" (aka Naphtha)	Dual (aka Metolachlor)
"T500 – 100" *	Cyclohexanone	Chlordane
Chloroform	Dichloromethane	Tetrachloromethane
Tricyclohexyltin hydroxide	Plictran	Thiodicarb
Thiram		

* - a mixture of similar aromatic compounds such as cumene, trimethylbenzene, ethylbenzene

While all of the compounds stored or used on the facility could be potentially released into the local community, many of the compounds listed were used in small quantities in the on-site laboratory. [7] These small quantities were unlikely to be released into the environment in amounts that could cause harm.

1.3 Demographics

Figure 4 in Appendix A shows the demographic breakdown of a 1 mile radius of the Red Panther site based on the 2010 census. The population within the 1 mile radius was 7,289 in 2010, a 20 % decrease from 9,428 in 2000. Approximately 97% of the population is black; 13% is aged 6 or younger; 11% is aged 65 or older; and 22% are women of childbearing years. Population density indicates a concentration to the west of the site known as the 18th Street Neighborhood with other densely populated areas to the east of the site across Desoto Avenue and southwest of the site on the far side of the city public works facility. The bulk of the population of the town is to the north and west of the site across State Street. However, the densest concentration of potentially sensitive populations (children 6 and younger; elderly 65; and older; women of childbearing years) is the area to the southwest of the site near the intersection of 20th Street and Center Street and to the east across Desoto Avenue. In contrast, the 18th Street Neighborhood currently consists mostly of adults under the age of 65 or children over the age of 6 with few women of childbearing age. In the past, it is likely that the demographic make-up of this neighborhood would have been different. The Health Resources and Services Administration, our sister agency in the U.S. Department of Health and Human Services, designated all of Coahoma County as a medically underserved area in 2011. [17]

2.0 Discussion

As indicated above, this consultation is focused on the data collected during the air deposition study in 2010 and the removal assessment sampling in 2005. The sample locations are shown in Appendix A (See Figures 2 and 3, respectively) [1,3]. We also focused on residential samples, primarily in the 18th Street Neighborhood. Additional information on the ATSDR evaluation process is provided in Appendix C [18]. In reviewing and interpreting environmental data, ATSDR begins by considering the quality of the environmental data provided. The sections of this discussion are laid out as follows: When the data is determined to be acceptable, ATSDR compares the maximum concentrations found with media specific health based comparison values (CV) (see subsection 2.1). When appropriate, statistical analysis of the environmental data may be performed. If the concentration of a chemical exceeds the comparison values, then ATSDR considers how individuals could be exposed to the chemical from that location; this is called an exposure pathway analysis (see Subsection 2.2).

For those chemicals found to exceed CV's and determined to be in a completed exposure pathway, ATSDR estimates the dose received by a community member living near that sample location. This dose is then compared with toxicological data or, when available, health guidance values. (Subsections 2.3 and 2.4).

ATSDR met with residents and state and local officials on various occasions and their concerns are summarized in Subsection 2.5. In the public health implications subsection (Subsection 2.6), ATSDR summarized the meaning of this analysis. General health information on the substances discussed beginning in subsection 2.3 is provided in Appendix D.

2.1 Chemicals above the Comparison Values.

Table 2 summarizes the maximum concentration of each of the compounds above the comparison values from each of the two sampling events considered. In the 2005 assessment, 22 surface soil samples (0-

6") were collected in residential settings. Four soil samples had toxaphene levels above the ATSDR comparison value and five samples had dieldrin levels above the ATSDR comparison value [1]. These sample locations are highlighted in Figure 3 (Appendix A).

In the 2010 study, 37 residential surface soil samples (0-3") were collected. The results from one sample were above the comparison values for heptachlor and heptachlor epoxide. The results from 6 samples (including the background sample) collected from 5 residential locations were found to be at levels above the comparison value for dieldrin. Four of the five sample locations at the site are highlighted in Figure 2 (Appendix A) by red ovals with yellow shading. One of the samples was a duplicate sample meaning that 2 samples were collected at the same location for quality control purposes. An additional location was a background sample collected approximately one mile north of the site and not shown on Figure 2.. In the 2010 study, an additional 6 samples were collected from the grounds of the closest school; no results from these samples were above the comparison values. [3]

Table 2
Chemicals identified above Comparison Values

Data Source	Compound	Number of Residential Detections	Range of Concentrations (µg/kg)	Average Concentration (µg/kg)	Comparison Values (µg/kg)	Number of Samples above Comparison
2010 Air Deposition Study	Dieldrin	30	1.2-840	58	CREG = 44	6
	Heptachlor	4	2.4-210	58	CREG = 160	1
	Heptachlor Epoxide	7	3.2-290	54	CREG = 77	1
2005 Removal Assessment	Toxaphene	4	810-4700	2978	CREG = 640	4
	Dieldrin	10	10-380	124	CREG = 44	5

CREG = Cancer risk evaluation guide based on a lifetime (70 year) 10^{-6} cancer risk
µg/kg = microgram of pesticide per kilogram of soil, also referred to as part per billion or ppb.

2.2 Exposure Pathway

Once contaminants that exceed health-based comparison values have been identified, then an evaluation is made on how individuals may come into contact with these contaminants. People can be exposed to a chemical only if they breathe it in (inhalation), eat or drink it (ingestion), or come into skin contact (dermal contact) with the substance. If no one is exposed to a chemical, then no harmful health effects can occur. Additionally, harmful effects may not occur with every exposure. The type and severity of health effects a person may experience depends on a number of factors, including:

1. The concentration of the chemical (how much chemical),
2. The exposure frequency (how often),
3. The exposure duration (how long),
4. The ease or ability of the body to absorb the chemical, and

5. The route or pathway of exposure (inhalation, ingestion, or dermal contact).

Once an exposure occurs, characteristics such as age, sex, nutritional status, genetics, lifestyle, and pre-existing health conditions of the individual influence how well the chemical is distributed, absorbed, and excreted. Together, the toxicity of the substance, the amount and kind of exposure, and the characteristics of the individuals who are exposed determine the health effects that may occur. [18] These individual characteristics are the main reasons why ATSDR cannot predict health outcomes for any given person.

An exposure pathway is the process by which an individual is exposed to a chemical. ATSDR identifies and evaluates exposure pathways by considering the following 5 elements:

1. A source of contamination (Where the chemical comes from)
2. Transport through the environment (Where the chemical goes after it is released)
3. A point of exposure (Where people may come into contact with the chemical)
4. A route of exposure (How the chemical can get into the bodies of people)
5. A receptor population (A group of people that may be harmed by the chemical).

ATSDR categorizes an exposure pathway as completed or potential. An example based on the interviews summarized in section 2.5 may help illustrate these 5 elements.

> Toxaphene dust from the packaging area of the plant (i.e., the *source*) may have been blown out the doors on a hot night into a drainage ditch where water from the last rain was moving towards the Sunflower River (i.e., the *transport* mechanisms). Children (i.e., the *receptor population*) playing in the drainage ditch to cool off (i.e., the *point of exposure*) splash water unintentionally into each other's mouth and then swallow (i.e., *route of exposure*).

An exposure pathway is considered complete if all 5 elements of an exposure pathway exist at a site. An exposure pathway is considered potentially complete if some of the elements are known to exist and the others are unknown. No exposure pathway exists if any of the 5 elements are known to be absent. [18]

Although the example of an exposure pathway above describes contamination due to surface water running off from the site, the focus of this health consultation is residential soils near the Red Panther site. While further characterization of the drainage paths from the site may be necessary, actions by the State before the site was listed (See Table 1) removed much of the contamination resulting from surface water runoff. Contaminants from the site detected in the yards of homes means that a completed exposure pathway exists for residents who come in contact with soil in their yards. ATSDR thus continues the evaluation to determine whether that exposure could cause harm.

2.3 Dose Calculations

The concentrations reported for soil samples in Table 2 do not represent what individuals may be absorbing. They have to be converted into doses in order to be compared with the relevant human or animal toxicological data available on the substance (see Appendix C). [18] Many variables affect how well any individual will absorb a chemical from soil and how that individual may react to that chemical. It is generally most difficult to predict or measure those variables, but we can estimate the possible

ranges for many of them. By selecting the highest values from those ranges, we can calculate the highest dosage that may be absorbed. An exposure to a lower concentration would result in a lower dose and less chance of harm occurring. For these chemicals, both ingestion and dermal exposures will be considered for soil and sediment samples in this subsection. Examples of each dose calculation discussed here is also shown in Appendix C.

2.3.1 Estimated dose by ingestion (swallowing)

The generic equation to calculate an exposure dose from an environmental concentration is:

$$D = \frac{C \times IR \times EF}{BW}$$

Where: D=Dose (in mg/kg/day)
C=Concentration (in mg/kg or milligrams/liter (mg/l))
IR=Intake rate (in mg/day or liters/day)
EF=Exposure factor (unitless)
BW=Body weight (in kg)
Other factors may be included as discussed in Appendix C.

" × " in the equation is the mathematical symbol for multiplication; identical to " * " in computer spreadsheets.

This dose calculation in Appendix C assumes 100% of the contaminant in the soil is available for absorption. As discussed in Appendix B, many organochlorine pesticides bind tightly to soil particles and may not be well absorbed by humans. Therefore, actual amounts absorbed from the GI tract are likely to be lower than the amount absorbed during the scientific studies from which the reference value was derived. To the extent this less efficient absorption occurs, the doses in tables 3 and 4 and the cancer risk in table 5 may be over estimated and health effects would be less likely to occur.

The comparison values used in Section 2.1 assumed a continuous exposure over a given period of time. In this section, an attempt is made to estimate a more likely exposure. The exposure factors in the equation above takes into account how often an individual is exposed (the frequency), how long each exposure event generally lasts (the duration), and how long this pattern of exposure lasts (averaging time) [18], In order to apply this equation to the exposure scenario discussed in section 2.2, ATSDR will assume the following for this site:

- C = the maximum concentration in Table 2 above.
- IR = 200 mg/day (less than 1/8 of a teaspoon) for an infant (less than 1 year old) or a child (aged 1-6) and 100 mg/day for an adult or older children
- The exposure factor will be based on the following assumptions: All residents are home 24 hours per day for 350 days per year. [Two weeks of absence from the home per year (e.g., vacation or summer camps or long weekends) will be assumed.]
- Body weight equals 10 kg (about 22 pounds) for an infant (less than 1), 16 kg (about 35 pounds) for a child (age 1-6), and 80 kg (176 pounds) for older children and adults.

A dose is calculated based on these assumptions and then compared with health guideline values or other toxicological information to determine if a health threat may exist. Please see Appendix C for examples of these calculations. The results for the compounds identified in Table 2 are shown in Table 3.

Table 3
Doses due to oral exposure from soil

Data Source	Compound	Maximum Concentration Detected (µg/kg)	Infant Dose (µg/kg/day)	Child Dose (µg/kg/day)	Adult Dose (µg/kg/day)	Health Guideline Value (µg/kg/day)
2010 Air Deposition Study	Dieldrin	840	0.0002	0.0006	0.0006	0.05*†
	Heptachlor	210	0.00005	0.0002	0.0002	0.5† 0.1§
	Heptachlor Epoxide	290	0.00007	0.0002	0.0002	0.013†
2005 Removal Assessment	Toxaphene	4,700	0.001	0.004	0.002	20§ 80†
	Dieldrin	380	0.00009	0.0003	0.0001	0.05*†

* – Based on ATSDR's chronic oral minimal risk level
† – Based on EPA's reference dose
§ – Based on ATSDR's intermediate oral minimal risk level
µg/kg = microgram of the chemical per kilogram of soil
µg/kg/day = microgram of the chemical per kilogram of bodyweight per day.

2.3.2 Estimated Dose by Dermal Absorption (Skin Contact)

Although the pesticides in Table 2 do not seem to be absorbed well through the skin, some animal studies indicate some penetration of the skin is possible under some circumstances. [16, 19, 20] A dermal absorption factor has not been derived by EPA for these pesticides; therefore, ATSDR is using the median value for the 4 other organo-chlorine pesticides listed in the EPA Risk Assessment Guidance. [See Appendix C] For dermal exposure, the following assumptions will be made:

* An infant crawls in the dirt twice a day, exposing arms, hands, legs, and feet;
* a child walks barefoot in the yard every day, exposing legs and feet; and,
* an adult mows the lawn once a week, exposing arms and hands.
* A skin absorption factor of 0.04 based on the median value of the skin absorption factor for other organo-chlorine pesticides

From these basic assumptions, a dose is calculated per each event by age and then a cumulative dose over the expected duration of exposure is calculated and presented in Table 4. The cumulative dose is then compared with oral health guideline values because dermal health guideline values are not available. Please see Appendix C for sample calculations.

Table 4

Doses due to dermal exposure from soil

Data Source	Compound	Maximum Concentration Detected (µg/kg)	Infant Dose (µg/kg/day)	Child Dose (µg/kg/day)	Adult Dose (µg/kg/day)	Health Guideline Value (µg/kg/day)
2010 Air Deposition Study	Dieldrin	840	0.00005	0.00007	0.000007	0.05*†
	Heptachlor	210	0.000002	0.000002	0.0000006	0.5† 0.1§
	Heptachlor Epoxide	290	0.00001	0.00002	0.000002	0.013†
2005 Removal Assessment	Toxaphene	4,700	0.0003	0.0004	0.00004	20§ 80†
	Dieldrin	380	0.00002	0.00003	0.000001	0.05*†

* – Based on ATSDR's chronic oral minimal risk level
† – Based on EPA's reference dose
§ – Based on ATSDR's intermediate oral minimal risk level
µg/kg = microgram of the chemical per kilogram of soil
µg/kg/day = microgram of the chemical per kilogram of bodyweight per day.

Under the exposure assumptions described in Section 2.2, the combination of the dermal and oral doses shown in Tables 3 and 4 from the maximum concentration of all compounds during the 2010 air deposition study and the 2005 removal assessment were below health guideline values. [18,19,20,21,22,23] Because the calculations were based on the maximum concentration detected, none of the other detections in the two EPA studies would be expected to result in doses as high as indicated here. Therefore, non-cancer health effects would not be expected from these doses of these chemicals.

2.4 Cancer Risk

In Subsection 2.3, exposure by skin contact and swallowing the soil was considered. None of the chemicals in Table 2 have been associated with cancer through dermal exposures; however, some animal studies indicate dermal absorption is possible. [16,17,20] Therefore, the dermal dose will be included in these calculations.

All four of the pesticides discussed in the previous sections are considered probable human carcinogen based on adequate information in animal studies (EPA cancer class B2). [21, 22, 23] All four compounds have cancer slope factors developed by EPA. Generally speaking, the higher the cancer slope factor, the greater is the cancer risk. A chemical with a higher cancer slope factor is sometimes referred to as a more potent carcinogen (cancer causing agent). In Table 5, the estimated lifetime cancer risk for an individual growing up from childhood to adult in the same home over 30 years of residency is provided. The value is based on the combined oral and dermal dose multiplied by the cancer slope factor and an exposure factor to adjust for a lifetime of exposure as described in Appendix C. [16, 19, 20]

The target lifetime cancer risk range in the Superfund process is from 1×10^{-4} to 1×10^{-6}. Under most circumstances, actions are not required below this range. In most cases, actions will be initiated if the estimated risk is substantially above this range. Within this range of estimated risk, further consideration is necessary. Based on the exposure assumption described in Section 2.2 and using the doses calculated in Section 2.3, the estimated lifetime cancer risks for all chemicals are in the lower half of the risk range. Dieldrin is the highest at 2.6×10^{-5}.

Table 5
Estimate Cancer Risks due to Exposure from Soil

Data Source	Compound	Maximum Concentration Detected (µg/kg)	Cancer Slope Factor $(mg/kg/day)^{-1}$	Life Time Cancer Risk
2010 Air Deposition Study	Dieldrin	840	16	2.6×10^{-5}
	Heptachlor	210	4.5	1.8×10^{-6}
	Heptachlor Epoxide	290	9.1	5.0×10^{-6}
2005 Removal Assessment	Toxaphene	4,700	1.1	7.9×10^{-6}
	Dieldrin	380	16	9.3×10^{-6}

µg/kg = microgram of pesticide per kilogram of soil
(mg/kg/day) = milligram of pesticide per kilogram of bodyweight per day.
-1 means the units in the parenthesis are inverted
1 mg = 1000 µg.

The concentration of dieldrin, under the anticipated exposure conditions discussed in Subsection 2.2, represents a dose that is slightly above the lower end of the EPA targeted risk range for carcinogens. Dieldrin has been associated with breast cancer in some but not all studies of humans; the route of exposure in these studies is not well defined. Dieldrin is also strongly associated with liver cancer in mice but less so with liver cancer in rats. [19] In the 2010 Air Deposition Study, the highest concentrations of dieldrin were found between 13th and 14th Streets along Center Street (Figure 2 in Appendix A.) In the 2005 Removal Assessment, the highest concentration of dieldrin was found in along 15th Street between Center Street and W. Tallahatchie (Figure 3 in Appendix A). The two studies did not sample the same yards in the neighborhood. Assuming the source of the pesticides is Red Panther, these 9 dieldrin samples (and the 4 toxaphene samples) above the comparison values might indicate a fairly wide dispersal through the neighborhood. [The heptachlor and heptachlor epoxide concentrations were found in one of the dieldrin samples.] In the 2010 air deposition study, EPA also detected dieldrin in three residential background samples. The highest detection was 52 µg/kg; (roughly 10 times less than the highest concentration found in the neighborhood). The fact that one of the three residential background samples from the 2010 study is also above the comparison value for dieldrin may indicate that Red Panther is not the source of dieldrin in the community. However, the difference in concentrations between the 18th Street neighborhood samples and the background may indicate a source of dieldrin is closer to the neighborhood than the rest of the community.

Toxaphene was not identified in residential soils at levels above our comparison values during the 2010 air deposition study. Figure 2 in Appendix A shows approximate contours of toxaphene concentrations during the air deposition study. The comparison value ATSDR used (i.e., 640 µg/kg) is slightly higher than the lower end of the range (i.e. 500 µg/kg) for the yellow shading in these contours. However, the actual sample values in the residential yards within the yellow shading were below the comparison value of 640 µg/kg (that is, between 500 µg/kg and 640 µg/kg). In the 2005 removal assessment, toxaphene was found in 4 residential samples. One sample each was located on 13th, 14th, 15th, and 16th Streets. The homes on the latter three streets were closer to Center Street while the home on 13th Street was closer to West Tallahatchie Street (Figures 2 and 3 in Appendix A). The estimated cancer risk for the maximum concentration of toxaphene under the assumed exposure scenario at these homes is slightly above the lower end of the EPA targeted risk range for carcinogens. Toxaphene is associated with liver and thyroid cancers in animals through ingestion. Two studies involving farm workers associated leukemia and non-Hodgkin lymphoma (NHL) after inhalation exposure to toxaphene. [16]

All four of the chemicals in Table 5 are associated with liver cancers. [16,19,20] Dieldrin and the two heptachlor compounds may be associated with breast cancer in humans. [19,20] Dieldrin may also be associated with biliary tract cancer (i.e., gall bladder). [19] Toxaphene may be associated with leukemia in humans and has been linked to thyroid cancers as well. [16] Given that all four compounds are associated with liver cancers, the combined risks may be considered additive and the overall risk from these maximum concentrations would be 1.3×10^{-4}. These four chemicals were not found at the same location at their maximum concentration; therefore, the actual cancer risk would be expected to be below this estimated maximum. Please see Appendices D and E for a discussion of cancer that can help put these estimated risks into perspective.

2.5 Community Concerns

In July and August of 2011, ATSDR staff met with 17 individuals and discussed their concerns about this site. Six were current residents; 1 was a former resident; 3 were former employees of Red Panther; 8 were from nearby businesses, including 2 daycare centers; 1 was the pastor of a church; and 3 were public officials (some individuals represented more than one group). Of the 7 current and former residents, 4 had relatives who were former employees of Red Panther. Almost everyone we spoke with was aware that Red Panther made pesticides.

Health concerns included reports that skin rashes and respiratory problems were common amongst their families. One resident mentioned having convulsions as a child living in the neighborhood. More than one of the residents reported that peach trees in the neighborhood were stunted in growth, had discolored leaves, and had stopped bearing fruit. They reported that a white to yellowish powder was commonly found on vegetables in gardens and floating on the water in the drainage ditches. They further indicated that plants would grow only after fresh soil was added to the gardens. One resident recalled eating berries with dust on them from the bushes near the plant with her friends. Another remembered swimming with friends in one of the drainage ditches with yellow powder. Another resident remembered the water from the drainage ditches running into their yard and their dog dying shortly after eating food that contacted the water. Another resident remembered sliding off the sloped metal roof of the solid pesticide line at the plant after normal working hours. One resident remembered 3 evacuations over the years, but the rest only recalled the evacuation due to the fire in 1985. One resident

remembered a tank explosion at the plant in the 1970's. Another resident remembered what he described as chemical mists and dusts coming off the site into their neighborhood.

Of the former employees, all remember dusty conditions and only one remembered routinely washing the dust off before leaving work. While they were given dust masks by the company, the workers often removed them because they would become clogged from the dust. They reported the dust would get into their clothing and into their eyes. One employee reported the dust changed the pigment of their skin and all former employees reported skin rashes, vision effects, and respiratory problems. Relatives of a former employee recounted how the worker would come home and cough up a yellow dust. One employee who was also a resident noted that after production of the pesticide Blade-X (Cyanazine), plants in the neighborhood became stressed and ultimately died apparently from the dust emissions. It should be noted that Blade-X is not on the list of pesticides made at Red Panther (See Section 1.2).

The current fire chief was involved in the response to the warehouse fire in 1985. He remembered the firefighters did not wear respiratory protection and several were ill after the fire. The drainage ditches around the plant had a bright yellow liquid in the runoff. The Police Chief and the Mayor indicated that the community was concerned that the contamination at the plant may have affected their health. The Mayor described an incident where several dead rodents were found on the plant site.

Symptoms described by the residents in our discussions that are consistent with exposure to organochlorine pesticides include: cancer, gastrointestinal disorders, cardiovascular effects, respiratory irritation, skin rashes, and neurological effects. These symptoms can have many causes, so it is likely not possible to attribute these health effects to the exposures. A review of current cancer statistics available from the National Cancer Institute's Surveillance Epidemiology and End Result (SEER) [available at www.cancer.gov] indicates that Coahoma County has an age adjusted incidence rate (i.e., diagnosis) for the type of cancers associated with these pesticides well below the State and National trends. [24] Data was not available from this site at the neighborhood level.

2.6 Public Health Implications

Table 1 above indicates a history of investigations and enforcement activities at this site since roughly the late 1970's that provides good information on conditions and operations at the site. As is often the case, information about the site prior to 1975 is less complete. The anecdotal information from the residents that was discussed in section 2.5 indicated a recurring pattern of releases from the facility into the community. The statements about residents replacing topsoil over the years may indicate subsurface contamination could be masked by the clean soil placed on top of the original dirt. Depending on where the replacement topsoil came from (e.g., a treated agricultural field), this soil may also contain trace amounts of chemicals that contributed to the overall pollution load in the residential yard. The available environmental data indicates the present human health hazard in the closest residential community is minimal. However the absence of environmental data prior to 1975 makes any evaluation of those early exposures difficult.

The ATSDR ToxFAQs for these chemicals are available on the Toxic Substance Portal at our website – www.atsdr.cdc.gov. For convenience, copies of these documents are provided in Appendix D. Given the many years of pesticide formulations at this location, it is possible that exposures to different, possibly higher or lower, concentrations of these or other pesticide associated with this site as described in section 1.1 may have occurred in the past. The comments and descriptions of the residents as they

grew up in the community discussed in section 2.5 suggest that such past exposures in the community to products made or formulated at the Red Panther facility may have been much greater than the data from the studies considered here would indicate. Again, the absence of environmental data in the neighborhood from that timeframe prevents a thorough evaluation of that exposure. In many cases, natural degradation of the pesticides - as discussed in the description of pesticides classes in Appendix B - would prevent the collection today of additional information to fill this data gap. Two exceptions may be suggested from the available data.

The toxaphene and dieldrin detected in the storm drain on the west side of the facility in 1984 described in section 1.1 (Sample SD-08) has not been investigated in detail as yet, based on the information provided to ATSDR. The reported concentrations in this sample were three orders of magnitude above the comparison values used in this consultation (e.g., the CREGs shown in Table 2). The EPA remedial project manager has received information from local authorities that drainage on the west side of the Red Panther facility would generally flow south towards Hicks Street and then cross the railroad tracks through a subdivision to a water treatment plant along the Sunflower River southwest of the 18th street neighborhood. [25] However, as indicated in Figure 4 in Appendix A, that residential area south of the Booker T. Washington Elementary School has a higher density of young children and women of child bearing years than the 18th Street Community. It would be prudent to investigate the fate and transport of the pesticides that seemed to have been discharged on the west side of the site to determine if there is a current exposure in this neighborhood.

As described in Table 1 above, wastewater from the pesticide operations were captured in an on-site septic system. While the area of the septic system has been investigated in the past, the analysis of the samples seems to have been limited to organochlorine pesticides. Normally, this would be appropriate and adequate. However, many of the environmental degradation processes of other pesticides associated with this site rely on exposure of those pesticides to the open environment. Discharged at a depth of up to 10 feet below the ground, it is unlikely that exposure to the open environment was possible. Given the overall low mobility in soils of most pesticides, direct exposure to these pesticides is unlikely. However, it would be advisable to verify these other pesticides from Red Panther's history are not present in the general area of the septic system in case conditions change (e.g., the soil in that area is excavated and moved to a location where exposure is more likely).

3.0 Conclusions

Conclusion 1: ATSDR concludes that exposure to toxaphene, heptachlor, heptachlor epoxide, and dieldrin in the residential soils in the 18th Street neighborhood is not expected to harm human health under current exposure conditions.

Basis: The concentrations detected in the residential soils during the 2010 Air Deposition Study and the 2005 Removal Assessment, while elevated, are well below levels believed to be associated with non-cancer health effects for humans under the estimated exposure conditions. The concentrations detected in these studies are only slightly above the lower end of EPA's target lifetime risk range for cancer effects under current exposures.

Conclusion 2: ATSDR is unable to determine to what extent past exposures to these pesticides and others may have occurred in the 18th Street community due to operations at Red Panther.

Basis: Several community residents have provided independent anecdotal evidence of past exposure events that appear to be consistent with the current environmental data. In addition, previous actions by environmental authorities indicate potential exposure pathways have existed. However, over the course of years, the addition of clean topsoil and similar actions taken by homeowners in their yards has likely lowered soil contaminant levels making it impossible to determine former soil contaminant levels.

One potential pathway is via the storm drainage from the west side of the plant. The contamination detected in the only soil sample collected on the west side of the plant in 1984 may not have been addressed in the response actions and the site investigations to date.

A second potential pathway is on site below the surface. Disposal in a septic system may have prevented the normal degradation of at least some pesticides associated with this site. If present at depth, these chemicals should not pose any threat under current conditions. If conditions change (e.g., contaminated soil removed from this area of the site to off-site locations), then a pathway of exposure may be inadvertently created.

4.0 Recommendations

ATSDR recommends that, while environmental data does not indicate a health hazard under current exposure conditions, additional sampling should be considered to ascertain the extent of potential contamination to the south and west of the site. Such sampling may include the following:

- Subsurface soil samples from homes identified as having elevated dieldrin and toxaphene levels in the 2010 Air Deposition Study and the 2005 Removal Assessment or in homes whose current residents are aware of topsoil replacement to determine the effectiveness of these impromptu removal efforts.
- Additional surface and subsurface soil samples from homes adjacent to those having elevated dieldrin and toxaphene levels in the two EPA studies discussed in section 2 above.
- Sampling and other characterization along the drainage pathway from the 1984 detection of toxaphene and dieldrin in the storm drain on the west side of the facility to determine the actual fate and transport of the discharges from this location.
- Sampling and other characterization efforts to identify and evaluate the fate and transport of discharges through the on-site septic system installed under the wastewater permit issued by the state.

The conclusions and recommendations in this health consultation are based on the information reviewed and collected by ATSDR. Additional or new information may affect these conclusions and subsequent recommendations. ATSDR is available to review additional information as it becomes available.

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ATSDR Glossary of Environmental Health Terms

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency with headquarters in Atlanta, Georgia, and 10 regional offices in the United States. ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. ATSDR is not a regulatory agency, unlike the U.S. Environmental Protection Agency (EPA), which is the federal agency that develops and enforces environmental laws to protect the environment and human health. This glossary defines some of the words used by ATSDR in communications with the public.

Absorption -The process of taking in. For a person or animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.
Acute exposure -Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with intermediate duration exposure and chronic exposure].
Adverse health effect -A change in body function or cell structure that might lead to disease or health problems.
Background level -An average or expected amount of a substance in a specific environment, or typical amounts of substances that occur naturally in an environment.
Biologic uptake -The transfer of substances from the environment to plants, animals, and humans.
Cancer -Any one of a group of diseases that occurs when cells in the body become abnormal and grow or multiply out of control.
Cancer risk -A statistical probability for getting cancer if a given population is exposed to a substance – typically calculated for an exposure of every day for 70 years (a lifetime exposure). The actual occurrence of cancer in that population might be different.
Carcinogen -A substance that causes cancer.
Chronic exposure -Contact with a substance that occurs over a long time (more than 1 year).
Comparison value (CV) -Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) - CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances.
Concentration -The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.
Contaminant -A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.
Dermal contact -Contact with (touching) the skin.
Dose -The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An exposure dose is how much of a substance is encountered in the environment. An absorbed dose is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

Dose-response relationship -The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).
Environmental media -soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.
Environmental media and transport mechanism -Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.
Exposure -Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].
Exposure assessment -The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.
Exposure pathway -The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching); and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway. In most cases, response actions like remedial actions or removal actions are designed to interrupt the exposure pathway in order to reduce or eliminate harm.
Hazard -A source of potential harm from past, current, or future exposures.
Hazardous Materials – Substances that may cause harm to people, property, or the environment under some circumstances. In the US, Hazardous Materials are defined by the US Department of Transportation under the authority provided in the Hazardous Materials Transportation Act. See 49 CFR 172. All Hazardous Substances are Hazardous Materials, but not all Hazardous Materials are also Hazardous Substances.
Hazardous Substances – Substances that may cause harm to people or the environment under some circumstances. In the US, Hazardous Substances are defined by the US EPA under the authority provided in pollution laws such as CERCLA. See 40 CFR 302. Most Hazardous Wastes are also considered Hazardous Substances, but Hazardous Substances may not always be Hazardous Wastes.
Hazardous waste -Potentially harmful substances that have been released or discarded into the environment. In the US, Hazardous Wastes are defined by the EPA under their authority provided by the Resource Conservation and Recovery Act. See 40 CFR 260.
Ingestion -The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way.
Inhalation -The act of breathing. A hazardous substance can enter the body this way.
Intermediate duration exposure -Contact with a substance that occurs for more than 14 days and less than a year.
Lowest-observed-adverse-effect level (LOAEL) -The lowest tested dose of a substance that has been reported to cause harmful (adverse) health effects in people or animals.
Migration -Moving from one location to another.
Minimal risk level (MRL) -An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of

harmful (adverse) health effects. That is, health effects are not inevitable if an environmental exposure exceeds the ATSDR MRL.

National Priorities List (or NPL) – EPA's list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis. Once a site is nominated for the NPL, certain actions in conjunction with a series of partner agencies are required of ATSDR by law.

No-observed-adverse-effect level (NOAEL) -The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

Point of exposure -The place where someone can come into contact with a substance present in the environment.

Prevention -Actions that reduce exposure or other risks, keep people from getting sick, or keep disease from getting worse.

Public comment period -An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public availability session -An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members and others to discuss health and site-related concerns.

Public health assessment (PHA) -An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health.

Public health consultation (HC) – An ATSDR product that answers a specific question regarding human health and hazardous substances. A HC may be verbal or written; if verbal, documentation of the HC will be developed after the fact. A HC may deal with a particular chemical or group of chemicals, a particular site, a specific release, a particular environmental media, a particular exposure, or a combination of all of these. A HC is a more focused document than a PHA, providing only enough information to answer the question posed to ATSDR. A series of HCs may be prepared in lieu of a single PHA for longer term responses like an NPL site.

Reference dose (RfD) -An EPA estimate, with uncertainty factors built in, of the daily dose of a substance that is unlikely to cause harm in humans over a lifetime of exposure.

Remedial investigation (RI) -The CERCLA process of determining the type and extent of hazardous material contamination at an NPL site. The data from an RI may be used to help determine the feasibility and scope of actions to remediate the site.

Remedial Action - Remedial Actions under Superfund are cleanup operations to resolve those hazards identified in the RI. Remedial actions may take years to complete and are often broken up into phases or specific portions of the site called operable units.

Removal Action – Removal Actions under Superfund are generally shorter-term response actions than Remedial Actions to address specific hazards at a site. Removals can happen at any time in the process from initial discovery until the site cleanup is determined to be complete.

Risk – The risk of harm exists when there is an exposure to a hazard. If the hazard can be removed, there is no further risk of harm. If the amount of exposure can be reduced, the risk of harm is also reduced.

Sample -A portion or piece of a whole. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Soil/Sediment – Sediments are soil samples taken from a streambed, lake, or other body of water. As opposed to soil samples, sediment samples usually have a high moisture content and may be more conducive to biological degradation of some chemicals than surface or subsurface soils.

Site Investigation – Any of a number of different types of field investigations of a site in order to determine the hazards associated with the site and the feasibility of the site being listed on the NPL. An SI may prompt further investigations or removal actions.
Source of contamination -The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.
Substance – As used here, a chemical.
Surface/Subsurface Soil Samples – Depending on the circumstances, the difference in depth between surface and subsurface samples is somewhat discretionary. Generally speaking, ATSDR assumes surface samples will be collected from a depth of 0-2 inches. With ground cover and caps, depths of up to 6 inches may be considered surface soils. Generally speaking any sample greater 6 inches would be considered subsurface.
Survey -A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment.
Toxicological profile -An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.
Toxicology -The study of the harmful effects of substances on humans or animals.
Uncertainty factor -Mathematical adjustments applied when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Uncertainty factors as used in toxicology should not be confused with safety factors, as used in other disciplines like engineering

7.0 Appendix

A. Figures
B. Pesticides
C. ATSDR Evaluation Process
D. Cancer and Carcinogens
E. ToxFAQ – Toxicological Frequently Asked Questions

Appendix A: Figures

Figure 1: Location of Red Panther

Figure 2: 2010 Air Deposition Sample locations

Figure 3: 2005 Removal Assessment Sample locations

Figure 4: Community Demographics

Figure 1: Location of Red Panther Chemical NPL Site

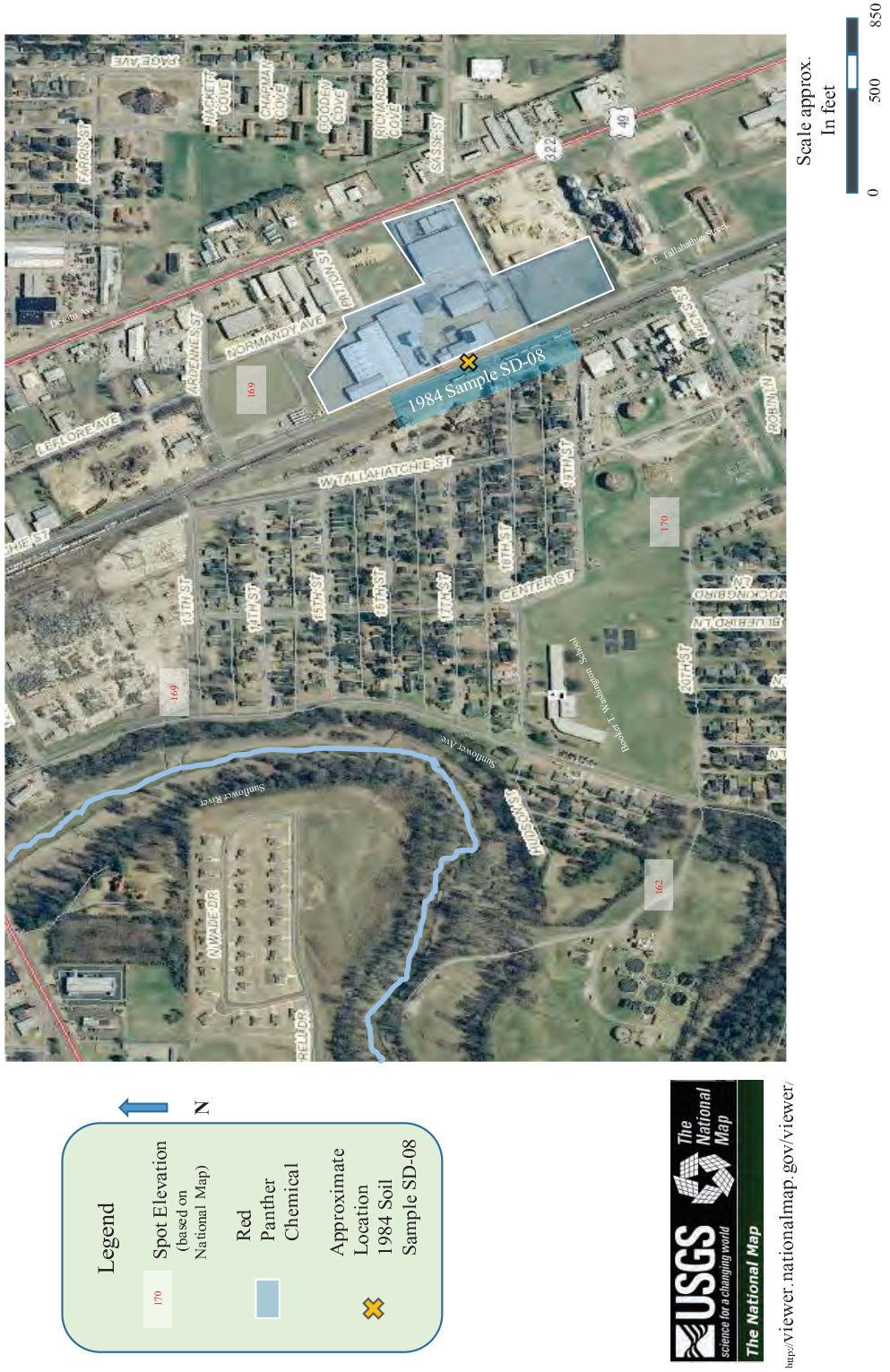
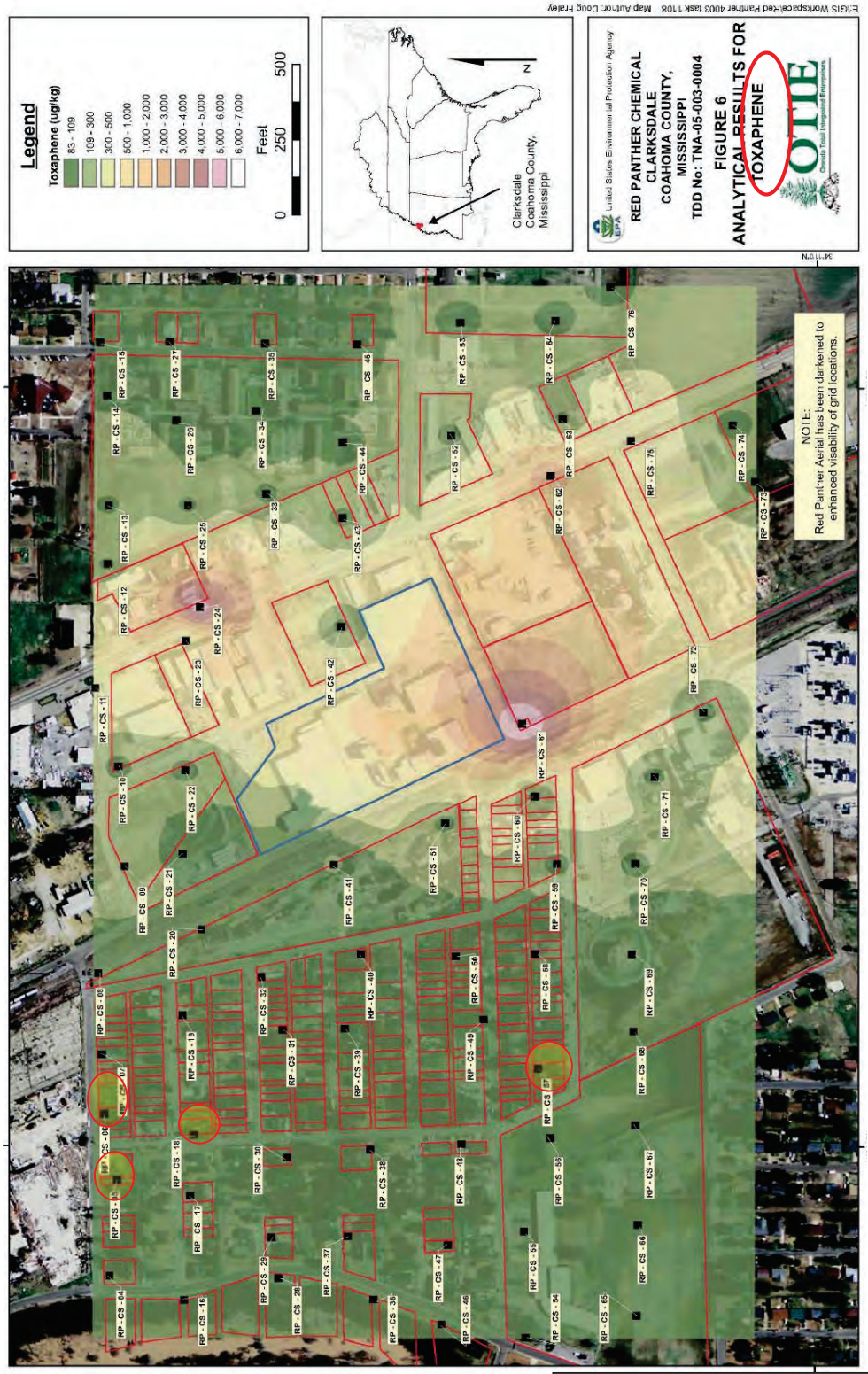
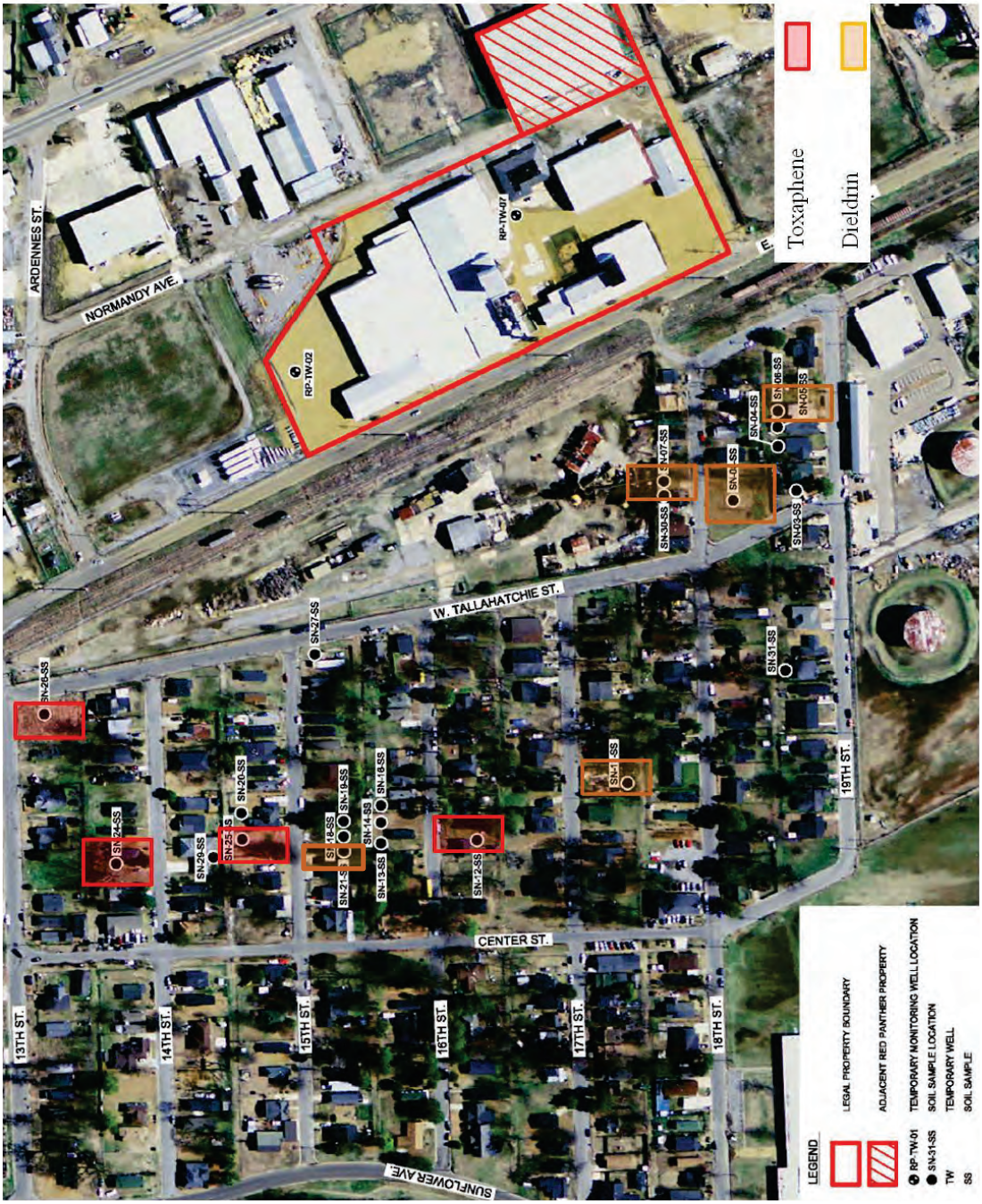


Figure 2: 2010 Sample Locations



Residential sample locations with high dieldrin, heptachlor, or heptachlor epoxide

Figure 3: 2005 Sample Locations



OTIE
Oneida Total Integrated Enterprises

FILE NAME: FIGURE 3 – SAMPLE LOCATION MAP – NOV 2010.DWG

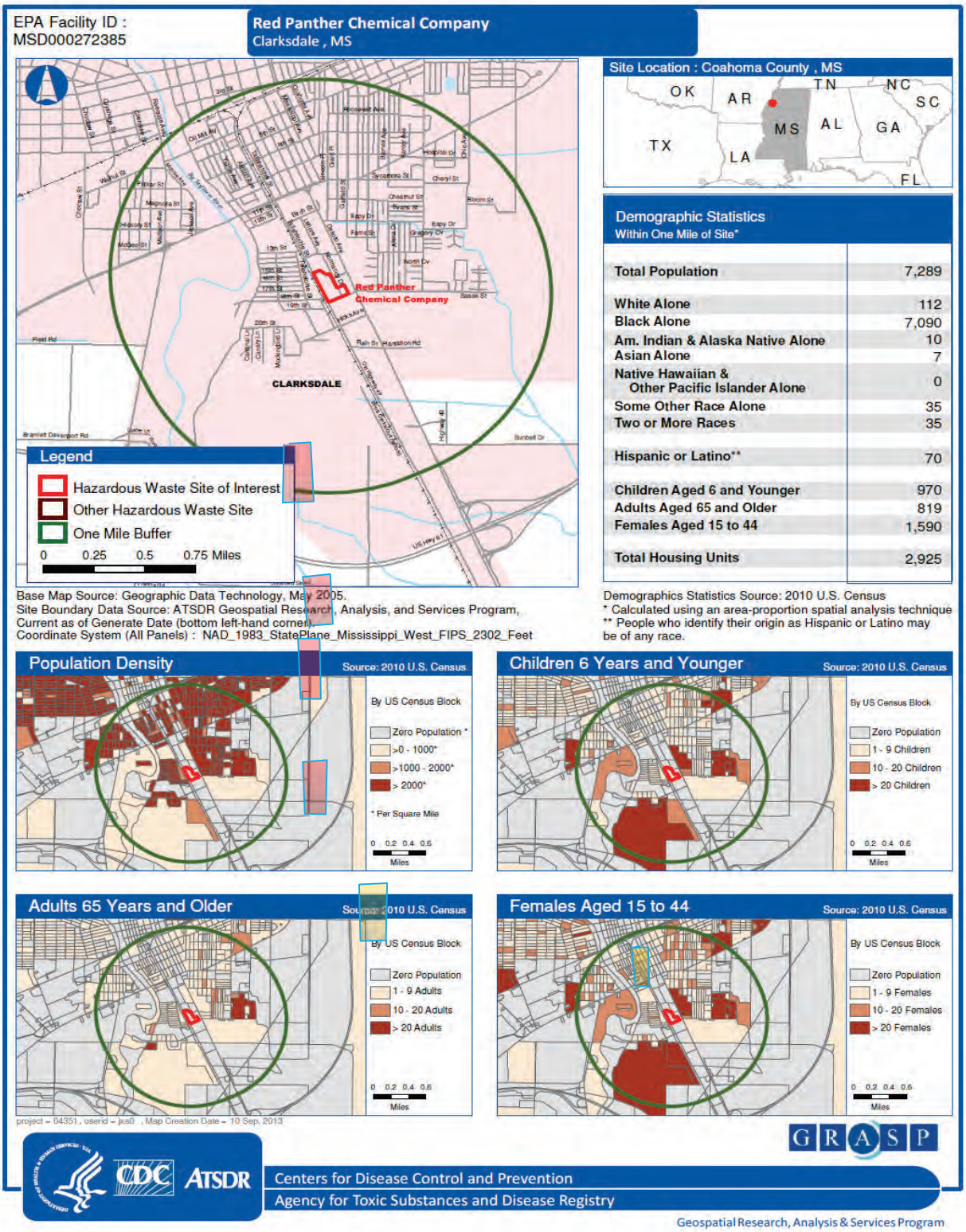
N

REFERENCES:
RESIDENTIAL SAMPLE LOCATIONS FROM: WESTON, FINAL REMOVAL ASSESSMENT LETTER REMOVAL REPORT: 18TH STREET NEIGHBORHOOD, DECEMBER 22, 2006.
BASEMAP FROM: WESTON, FINAL REMOVAL ACTION LETTER REPORT, REVISION 1: RED PANTHER CHEMICAL COMPANY, DECEMBER 27, 2006.
GROUNDWATER LOCATIONS FROM: TN&A, SITE INVESTIGATION REPORT FOR THE RED PANTHER CORPORATION, REVISION 1, SEPTEMBER 22, 2006.

Sample Result above Toxaphene Comparison Value

Sample Result above Dieldrin Comparison Value

Figure 4: Community Demographics



Appendix B: Pesticides
Oraganochlorines: Toxaphene and Dieldren

General: Most pesticides in their pure form are solids or semi-solids. In order to be used with liquid sprayers or granular spreaders, the pesticides often have to be dissolved in a liquid other than water or mixed with other solids that keep the pesticide from clumping. These liquids and other solids tend to be called carriers. Carriers can affect how a pesticide interacts with humans, animals, pests, and the environment. For instance, a pesticide may be odorless but a liquid solvent used as the carrier may have a very distinctive smell. In order to provide consistently reviewed information, the information provided in this appendix is based on the pure pesticides, primarily from the Hazardous Substance Databank (HSDB) in the Toxicology Data Network (Toxnet) available at the National Library of Medicine website [toxnet.nlm.nih.gov]. The pesticide formulation that may have been released or produced at any given site may be different. Those differences should be listed in the Safety Data Sheets (formerly, Material Safety Data Sheets) for the specific formulation by a specific manufacturer.

Additional sources of information on pesticides are available at the following websites:

http://www2.epa.gov/pesticide-worker-safety/recognition-and-management-pesticide-poisonings

http://www.epa.gov/pesticides/about/types.htm

http://www.who.int/ipcs/publications/pesticides_hazard/en/

http://www.epa.gov/pesticides/pfate

http://npic.orst.edu/

http://www.atsdr.cdc.gov/substances/index.asp

Organochlorine Pesticides Sample compounds: Toxaphene & Dieldrin

Organochlorine pesticides tend to be colorless to yellowish solids with a slight fruity or piney odor. (1,2) They are used as insecticides and most liquid formulations have a petroleum (2) or aromatic hydrocarbon carrier (1). Some formulations may be combustible. (1) These pesticides tend to sink and dissolve slowly in water. (1,2) They vaporize slowly and break down in the open air in a few days. Organochlorine compounds generally have low mobility in most soils, strongly adsorb to soils and sediments, and tend to break down very slowly. (1) Once released into the environment, they may persist for years or decades. (1,2) Organochlorine pesticides in water will tend to cling to sediments and can last for years in the water. (1,2) Generally speaking, the more chlorine in the formula, the more persistent the chemical. Some of these chemicals will accumulate in fish and other wildlife. (1,2) Depending on the formulation, these pesticides may have low odor thresholds, meaning many people can smell them at low concentration. (2)

Organochlorine pesticides are absorbed best by ingestion, less so by inhalation, and barely by skin contact. Like other pesticides, additives may be put into products to improve absorption and some products are actually well absorbed through the skin. Generally, liquid formulations are more readily absorbed than powder ones. Organochlorine pesticides are metabolized slowly and tend to accumulate in fatty tissues. (1,2) They may be retained in our system for months to years. (2) Similar blood levels of organochlorine pesticides in mothers and unborn offsprings implies that these compounds may affect the children. (2)

Many organochlorine chemicals cause cancer in animals and are considered probable carcinogens in humans. (1) These pesticides mildly irritate the skin and eyes unless in the presence of moisture; exposure to sweaty skin may increase the irritation. Symptoms of exposure include muscle tremors, diarrhea, vomiting, convulsions, respiratory irritation, liver and kidney damage, cardiac arrest, and damage to chromosomes. Individuals may experience nervous system effects like numbness or tingling of hands and feets, confusion, headaches, and fatigue. Many of these compounds are considered endocrine disruptors, meaning that they can affect hormones. (1,2)

Based on animal studies, health effects may begin at 0.5 mg/kg/day (2) to 2 mg/kg/day (1). ATSDR has established a chronic oral MRL of 0.05 mg/kg/day for dieldrin, which is equal to the EPA RfD. ATSDR has established a chronic MRL of 0.002 mg/kg/day for toxaphene. Occupational standards are 0.5 mg/m3 for toxaphene and 0.25 mg/m3 for dieldrin. (1,2)

(1) HSDB, 2005. Toxaphene. Hazardous Substance Databank, Toxicology Data Network. National Library of Medicine, National Institutes of Health. Bethesda, MD. Last revised: Aug. 2005

(2) HSDB, 2005. Dieldrin. Hazardous Substance Databank, Toxicology Data Network. National Library of Medicine, National Institutes of Health. Bethesda, MD. Last revised: August 2005.

EPA Reference Doses (RfDs) are available at www.epa.gov/iris.
ATSDR Minimal Risk Levels (MRLs) are available at www.atsdr.cdc.gov/substances.

Arsenical pesticides Sample compound: DSMA; MSMA

Arsenical pesticides tend to be organic salts and generally are white solids that mix readily with water. Most of these compounds are heavier than water and the dissolved solids would tend to collect near the bottom of still waters like ponds. They do not vaporize much at all and tend to form arsenic salts in the soils. These compounds are not very mobile in soil and tend to stay where they are applied. Organic arsenical pesticides are generally used as herbicides. (1,2)

Organic arsenicals are not carcinogenic by themselves. (1) Other forms of arsenic compounds are known human carcinogens. It is possible that, after application in the open environment or absorption, these compounds may be transformed under some conditions into a one of these other forms of arsenic. These pesticides irritate the skin and eyes. (1) They cause respiratory distress and irritation to the stomach and intestinal tracts. They may affect the kidney and cause hepatitis (2) Birth defects have been noted in animals when the parent is exposed to organic arsenicals, but generally the effects were less severe than would be expected from inorganic arsenic compounds at the same dose. (1)

Potential doses leading to health effects appear to vary significantly among the chemicals in this class. (1,2) These compounds can be toxic by inhalation, ingestion, or skin contact. Approximately 78% of the absorbed dose is eliminated after 4 days (1), mostly through the urine and feces. (2) Arsenical pesticides tend to adsorb to clay in soils, but may leach to the groundwater in other types of soil. (1) Lethal doses (LD_{50}s) tend to range from 100-300 mg of arsenical pesticide per kg of body weight [mg/kg] (1,2) while the lowest observed adverse effect level (LOAEL) was 50 mg/kg in rabbits. (2) For inorganic forms of arsenic, EPA established a reference dose (RfD) of 0.3 micrograms per kilogram bodyweight per day (ug/kg/day) in 1993. ATSDR recommended a chronic minimal risk level (MRL) of 0.3 ug/kg/day in 2007. The OSHA PEL is equal to the ACGIH TLV-TWA of 0.5 mg/m^3

[1] HSDB, 2003. Disodium Methanearsenate (DSMA; CAS #144-21-8) . Hazardous Substance Databank, Toxicology Data Network. National Library of Medicine, National Institutes of Health. Bethesda, MD. Last revised: Feb 2003. (Available at toxnet.nlm.nih.gov)

[2] HSDB, 2003. Monosodium Methanearsenate (MSMA; CAS #144-21-8) . Hazardous Substance Databank, Toxicology Data Network. National Library of Medicine, National Institutes of Health. Bethesda, MD. Last revised: Feb 2003. (Available at toxnet.nlm.nih.gov)

EPA Reference Doses (RfDs) are available at www.epa.gov/iris.
ATSDR Minimal Risk Levels (MRLs) are available at www.atsdr.cdc.gov/substances.

Carbamate pesticides Sample compound: Carbaryl, Aldicarb

Carbamates tend to be colorless to light tan or gray solids, usually odorless, that sink and mix slowly in water. (1) Carbamates are used primarily as insecticides. (1,2) They vaporize slowly and break down in the atmosphere in a few hours or days. (1) Carbamates have a moderate mobility in most soils and will break down into harmless products through natural bacteria action or exposure to light or water over a period of days to weeks. (1,2) Carbamates in water will tend to cling to sediments and dust particles dissolved in the water and can last from days to weeks in the water. (2)

Carbamate pesticides are rapidly absorbed, metabolized and excreted by mammals, including human beings. (1) It is unlikely we would store these compounds in our bodies. We absorb carbamates by breathing them in or ingesting them but these chemicals in their pure form do not pass through our skin easily. (1) Humans tend to metabolize or change these pesticides fairly rapidly, usually within minutes to hours of exposure. Symptoms occur shortly after exposure and disappear quickly once exposure is stopped. (1) The result of this metabolism of these pesticides is usually a less toxic substance than the original chemical, but may still be harmful. (2)

Carbamates may cause cancer in animals. (1) These pesticides irritate the skin and eyes. When the mother is exposed to carbamates, unborn offspring may be affected but not without the mother showing signs of exposure. (1) Like organophosphate pesticides, carbamates inhibit an enzyme called cholinesterase that is used by our nervous system to transmit signals from our brains to our muscles. This can cause loss of control of our bodily functions resulting in vomiting and diarrhea, excessive salivation and sweating, and runny nose followed by muscle control problems like trembling or stumbling when we walk. (1) Our eyes may have unusually small pupils (the black part at the center of the eye). With most carbamate pesticides, these symptoms stop soon after the chemical is removed. The nervous system effects like the trembling are less likely to be permanent than with some other pesticides. (1,2)

Carbamates have a moderate to high degree of mobility in soils, mostly dependent on whether the pesticides adsorbs to the soil (Some do (1) and some don't (2)). The half-life in soils is measured in days to weeks (1,2) and some carbamates can be absorbed from the soil by plants (2).

Lethal doses in mice for these compounds can range from 0.3 mg/kg (2) up to 128 mg/kg (1) while No Observed Adverse Effect Level ranges from 6 (1) to 100 ug/kg/day (2). The World Health Organization has established an Acceptable Daily intake for some carbamates at 1 ug/kg/day. (2) EPA established Reference Doses for carbamates ranging from 1 ug/kg/day. (2) to 100 ug/kg/day (1) These doses can be used to compare the chemicals in this class of pesticides with the other types of pesticides.

(1) HSDB, 2009. Carbaryl (Sevin; CAS #63-25-2) Hazardous Substance Databank, Toxicology Data Network. National Library of Medicine, National Institutes of Health. Bethesda, MD. Last revised: Jun 2009 (Available at toxnet.nlm.nih.gov)

(2) HSDB, 2014. Aldicarb (CAS #116-06-3) Hazardous Substance Databank, Toxicology Data Network. National Library of Medicine, National Institutes of Health. Bethesda, MD. Last revised: Jun 2014 (Available at toxnet.nlm.nih.gov)

EPA Reference Doses (RfDs) are available at www.epa.gov/iris;
ATSDR Minimal Risk Levels (MRLs) are available at www.atsdr.cdc.gov/substances.

Chlorothalonil

Sample compound: Chlorothalonil
(CAS 1897-45-6)

Chlorothalonil is a white odorless solid that is used as a fungicide, bactericide, and nematocide. It sinks but does not mix in water. It does not vaporize well, but once in the air, it can persist for years. Chlorothalonil tends to adsorb to soil and sediments and is not very mobile in most soils. It will break down into harmless products in soil over a period of days to months. Chlorothalonil in water will tend to cling to sediments and can last from days to weeks in the water. This compound tends to biodegrade. Under some conditions, this pesticide may bioconcentrate in plants.

When exposed, chlorothalonil is rapidly absorbed, metabolized and excreted by the body. The metabolite is less harmful as the pesticide itself but still toxic. It is unlikely we would store this compound in our bodies and the bulk of the material is excreted with a few days after exposure stops.

Chlorothalonil is a known animal carcinogen at very high concentrations and is considered to probably be a human carcinogen as well. This chemical causes skin rashes, conjunctivitis in the eye, and makes one sensitive to light. Kidneys followed by the liver and then the blood are the primary target organs of this substance. Chlorothalonil may be a sensitizer.

The lowest observed adverse effect level in animal is 3 milligrams (mg) per kilogram (kg) of body weight per day. The no observed adverse effect levels in animals is 1.5 mg/kg/day. EPA has established a reference dose (RfD) of 25 ug/kg/day. WHO/FAO set a range for their acceptable daily intake from 15-30 ug/kg. These doses can be used to compare the chemicals in this class of pesticides with the other types of pesticides.

HSDB, 2006. Chlorothalonil. Hazardous Substance Databank, Toxicology Data Network. National Library of Medicine, National Institutes of Health. Bethesda, MD. Last revised: August 2006.

EPA Reference Doses (RfDs) are available at www.epa.gov/iris.
ATSDR Minimal Risk Levels (MRLs) are available at www.atsdr.cdc.gov/substances.

Organophosphate pesticides Sample compounds: Parathion, Malathion, & Chlorpyrifos

Organophosphates are insectides and tend to be white solids or light color (yellow or tan) liquids, with a garlic or natural gas odor, that sink and mix slowly in water. (1,2,3) They vaporize slowly and break down in the open air in a few hours or days. (1,2) Organophosphates tend to have a low-to-moderate mobility in most soils and will break down into harmless products through exposure to light or water over a period of days to months. (1,3) Organophosphates in water will tend to cling to sediments and can last from days to weeks in the water. (1,2) The higher the clay content of the soil or sediments, the more tightly the pesticide will bond to the soil. (1)

Organophosphate pesticides are rapidly absorbed, metabolized and excreted by mammals, including human beings, within hours or days after the exposure is stopped. (1,2,3) For many of these compounds, the metabolite may be as harmful than the pesticide itself. (1,3) It is unlikely we would store these compounds in our bodies, but the effects may appear some time after exposure and last for several years. (1,2) We can absorb organophosphates by breathing them in, ingesting them, or with direct contact with the skin. (1) Organophosphates can cross from the mother to the unborn child (2,3) and at high doses may cause reproductive effects in both males and females (2,3) Some organophosphates have very low odor thresholds and can be smelled readily. (3)

Most organophosphates are not suspected of causing cancer. (1,2,3) Some organophospates irritate the skin and mucuous membranes. (1) Like carbamates, organophosphates tend to inhibit an enzyme called cholinesterase that is used by our nervous system to transmit signals from our brains to our muscles. (1,2,3) This can cause loss of control of our bodily functions resulting in vomiting and diarrhea, excessive salivation and sweating, and runny nose followed by muscle control problems like trembling or stumbling when we walk. (1,2,3) Our eyes may have unusually small pupils (the black part at the center of the eye). (1,2,3) With most organophosphate pesticides, these symptoms are more severe than after exposure to a carbamate and tend to last longer. (1)

Adverse effects have been reported in both humans (2) and animals (3) at doses in the range of 0.1-0.2 mg/kg/day. (2,3) Occupational standards for an 8-10 hour workday tend to range from 0.02 mg/m3 (3) up to 1 mg/m3. (1) Health guidance values (i.e., MRLs and RfDs) range from 0.0003 mg/kg/day for parathion and chlorpyrifos up to 0.02 mg/kg/day for malathion. These doses can be used to compare the chemicals in this class of pesticides with the other types of pesticides.

(1) HSDB, 2012. Malathion. Hazardous Substance Databank, Toxicology Data Network. National Library of Medicine, National Institutes of Health. Bethesda, MD. Last revised: Oct. 2012

(2) HSDB, 2008. Chlorpyrifos. Hazardous Substance Databank, Toxicology Data Network. National Library of Medicine, National Institutes of Health. Bethesda, MD. Last revised: Apr. 2008

(3) HSDB, 2014. Parathion. Hazardous Substance Databank, Toxicology Data Network. National Library of Medicine, National Institutes of Health. Bethesda, MD. Last revised: Sep. 2014

EPA Reference Doses (RfDs) are available at www.epa.gov/iris.
ATSDR Minimal Risk Levels (MRLs) are available at www.atsdr.cdc.gov/substances.

Organotins Sample compound: Tricyclohexyltin Hydroxide and Tin

Organotin pesticides are used as fungicides and insecticides (1) and tend to be white solids. (2) These pesticides are odorless and virtually insoluble in water. They do not vaporize easily. (2) They tend to be persistent in the open environment with a half-life of weeks to months (2) and may transform into less toxic compounds by exposure to the sun. (1,2) Organotins adsorb to soil and are not considered mobile in the environment. (1,2)

Organotins can be absorbed by inhalation, ingestion, and direct contact with the skin (2), but dermal exposure seems to be the dominant route of exposure. (1) These compounds are excreted within days to weeks after exposure ends. (1,2). There is limited data on health effects in humans, but organotin compounds are not carcinogenic in animals. (1) Health effects tend to be similar to other metals and include reproductive and CNS effects (1). Respiratory, gastro-intestinal, and cardiovascular effects may also occur. (1,2) Some tin compounds cause skin irritation and may cause a delayed skin rash. (1) The lowest dose where some of these effects have been seen in animals is 3.75 mg/kg/day. (2). Occupational standards range from 0.1 mg/m3 (1) up to 5 mg/m3 (2).

(1) HSDB, 2005. Tin Compounds. Hazardous Substance Databank, Toxicology Data Network. National Library of Medicine, National Institutes of Health. Bethesda, MD. Last revised: Jun. 2005

(2) HSDB, 2005. Tricyclohexyltin Hydroxide Hazardous Substance Databank, Toxicology Data Network. National Library of Medicine, National Institutes of Health. Bethesda, MD. Last revised: Jun. 2005

EPA Reference Doses (RfDs) are available at www.epa.gov/iris.
ATSDR Minimal Risk Levels (MRLs) are available at www.atsdr.cdc.gov/substances.

Synthetic Pyrethroids Sample compounds: Fenvalerate, Cypermethrin, & Permethrin

Note: "Pyrethrins" is the name given to a set of naturally occurring chrysanthemic esters with insecticidal activity. The crude extract from the plants is known as "pyrethrum". Synthetic analogs of these naturally occurring compounds are referred to as "pyrethroids". (2). Pyrethroids are classified as Type I and Type II. Type I pyrethroids have a mechanism of action similar to pyrethrins while Type II pyrethroids include a cyano-group (e.g., cyanide) to increase their toxiciity (3)

Pyrethroid insecticides tend to be light colored viscous semi-solids, usually odorless, that sink in water. (1,2,3) They are virtually insoluble and tend to vaporize very slowly. (1,2) Pyrethroids are almost immobile in most soils and will break down into harmless products through natural bacteria action over a period of weeks to months. (1,3) Pyrethroids in water will tend to cling to sediments and can last from weeks to months in the water. Some of these pesticides may accumulate in fish. (3)

Synthetic pyrethroid pesticides are rapidly absorbed, metabolized and excreted by mammals, including human beings, usually within hours of exposure. (1,2,3) Although some of these pesticides are considered lipophilic (1), the speed of excretion makes it unlikely we would store significant amounts of these compounds in our bodies. (2,3) These pesticides are metabolized so rapidly that a chemical called piperonyl butoxide is often added to slow down this process long enough for the pesticide to work. (2)

Type II pyrethroids are generally not expected to cause cancer (1,2) while some Type I pyrethroids are considered to be likely carcinogens. (3) Symptoms include a tingling sensation and some trembling in the arms, fingers, and toes; dizziness; headaches; nausea & vomiting; skin and eye irritation; stomach pains & diarrhea; and a red rash (erythema). (1,2,3) These effects may be delayed for minutes to hours and last for up to 24 hours after exposure. (1,2) Exposure may result in skin sensitizing and increased sensitivity to sound. (1)

The dose where these symptoms begin range from 2.5 milligrams (mg) per kilogram (kg) of body weight per day (1) up to 410 mg/kg/day (3). ATSDR set an acute MRL for cypermethrin of 0.02 mg/kg/day while EPA established an RfD for permethrin at 0.05 mg/kg/day. These doses can be used to compare the chemicals in this class of pesticides with the other types of pesticides.

(1) HSDB, 2009. Fenvalerate. Hazardous Substance Databank, Toxicology Data Network. National Library of Medicine, National Institutes of Health. Bethesda, MD. Last revised: Feb. 2009

(2) HSDB, 2012. Cypermethrin. Hazardous Substance Databank, Toxicology Data Network. National Library of Medicine, National Institutes of Health. Bethesda, MD. Last revised: Feb. 2012

(3) HSDB, 2014. Permethrin. Hazardous Substance Databank, Toxicology Data Network. National Library of Medicine, National Institutes of Health. Bethesda, MD. Last revised: Sep. 2014

EPA Reference Doses (RfDs) are available at www.epa.gov/iris.
ATSDR Minimal Risk Levels (MRLs) are available at www.atsdr.cdc.gov/substances.

Appendix C: ATSDR's Evaluation Process

Step 1 – Comparison Values and the Screening Process

To evaluate the available data, ATSDR used comparison values (CVs) to determine which chemicals to examine more closely. CVs are the chemical concentrations found in a specific media (for example: air, soil, or water) and are used to select chemicals for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of air, soil, or water that someone may take into their body each day. CVs are generated to be conservative and non-site specific. These values are used only to screen out chemicals that do not need further evaluation. CVs are not intended as environmental clean-up levels or to indicate that health effects occur at concentrations that exceed these values.

CVs can be based on either carcinogenic (cancer-causing) or non-carcinogenic effects. Cancer-based comparison values are calculated from the U.S. Environmental Protection Agency's (EPA) oral cancer slope factor (CSF) or inhalation risk unit. CVs based on cancerous effects account for a lifetime exposure (70 years) with a theoretical excess lifetime cancer risk of 1 extra case per 1 million exposed people. Non-cancer values are calculated from ATSDR's Minimal Risk Levels (MRLs), EPA's Reference Doses (RfDs), or EPA's Reference Concentrations (RfCs). When a cancer and non-cancer CV exists for the same chemical, the lower of these values is used in the comparison for health protectiveness. The chemical and media-specific CVs utilized during the preparation of this document are listed below:

An **Environmental Media Evaluation Guide (EMEG)** is an estimated comparison concentration calculated from an ATSDR MRL for which exposure is unlikely to cause adverse health effects, as
determined by ATSDR from its toxicological profiles for a specific chemical and from ATSDR's Public Health Assessment Guidance Manual using standard exposure factors.

A **Reference Dose Media Evaluation Guide (RMEG)** is an estimated comparison concentration calculated from an EPA RfD that represents concentrations of chemicals (in water, soil, and air) to which humans may be exposed without experiencing adverse health effects.

A **Cancer Risk Evaluation Guide (CREG)** is a comparison concentration that is based on an excess cancer rate of one in a million persons and is calculated using
EPA's cancer slope factor (CSF) and ATSDR's exposure factors..

Step 2 – Evaluation of Public Health Implications

The next step in the evaluation process is to take those chemicals that are detected at concentrations above their respective CVs and further identify the site-specific exposure situations and the likelihood that these exposures could pose a health hazard. Therefore, calculations are performed to estimate the possibility of cancer and non-cancer health impacts. The calculations consider the activities of people living in the community. The calculation for oral exposure to contaminants in soil or sediment is accomplished using the following equation:

$$D = \frac{C \times IR \times EF \times CF}{BW}$$

Where: D = exposure dose (in milligram of substance per kilogram of bodyweight per day or mg/kg/day or similar units)
C = concentration of the substance in the soil (in milligram of substance per kilogram of soils or mg/kg or similar units)
IR = intake rate of contaminated soil (in milligrams per day or mg/day or similar units) as described in the Discussion.
EF = exposure factor (unitless) - takes into account frequency and duration of exposure as described in the equation below.
CF = conversion factor – a constant value required by the formula
BW = Bodyweight (in kilograms or kg) as described in the Discussion.

"× " in the equation is the mathematical symbol for multiplication; identical to " * " in computer spreadsheets.

$$EF = \frac{F \times ED}{AT}$$

Where: EF = Exposure Factor (unitless)
F = Frequency of Exposure (days)
ED = Exposure Duration (years)
AT_n = Averaging Time (ED X 365 days/year) for non-cancer effects.
AT_c = Averaging Time (78 years [average lifetime] X 365 days/year) for cancer effects

" × " in the equation is the mathematical symbol for multiplication; identical to " * " in computer spreadsheets.

Example Calculation:

For a 16 kg child living in the home at sample point SN-24-SS from the 2005 Removal Assessment, the estimated oral dose for toxaphene would be:

F = 350 days/year (15 days away from home for vacation, camp, etc.)
ED = 5 years
AT = 78 years X 365 days/year

Therefore: EF = 0.06

C= 4,700 µg/kg = 4.7 mg/kg
IR= 200 mg/day
BW = 16 kg

Therefore: D = (4.7 X 200 X 0.06 X 0.000001)/16 = 3.5 X 10^{-6} mg/kg/day = 0.004 µg/kg/day

When considering only the oral dose, ATSDR does not usually calculate cumulative dose over a lifetime. When combining oral exposures with dermal exposures, the oral dose needs to conform to the same duration as the dermal dose exposure.

Doses from Dermal Exposures (i.e., Skin Contact)

Many chemicals can be absorbed through the skin. To calculate a dose received from this route of exposure, a two step calculation is necessary. The first calculation is to estimate how well a chemical is absorbed in each exposure event. The second is to estimate how often such exposure events occur.

The calculation for the exposure event uses the following formula:

$$DA_{event} = C_{soil/sediment} \text{ X } CF \text{ X } AF \text{ X } ABS_d$$

Where:
DA_{event} = The absorbed dose per event (mg/cm^2-event)
$C_{soil/sediment}$ = Chemical concentration in soil or sediment (mg/kg)
CF = Conversion Factor (10^{-6} kg/mg)
AF = Adherence factor of soil/sediment to skin (mg/cm^2)
ABS_d = Dermal Absorption fraction for soil and sediment

"×" in the equation is the mathematical symbol for multiplication; identical to " * " in computer spreadsheets.

The calculation for the exposure frequency and duration results in the dermal absorbed dose as follows:

$$DAD = \frac{DAevent \text{ X } EF \text{ X } ED \text{ X } EV \text{ X } SA}{BW \text{ X } AT}$$

Where:
DAD = Dermal Absorbed Dose (mg/kg/day)
DA_{event} = Absorbed dose per event (mg/cm^2 / event)
{as calculated in the preceding equation)
EF = Exposure Frequency (days/year)
ED = Exposure duration (years)
EV = Event frequency (events/day)
SA = Surface area available (cm^2)
BW = Body weight (kg)
ATn = Averaging Time (non-cancer) = ED X 365 days/year
ATc = Averaging Time (cancer) = 78 years X 365 days/year

" × " in the equation is the mathematical symbol for multiplication; identical to " * " in computer spreadsheets.

Example Calculation:

For an adult exposed dermally to dieldrin at the home where sample # SN-21-SS was collected during the 2005 Removal Assessment under the exposure assumptions described in Section 2.3.2 (e.g., mows the lawn once a week exposing arms and hands).

C= 380 µg/kg = 0.38 mg/kg
SA = 5,700 cm^2 [Taken from Exhibit 3-5, EPA's Risk Assessment Guidance Part E, 2004]
AF = 0.07 mg/cm^2 [Taken from Exhibit 3-5, EPA's Risk Assessment Guidance Part E, 2004]
ABS = 0.04 [Taken from Exhibit 3-4, EPA's Risk Assessment Guidance Part E, 2004; central tendency {mode} of absorption factors for all organochlorine pesticides listed]
EV= 1 event/day
EF=52 days/year [one day/week for 52 weeks]
ED = 30 years [average time spent in one residence]
BW = 80 kg
ATn= 30 years X 365 days/year = 10,950

Therefore:

DAE = 0.38 mg/kg X 0.000001 kg/mg X 0.07 mg/cm^2 X 0.04= 1.06 X 10^{-9} mg/cm^2-event

DAD = (1.06 X 10^{-9} mg/cm^2-event X 1 event/day X 52 days/year X 5,700 cm^2 X 30 years)/(80 kg X 10,950 days) = 3.32 X 10^{-9} mg/kg/day = 0.000003 µg/kg/day

Non-Cancer Health Effects

The doses calculated for exposure to each individual chemical at the site are then compared to established health guidelines, such as ATSDR's Minimal Risk Levels (MRLs) or EPA's Reference Doses (RfDs), in order to assess whether adverse non-cancer health impacts from exposure are expected. These health guidelines, described in more detail in the following text, are chemical-specific values that are based on the available scientific literature and are considered protective of human health. When dermal health guideline values are not available, oral health guidelines values may be substituted to assess whether health impacts are possible.

Minimal Risk Levels (MRLs)

ATSDR has developed MRLs for contaminants commonly found at hazardous waste sites. The MRL is an estimate of daily exposure to a contaminant below which non-cancer, adverse health effects are unlikely to occur. MRLs are developed for different routes of exposure, such as inhalation and ingestion, and for lengths of exposure, such as acute (less than 14 days), intermediate (15-364 days), and chronic (365 days or greater). At this time, ATSDR has not developed MRLs for dermal exposure. A complete list of the available MRLs can be found at http://www.atsdr.cdc.gov/mrls.html. For this health consultation, ATSDR utilized

Oral MRLs for chronic exposures when possible. Oral Intermediate MRLs were used when chronic MRLs were unavailable.

Reference Doses (RfDs)
An estimate of the daily, lifetime exposure of human populations to a possible hazard that is not likely to cause non-cancerous health effects. RfDs consider exposures to sensitive sub-populations, such as the elderly, children, and the developing fetus. EPA's RfDs have been developed using information from the available scientific literature and have been calculated for oral and inhalation exposures. A complete list of the available RfDs can be found at http://www.epa.gov/iris.

Non-carcinogenic effects, unlike carcinogenic effects, are believed to have a threshold, that is, a dose below which adverse health effects will not occur. As a result, the current practice for deriving health guidelines is to identify, usually from animal toxicology experiments, a No Observed Adverse Effect Level (or NOAEL), which indicates that no effects are observed at a particular exposure level. This is the experimental exposure level in animals (and sometimes humans) at which no adverse toxic effect is observed. The NOAEL is then modified with an uncertainty factor, which reflects the degree of uncertainty that exists when experimental animal data are extrapolated (or applied) to the general human population. The magnitude of the uncertainty factor considers various factors such as sensitive subpopulations (for example; children, pregnant women, and the elderly), extrapolation from animals to humans, and the completeness of available data. Thus, exposure doses at or below the established health guideline are not expected to result in adverse non-cancer health effects.

Uncertainty factors can be a difficult concept to explain, but they are important in understanding health effects and risk. Otherwise, individual persons can become lost in evaluations based on health effects of groups. An analogy may help. For instance, if toxicity were a room, health guideline values could be the "floor". Known health effects would not be expected to occur until one reaches the concentration or dose in the primary study (when using a LOAEL) and perhaps higher (when using a NOAEL). In that case, that primary study would represent the "ceiling". The "height" of the room could represent the uncertainty factors associated with each health guideline values such as an ATSDR MRL or EPA RfD.

When site-specific exposure doses exceed health guidelines, it does not necessarily indicate that health effects will occur. Rather, it indicates that a more thorough look at the known toxicological values for the chemical and the site-related exposures are needed. The known toxicological values are doses derived from human and animal studies that are presented in the ATSDR Toxicological Profiles and EPA's Integrated Risk Information System (IRIS). A direct comparison of site-specific exposure doses to study-derived exposures and doses found to cause adverse health effects is the basis for deciding whether health effects are likely to occur. This in-depth evaluation is performed by comparing calculated exposure doses with known toxicological values, such as the NOAEL and the lowest-observed-adverse-effect-level (LOAEL) from studies used to derive the MRL or RfD for a chemical. In practice, if the calculated dose based on the estimated exposures is within the uncertainty range of a health guideline, then adverse health effects are unlikely based on the consistently conservative assumptions in those estimates and calculations.

It is important to consider that the methodology used to develop these health guidelines does not provide any information on the presence, absence, or level of cancer risk. Therefore, a separate cancer evaluation is necessary for potentially cancer-causing chemicals detected in samples at this site.

Cancer Risks

The estimated excess risk of developing cancer from exposure to chemicals associated with a site was calculated by multiplying the exposure doses by EPA's oral cancer slope factor (CSFs or cancer potency estimates) for the compounds, which is available on the EPA Integrated Risk Information System (IRIS) at http://www.epa.gov/iris/subst/0278.htm. The Cancer Risk is calculated according to the following formula:

$$CR = (D\ X\ CSF) X\ EF$$

Where: CR = Cancer Risk (unitless)
D = Dose calculated as described above
CSF = Cancer Slope Factor (in units that are the reciprocal of the Dose)
EF = Exposure factor (unitless) as described in the Discussion.
[An exposure factor is necessary because the averaging time (AT) factor is different for cancer risk than for non-cancer risk.]

Example Calculation:

For the estimated lifetime cancer risk due to heptachlor for a person living as a child and then an adult at the home where sample RP-CS-05 from the 2010 Air Deposition study was collected:

Adult Total Dose = $1.57 \text{ X } 10^{-7}$ mg/kg/day
Infant & Child Total Dose = $2.42 \text{ X } 10^{-7}$ mg/kg/day
CSF = 4.5 [Taken from EPA IRIS database; available at epa.gov/iris]

The exposure factor was already included in the calculation of the total dose; therefore:

$$CR=(1.57 \text{ X } 10^{-7} \text{ X } 4.5) + (2.42 \text{ X } 10^{-7} \text{ X } 4.5) = 1.8 \text{ X } 10^{-6}$$

Please see Appendix E to gain a perspective on cancer and cancer risks.

Note that cancer risk calculated for exposures occurring during adulthood and childhood are combined and expressed as the risk of an individual developing cancer over his or her lifetime. An increased excess lifetime cancer risk is not a specific estimate of expected cancers. Rather, it is an estimate of the increase in the probability that a person may develop cancer sometime during his or her lifetime following exposure to a particular chemical. Therefore, the cancer risk calculation incorporates the equations and parameters (including the exposure duration and frequency) used to calculate the dose estimates, but the estimated value is divided by 28,470 days (or the averaging time), which is equal to a lifetime of exposure (78 years) for 365 days/year.

There are varying suggestions among the scientific community regarding excess lifetime cancer risk, due to the uncertainties regarding the mechanism of cancer. EPA targets the risk range of 1 in one million to 1 in ten thousand (often referred to as $1 \text{ x } 10^{-6}$ to $1 \text{ x } 10^{-4}$, respectively) excess cancer cases for risk management in the Superfund program. Exposure to a lifetime cancer risk less than 1 in

1,000,000 (or 1 x 10^{-6}) is not typically considered a health concern; between 1 x 10^{-6} and 1 x 10^{-4} may be a concern under some conditions; and more than 1 x 10^{-4} is generally considered a health concern except possibly under extraordinary conditions. An important consideration when determining cancer risk estimates is that the risk calculations incorporate several very conservative assumptions that are expected to overestimate actual exposure scenarios. For example, the method used to calculate EPA's CSFs assumes that high-dose animal data can be used to estimate the risk for low dose exposures in humans. The method also assumes that there is no safe level for exposure. Lastly, the method computes the 95% upper bound for the risk, rather than the average risk, suggesting that the average cancer risk is actually lower, perhaps by several orders of magnitude.

Because of the uncertainties involved with estimating cancer risk, ATSDR also employs a qualitative approach in evaluating all relevant data. The actual environmental exposures have been given careful and thorough consideration in evaluating the assumptions and variables relating to both toxicity and exposure. A complete review of the toxicological data regarding the doses associated with the production of cancer and the site-specific doses is an important element in determining the likelihood of exposed individuals being at a greater risk for cancer.

[1] Agency for Toxic Substances and Disease Registry. Public Health Assessment Guidance Manual. Atlanta: US Department of Health and Human Services. January 2005.

[2] U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual. Part A. December 1989.

[3] U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual. Part E, Supplemental Guidance for Dermal Exposure. July 2004.

[4]U.S. Environmental Protection Agency. Exposure Factors Handbook. September 2011.

Appendix D: ToxFAQs

ATSDR ToxFAQ for Aldrin/Dieldrin, September 2002

ATSDR ToxFAQ for Toxaphene, September 2010

ATSDR ToxFAQ for Heptachlor/Heptachlor Epoxide, August 2007

For information on additional chemicals, please visit www.atsdr.cdc.gov/substances.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

ALDRIN and DIELDRIN

CAS # 309-00-2 and 60-57-1

Division of Toxicology ToxFAQs™ **September 2002**

This fact sheet answers the most frequently asked health questions (FAQs) about aldrin and dieldrin. For more information, call the ATSDR Information Center at 1-888-422-8737. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Exposure to aldrin and dieldrin happens mostly from eating contaminated foods, such as root crops, fish, or seafood. Aldrin and dieldrin build up in the body after years of exposure and can affect the nervous system. Aldrin has been found in at least 207 of the 1,613 National Priorities List sites identified by the Environmental Protection Agency (EPA). Dieldrin has been found in at least 287 of the 1,613 sites.

What are aldrin and dieldrin?

Aldrin and dieldrin are insecticides with similar chemical structures. They are discussed together in this fact sheet because aldrin quickly breaks down to dieldrin in the body and in the environment. Pure aldrin and dieldrin are white powders with a mild chemical odor. The less pure commercial powders have a tan color. Neither substance occurs naturally in the environment.

From the 1950s until 1970, aldrin and dieldrin were widely used pesticides for crops like corn and cotton. Because of concerns about damage to the environment and potentially to human health, EPA banned all uses of aldrin and dieldrin in 1974, except to control termites. In 1987, EPA banned all uses.

What happens to aldrin and dieldrin when they enter the environment?

- ❑ Sunlight and bacteria change aldrin to dieldrin so that we mostly find dieldrin in the environment.
- ❑ They bind tightly to soil and slowly evaporate to the air.
- ❑ Dieldrin in soil and water breaks down very slowly.
- ❑ Plants take in and store aldrin and dieldrin from the soil.
- ❑ Aldrin rapidly changes to dieldrin in plants and animals.
- ❑ Dieldrin is stored in the fat and leaves the body very slowly.

How might I be exposed to aldrin or dieldrin?

- ❑ Dieldrin is everywhere in the environment, but at very low levels.
- ❑ Eating food like fish or shellfish from lakes or streams contaminated with either chemical, or contaminated root crops, dairy products, or meats.
- ❑ Air, surface water, or soil near waste sites may contain higher levels.
- ❑ Living in homes that were once treated with aldrin or dieldrin to control termites.

How can aldrin and dieldrin affect my health?

People who have intentionally or accidentally ingested large amounts of aldrin or dieldrin have suffered convulsions and some died. Health effects may also occur after a longer period of exposure to smaller amounts because these chemicals build up in the body.

Some workers exposed to moderate levels in the air for a long time had headaches, dizziness, irritability, vomiting, and uncontrolled muscle movements. Workers removed from the source of exposure rapidly recovered from most of these effects.

Animals exposed to high amounts of aldrin or dieldrin also had nervous system effects. In animals, oral exposure to lower levels for a long period also affected the liver and decreased their ability to fight infections. We do not know whether aldrin or dieldrin affect the ability of people to fight disease.

Studies in animals have given conflicting results about whether aldrin and dieldrin affect reproduction in male animals and whether these chemicals may damage the sperm.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, Public Health Service
Agency for Toxic Substances and Disease Registry

ALDRIN and DIELDRIN

CAS # 309-00-2 and 60-57-1

ToxFAQs™ Internet address is http://www.atsdr.cdc.gov/toxfaq.html

We do not know whether aldrin or dieldrin affect reproduction in humans.

How likely are aldrin and dieldrin to cause cancer?

There is no conclusive evidence that aldrin or dieldrin cause cancer in humans. Aldrin and dieldrin have been shown to cause liver cancer in mice. The International Agency for Research on Cancer (IARC) has determined that aldrin and dieldrin are not classifiable as to human carcinogenicity. The EPA has determined that aldrin and dieldrin are probable human carcinogens.

How can aldrin and dieldrin affect children?

Children can be exposed to aldrin and dieldrin in the same way as adults. There are no known unique exposure pathways for children. Children who swallowed amounts of aldrin or dieldrin much larger than those found in the environment suffered convulsions and some died, as occurred in adults. However, we do not know whether children are more susceptible than adults to the effects of aldrin or dieldrin.

We do not know whether aldrin or dieldrin cause birth defects in humans. Pregnant animals that ingested aldrin or dieldrin had some babies with low birth weight and some with alterations in the skeleton. Dieldrin has been found in human breast milk, therefore, it can be passed to suckling infants.

How can families reduce the risk of exposure to aldrin and dieldrin?

- Since aldrin and dieldrin are no longer produced or used, exposure to these compounds will occur only from past usage.
- Because aldrin and dieldrin were applied to the basement of some homes for termite protection, before buying a home families should investigate what, if any, pesticides have been used within the home.

Is there a medical test to show whether I've been exposed to aldrin and dieldrin?

There are laboratory tests that can measure aldrin and dieldrin in your blood, urine, and body tissues. Because aldrin changes to dieldrin fairly quickly in the body, the test has to be done shortly after you are exposed to aldrin. Since dieldrin can stay in the body for months, measurements of dieldrin can be made much longer after exposure to either aldrin or dieldrin. The tests cannot tell you whether harmful health effects will occur. These tests are not routinely available at the doctor's office because they require special equipment.

Has the federal government made recommendations to protect human health?

The EPA limits the amount of aldrin and dieldrin that may be present in drinking water to 0.001 and 0.002 milligrams per liter (mg/L) of water, respectively, for protection against health effects other than cancer. The EPA has determined that a concentration of aldrin and dieldrin of 0.0002 mg/L in drinking water limits the lifetime risk of developing cancer from exposure to each compound to 1 in 10,000.

The Occupational Safety and Health Administration (OSHA) sets a maximum average of 0.25 milligrams of aldrin and dieldrin per cubic meter of air (0.25 mg/m^3) in the workplace during an 8-hour shift, 40 hour week. The National Institute for Occupational Safety and Health (NIOSH) also recommends a limit of 0.25 mg/m^3 for both compounds for up to a 10-hour work day, 40-hour week.

The Food and Drug Administration (FDA) regulates the residues of aldrin and dieldrin in raw foods. The allowable range is from 0 to 0.1 ppm, depending on the type of food product.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2002. Toxicological Profile for Aldrin/Dieldrin (Update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-888-422-8737, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

TOXAPHENE

CAS # 8001-35-2

Division of Toxicology and Environmental Medicine ToxFAQs™ **September 2010**

This fact sheet answers the most frequently asked health questions (FAQs) about toxaphene. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because this substance may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: Toxaphene is a pesticide which is currently banned for all uses in the United States. Breathing, eating, or drinking high levels of toxaphene could damage the nervous system, the liver, and kidneys, and even cause death. Toxaphene has been found in at least 68 of the 1,699 National Priorities List sites identified by the Environmental Protection Agency (EPA).

What is toxaphene?

Toxaphene is a mixture of hundreds of different chlorinated compounds. It was one of the most heavily used pesticides in the Unites States until 1982, when it was canceled for most uses. All registered uses were banned by 1990. Toxaphene was used primarily in the southern United States to control insect pests on cotton and other crops.

Toxaphene is usually found as a solid or a gas. In its original form, toxaphene is a yellow to amber waxy solid that has a piney odor.

What happens to toxaphene when it enters the environment?

- ❏ When released to the environment, it can enter the air, the soil, and water.
- ❏ It does not dissolve well in water and evaporates easily.
- ❏ Toxaphene is more likely found in air, soil, and sediment at the bottom of lakes or streams, than in surface water.
- ❏ Toxaphene can stay in the environment for a long time because it breaks down very slowly.
- ❏ Toxaphene can be carried long distances in the air.
- ❏ Toxaphene accumulates in fatty tissues of fish and mammals.

How might I be exposed to toxaphene?

- ❏ People living near a location with heavy toxaphene contamination, such as a hazardous waste site, may be exposed to higher levels through breathing contaminated air or through direct skin contact with contaminated soil or water.
- ❏ People who eat large quantities of fish, shellfish, or wild game animals from areas contaminated with toxaphene may have higher exposure to this substance since these animals tend to accumulate toxaphene in fatty tissues.
- ❏ Individuals may be exposed to toxaphene through drinking water contaminated with toxaphene runoff from contaminated soils.

How can toxaphene affect my health?

Breathing, eating, or drinking high amounts of toxaphene could damage the nervous system, liver, and kidneys, and even cause death. However, since toxaphene is no longer used in the United States, most people would not be exposed to high levels of it.

Studies showed that animals which ate food or drank water containing toxaphene had effects on the liver, kidneys, and immune system.

It is not known whether toxaphene can affect reproduction in humans.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, Public Health Service
Agency for Toxic Substances and Disease Registry

TOXAPHENE
CAS # 8001-35-2

ToxFAQs™ Internet address is http://www.atsdr.cdc.gov/toxfaq.html

How likely is toxaphene to cause cancer?

It is not known whether toxaphene would cause cancer in people. Toxaphene caused liver cancer in mice and possible thyroid cancer in rats that were given large amounts of toxaphene by mouth.

The Department of Health and Human Services (DHHS) has determined that toxaphene may reasonably be anticipated to be a carcinogen. The International Agency for Research on Cancer (IARC) has determined that toxaphene is possibly carcinogenic to humans. The EPA has determined that toxaphene is a probable human carcinogen.

How can toxaphene affect children?

Toxaphene would be expected to affect children in the same manner as adults. It is not known whether children are more susceptible than adults to the effects of toxaphene.

A few studies in animals have shown minor changes in fetal development. We do not know if toxaphene would cause developmental effects in humans.

How can families reduce the risk of exposure to toxaphene?

- ❑ For people who live in areas where surface waters (for example lakes) have been contaminated with toxaphene, consumption of toxaphene-contaminated foods such as fish may need to be reduced.
- ❑ Avoid drinking water contaminated with toxaphene.

Is there a medical test to determine whether I've been exposed to toxaphene?

Toxaphene and some of its breakdown products can be detected in blood, urine, breast milk, and body tissues. Urine and blood tests are the most common tests used.

These tests are not available at most doctor' offices, but can be done at special laboratories that have the right equipment.

These tests cannot determine how much toxaphene you have been exposed to, or whether you will experience any health effects.

Has the federal government made recommendations to protect human health?

The EPA has determined that exposure to toxaphene in drinking water at concentrations of 0.004 milligrams per liter (mg/L) for up to 10 days is not expected to cause any adverse effects in a child.

The EPA has determined that lifetime exposure to 0.01 mg/L toxaphene in the drinking water is not expected to cause any adverse noncancer effects if the only source of exposure to toxaphene is the drinking water.

The Food and Drug Administration (FDA) has determined that the concentration of toxaphene in bottled drinking water should not exceed 0.003 mg/L.

The Occupational Safety and Health Administration (OSHA) set a legal limit of 0.5 mg/m^3 for toxaphene in air averaged over an 8 hour work day.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2010. Toxicological Profile for Toxaphene (Draft for Public Comment). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-62, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

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AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

HEPTACHLOR and HEPTACHLOR EPOXIDE

CAS # 76-44-8 and 1024-57-3

Division of Toxicology and Environmental Medicine ToxFAQs™ **August 2007**

This fact sheet answers the most frequently asked health questions (FAQs) about heptachlor and heptachlor epoxide. For more information, call the ATSDR Information Center at 1-800-232-4636. This fact sheet is one in a series of summaries about hazardous substances and their health effects. It is important you understand this information because these substances may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

HIGHLIGHTS: The primary exposure to heptachlor and heptachlor epoxide is from contaminated foods and milk. Little is known about their health effects in humans. At high levels, they may cause damage to your liver and nervous system. Exposure of animals during gestation and infancy can result in damage to the nervous system and the immune systems. Heptachlor and heptachlor epoxide have been found in at least 210 and 200, respectively, of the 1,684 National Priority List sites identified by the Environmental Protection Agency (EPA).

What are heptachlor and heptachlor epoxide?

Heptachlor is a manufactured chemical and doesn't occur naturally. Pure heptachlor is a white powder that smells like camphor (mothballs). The less pure grade is tan. Trade names include Heptagran®, Basaklor®, Drinox®, Soleptax®, Termide®, Gold Crest H-60®, and Velsicol 104®.

Heptachlor was used extensively in the past for killing insects in homes, buildings, and on food crops. These uses stopped in 1988. Currently it can only be used for fire ant control in underground power transformers.

Heptachlor epoxide is also a white powder. Bacteria and animals break down heptachlor to form heptachlor epoxide. The epoxide is more likely to be found in the environment than heptachlor.

What happens to heptachlor and heptachlor epoxide when they enter the environment?

- ❑ Heptachlor doesn't dissolve easily in water; heptachlor epoxide dissolves more easily
- ❑ They stick strongly to soil particles and evaporate slowly to air.
- ❑ Heptachlor epoxide can stay in the soil and water for many years.
- ❑ Plants can take up heptachlor from the soil. Levels of heptachlor and heptachlor epoxide can build up in the tissues of fish and cattle.

How might I be exposed to heptachlor or heptachlor epoxide?

- ❑ Eating fish, dairy products, and fatty meats from animals exposed to heptachlor in their food.
- ❑ Breast milk from mothers who had high exposures can expose breastfed infants.
- ❑ Drinking water, breathing air, or touching soil at waste sites that contain these substances.

How can heptachlor and heptachlor epoxide affect my health?

There is no reliable information on health effects in humans. Liver damage, excitability, and decreases in fertility have been observed in animals ingesting heptachlor. The effects are worse when the exposure levels were high or when exposure lasted many weeks.

Although there is very little information on heptachlor epoxide, it is likely that similar effects would also occur after exposure to this compound.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES, Public Health Service
Agency for Toxic Substances and Disease Registry

HEPTACHLOR and HEPTACHLOR EPOXIDE
CAS # 76-44-8 and 1024-57-3

ToxFAQs™ Internet address is http://www.atsdr.cdc.gov/toxfaq.html

How likely are heptachlor and heptachlor epoxide to cause cancer?

Lifetime exposure to heptachlor resulted in liver tumors in animals. The International Agency for Research on Cancer (IARC) and the EPA have classified heptachlor as a possible human carcinogen. EPA also considers heptachlor epoxide as a possible human carcinogen.

How can heptachlor and heptachlor epoxide affect children?

Animals exposed to heptachlor during gestation and infancy may be very sensitive to heptachlor and heptachlor epoxide. Changes in nervous system and immune function were found in these animals. Exposure to higher doses of heptachlor in animals can also result in decreases in body weight and death in newborn animals.

How can families reduce the risks of exposure to heptachlor and heptachlor epoxide?

❑ People who live in homes where heptachlor was used for termite control or on farms where heptachlor was used on crops may have a higher risk of exposure through contaminated crops, soil, water, and air. To avoid exposure from contaminated soil, you should discourage your children from eating dirt. Make sure they wash their hands frequently and before eating. Discourage children from putting their hands in their mouths or other hand-to-mouth activities.

❑ Heptachlor and heptachlor epoxide are also persistent in food and milk. Eating fish from contaminated water can increase exposure to heptachlor. Do not fish or eat fish from contaminated water. Local fishing advisories can tell you if the water is contaminated.

Is there a medical test to determine whether I've been exposed to heptachlor or heptachlor epoxide?

Laboratory tests can detect heptachlor and heptachlor epoxide in blood, fat, breast milk, and body tissues after exposure to high levels of these chemicals. These tests are not commonly available at your doctor's office. Most often, the test for heptachlor epoxide is used because heptachlor is quickly changed into heptachlor epoxide in your body. Blood samples are used most often because they are easy to collect. These tests are specific for heptachlor and heptachlor epoxide.

Methods for measuring heptachlor and heptachlor epoxide in body fat are more precise and can detect lower levels than tests that measure levels in blood. If heptachlor or heptachlor epoxide is found in your blood or fat, it is not possible to tell when you were exposed to these chemicals or if harmful health effects will occur.

Has the federal government made recommendations to protect human health?

The EPA requires that drinking water should not contain more than 0.0004 milligrams heptachlor per liter of water (0.0004 mg/L) and 0.0002 mg heptachlor epoxide per liter of water (0.0002 mg/L).

The FDA controls the amount of heptachlor and heptachlor epoxide on raw food crops and on edible seafood. The limit on food crops is 0.01 parts heptachlor per million parts food (0.01 ppm). The limit in milk is 0.1 parts per million of milk fat. The limit on edible seafood is 0.3 ppm.

The Occupational Safety and Health Administration (OSHA) has set a limit of 0.5 milligrams heptachlor per cubic meter of workplace air (0.5 mg/m^3) for 8 hour shifts and 40 hour work weeks.

References

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological Profile for Heptachlor and Heptachlor Epoxide (Update). Atlanta, GA: U.S. Department of Public Health and Human Services, Public Health Service.

Where can I get more information? For more information, contact the Agency for Toxic Substances and Disease Registry, Division of Toxicology and Environmental Medicine, 1600 Clifton Road NE, Mailstop F-32, Atlanta, GA 30333. Phone: 1-800-232-4636, FAX: 770-488-4178. ToxFAQs Internet address via WWW is http://www.atsdr.cdc.gov/toxfaq.html. ATSDR can tell you where to find occupational and environmental health clinics. Their specialists can recognize, evaluate, and treat illnesses resulting from exposure to hazardous substances. You can also contact your community or state health or environmental quality department if you have any more questions or concerns.

Appendix E: Cancer Classifications
As explained by the American Cancer Society

Known and Probable Human Carcinogens

Introduction

Many people worry that substances or exposures in their environment may cause cancer. As part of the American Cancer Society's role in informing and educating people about cancer and its possible causes, this document provides lists of substances and exposures that are known or suspected to cause cancer. The lists below have been developed by two highly respected agencies – the International Agency for Research on Cancer (IARC) and the US National Toxicology Program (NTP). Some related information is included on how these and other agencies and groups test and classify possible carcinogens.

The American Cancer Society does not keep detailed information on each of the exposures on these lists. If you are looking for more in-depth information on a particular item on these lists, please refer to the agencies in the "Additional resources" section of this document.

What is a carcinogen?

Cancer is caused by changes in a cell's DNA – its genetic "blueprint." Some of these changes may be inherited from our parents, while others may be caused by outside exposures, which are often referred to as *environmental factors*. Environmental factors can include a wide range of exposures, such as:

Lifestyle factors (nutrition, tobacco use, physical activity, etc.)

Naturally occurring exposures (ultraviolet light, radon gas, infectious agents, etc.)

Medical treatments (chemotherapy, radiation, immune system-suppressing drugs, etc.)

Workplace exposures

Household exposures

Pollution

Substances and exposures that can lead to cancer are called *carcinogens*. Some carcinogens do not affect DNA directly, but lead to cancer in other ways. For example, they may cause cells to divide at a faster than normal rate, which could increase the chances that DNA changes will occur.

Carcinogens do not cause cancer in every case, all the time. Substances labeled as carcinogens may have different levels of cancer-causing potential. Some may cause cancer only after prolonged, high levels of exposure. And for any particular person, the risk of developing cancer depends on many factors, including how they are exposed to a carcinogen, the length and intensity of the exposure, and the person's genetic makeup.

How do researchers determine if something is a carcinogen?

Testing to see if something can cause cancer is often difficult. It is not ethical to test a substance by exposing people to it and seeing if they get cancer from it. That's why scientists must use other types of tests, which may not always give clear answers.

Lab studies

Scientists get much of their data about whether something might cause cancer from lab studies in cell cultures and animals. There are far too many substances (both natural and man-made) to test each one in lab animals, so scientists use what is already known about chemical structures, results from other types of lab tests, the extent of human exposure, and other factors to select chemicals for testing. For example, they can often get an idea about whether a substance might cause a problem by comparing it to similar chemicals that have already been studied.

Although lab studies alone can't always predict if a substance will cause cancer in people, virtually all known human carcinogens that have been adequately tested also cause cancer in lab animals. In many cases, carcinogens are first found to cause cancer in lab animals and are later found to cause cancer in people.

Most studies of potential carcinogens expose the lab animals to doses that are much higher than common human exposures. This is so that cancer risk can be detected in relatively small groups of animals. It is not always clear if the results from animal studies will be the same for people as they are normally exposed to a substance. For example, the effects seen in lab studies with very high doses of a substance may not be the same at much lower doses, or the effects of a substance when it is inhaled may not be the same as if it is applied to the skin. Also, the bodies of lab animals and humans don't always process substances in the same way.

But for safety reasons, it is usually assumed that exposures that cause cancer at larger doses in animals may also cause cancer in people. It isn't always possible to know how the exposure dose might affect risk, but it is reasonable for public health purposes to assume that lowering human exposure will reduce risk.

Studies in people

Another important way to identify carcinogens is through epidemiologic studies, which look at human populations to determine which factors might be linked to cancer. These studies also provide useful information, but they have their limits. Humans do not live in a controlled environment. People are exposed to many substances at any given time, including those they encounter at work, school, or home; in the food they eat; and in the air they breathe. It's very unlikely they know exactly what they've been exposed to or that they would be able to remember all of their exposures if asked by a researcher. And there are usually many years (often decades) between exposure to a carcinogen and the development of cancer. Therefore, it can be very hard to definitely link any particular exposure to cancer.

By combining data from both types of studies, scientists do their best to make an educated assessment of a substance's cancer-causing ability. When the evidence is conclusive, the substance is labeled as a carcinogen. When the available evidence is compelling but not felt to be conclusive, the substance may be considered to be a probable carcinogen. But in some cases there simply isn't enough information to be certain one way or the other.

Who determines how carcinogens are classified?

Several agencies (national and international) are responsible for determining the cancer-causing potential of different substances.

International Agency for Research on Cancer

The International Agency for Research on Cancer (IARC) is part of the World Health Organization (WHO). Its major goal is to identify causes of cancer. The most widely used system for classifying carcinogens comes from the IARC. In the past 30 years, the IARC has evaluated the cancer-causing potential of more than 900 likely candidates, placing them into one of the following groups:

Group 1: Carcinogenic to humans

Group 2A: Probably carcinogenic to humans

Group 2B: Possibly carcinogenic to humans

Group 3: Unclassifiable as to carcinogenicity in humans

Group 4: Probably not carcinogenic to humans

Perhaps not surprisingly, based on how hard it can be to test these candidate carcinogens, most are listed as being of probable, possible, or unknown risk. Only a little over 100 are classified as "carcinogenic to humans."

National Toxicology Program

The National Toxicology Program (NTP) is formed from parts of several different US government agencies, including the National Institutes of Health (NIH), the Centers for Disease Control and Prevention (CDC), and the Food and Drug Administration (FDA). The NTP updates its *Report on Carcinogens* (RoC) every few years.

The *Report on Carcinogens* identifies 2 groups of agents:

"Known to be human carcinogens"

"Reasonably anticipated to be human carcinogens"

The current version of the RoC lists about 240 substances and exposures. Unlike the IARC's list, the RoC does not list substances that have been studied and found not to be carcinogens.

Environmental Protection Agency

The US Environmental Protection Agency (EPA) maintains the Integrated Risk Information System (IRIS), an electronic database that contains information on human health effects from exposure to certain substances in the environment. The EPA uses a rating system similar to that of IARC when describing the cancer-causing potential of a substance:

Group A: Carcinogenic to humans

Group B: Likely to be carcinogenic to humans

Group C: Suggestive evidence of carcinogenic potential

Group D: Inadequate information to assess carcinogenic potential

Group E: Not likely to be carcinogenic to humans

Other agencies and groups

Other federal agencies, such as the CDC's National Institute for Occupational Safety and Health (NIOSH), the Food and Drug Administration (FDA), and the National Cancer Institute may comment on whether a substance or exposure may cause cancer and/or what levels of exposure to a particular substance might be considered acceptable.

Some state agencies also keep lists of known or probable carcinogens. For example, the California Environmental Protection Agency (CalEPA) maintains a list of "chemicals known to the state to cause cancer or reproductive toxicity." (Much of this list is based on the IARC and NTP lists below.)

American Cancer Society, 2012 Available at http://www.cancer.org/cancer/cancercauses/othercarcinogens/generalinformationaboutcarcinogens/known-and-probable-human-carcinogens

Red Panther Chemical Company Clarksdale, Mississippi

From 1949 until 1996, the Red Panther Chemical Company made pesticides at a manufacturing plant in Clarksdale, Mississippi. In 2005 and 2010, the U.S. Environmental Protection Agency (EPA) tested soil samples from yards in the 18th Street neighborhood and nearby areas to see if pesticides from the site had gotten into home yards. EPA found pesticides in some yards and asked the Agency for Toxic Substances and Disease Registry (ATSDR) to review its test results to see if exposure to these pesticides could harm people's health. ATSDR reviewed the test results and released a report in 2017. The report includes a description of what we did and recommendations we made to protect people's health. This is a summary of the report.

The Bottom Line

- Current exposure to four pesticides (toxaphene, heptachlor, heptachlor epoxide, and dieldrin) found in residential soil is not expected to harm people's health.
- There is not enough information to say if past exposure to the pesticides found in soil could have harmed people's health.
- ATSDR recommends additional sampling south and west of the site and on-site near the septic field to see if there are additional areas of contamination that people might be exposed to.

Will pesticides in the soil in my yard harm my health?

Soil test results showed that some pesticides have moved from the plant to some yards in homes in the 18th Street neighborhood and nearby areas. ATSDR reviewed the test results and found that the levels of toxaphene, heptachlor, heptachlor epoxide, and dieldrin in residential soil are low. Exposure to these pesticides is not expected to cause non-cancer health effects.

These pesticides can cause cancer in people if they are exposed to a high level for a long time. However, the risk is very low that people might develop cancer from the levels of pesticides found in these residential soil samples.

ATSDR works with medical groups that can talk with you about how exposure to pesticides in soil can affect your health. For more information about these medical groups, contact Leann Bing (see contact information on back of flier).

How can I be exposed to pesticides in soil?

Every day, and mostly by accident, most people will swallow a little soil along with any chemicals in the soil. Because they touch soil more often, gardeners might be exposed to more chemicals in soil. Children who play in soil and put dirt-covered toys and hands in their mouths might be exposed to chemicals in soil more than adults.

Fruits and vegetables grown in contaminated soil can take up pesticides, and pesticides can also stick to the outside of the fruits and vegetables. People can be exposed to these pesticides when they handle the fruits and vegetables, eat contaminated fruits and vegetables, or eat fruits and vegetables that are not washed well enough to get rid of the pesticides on the outside.

Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations

ATSDR

CS277767-A

Red Panther Chemical Company - Clarksdale, Mississippi

Red Panther, the state of Mississippi, EPA, and others have cleaned up pesticides on the site and in drainage ditches east of the plant to lower pesticide exposure.

How can I reduce my family's exposure to pesticides in soil?

You can protect your health and your children's health by lowering the amount of soil you accidentally swallow. Follow these simple steps to lower the amount of soil you get into your body:

- Wipe your shoes on a doormat and take your shoes off when you come into your house.
- Damp mop floors and wipe down counters and furniture with a wet cloth often.
- Wash and peel all fruits, vegetables, and root crops raised on your property before cooking and eating them.
- Wash pets often.
- Wash children's toys often.
- Wash children's hands, feet and face after they have been playing outside.
- Do not eat food, chew gum, or smoke when working in the yard.
- Wear long-sleeved shirts, long pants, and gloves to keep soil off your skin. In the summer, wear light-weight clothing so you don't get too hot.

What medical tests can measure the levels of these pesticides in my body?

Special medical tests can measure levels of these four pesticides in your body. However, ATSDR does not recommend you get these tests. The tests cannot tell where the pesticides came from, or if the levels in your body can make you sick. Most doctors' offices do not do these tests. The tests need to be done at special laboratories that have the right equipment.

What will ATSDR do next?

- ATSDR addressed community concerns in the report and will continue to answer your health concerns at the site.
- ATSDR will continue to review the available test results and make recommendations to protect people's health from exposure to pesticides in soil at this site, as necessary.

Where can I learn more?

- Read the full report on the ATSDR website at https://www.atsdr.cdc.gov/HAC/PHA/HCPHA.asp?State=MS
- Read the report at the Carnegie Public Library of Clarksdale, located at 114 Delta Avenue, Clarksdale MS.
- For more information about ATSDR's work at the Red Panther Chemical Site, phone Leann Bing at 404-562-1784, or send an email to her at KBing@cdc.gov.