Health Consultation

NEW WARRINGTON & NAVY GROUNDWATER
PESTICIDE STUDY AREA

PENSACOLA, ESCAMBIA COUNTY, FLORIDA

JUNE 13, 2006

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

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

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HEALTH CONSULTATION

NEW WARRINGTON & NAVY GROUNDWATER PESTICIDE STUDY AREA

PENSACOLA, ESCAMBIA COUNTY, FLORIDA

Prepared by:

Florida Department of Health
Bureau of Community Environmental Health
Under Cooperative Agreement with
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Summary

The Florida Department of Health (FDOH) evaluated groundwater data collected primarily northwest of the intersection of New Warrington Road and Navy Boulevard in Pensacola. All residents and businesses in the study area are supplied with municipal water. Water distributors filter groundwater from the nearby public supply wells through granular activated carbon units to remove volatile organic compounds (VOCs) and pesticides prior to distribution. Therefore, this report addresses the public health implications of the use of water supplied by privately owned, *unfiltered* irrigation wells. Approximately 200 irrigation wells are permitted in the groundwater study area, and 50 were sampled for this study. Groundwater in portions of the study area contains levels of dieldrin, alpha- and beta-hexachlorocyclohexane (HCH) isomers, and heptachlor epoxide (organochlorine pesticides) above each chemical's health-based screening level. No VOCs were detected above screening values in these samples. FDOH found that the use of this shallow groundwater for irrigation of edible fruits and vegetables was acceptable. Other incidental routes of exposure (e.g. dermal contact, inhalation) to groundwater contacts were evaluated and found to be below levels of health concern. FDOH will inform nearby residents of the conclusions and recommendations in this report and will evaluate any future environmental test results.

Purpose

The FDOH evaluates the public health significance of groundwater contamination through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR) in Atlanta, Georgia. In June 2005, the Florida Department of Environmental Protection FDEP asked the Florida DOH to evaluate the public health threat from chemicals found in groundwater from wells primarily northwest of the intersection of New Warrington Road and Navy Boulevard in Pensacola.

Background

Low levels of dieldrin and other organochlorine pesticides were measured in samples from the Corry Station potable supply wells in 1984. Corry Station is located in southwest Pensacola, Escambia County, Florida; it appears as "U.S. Naval Reservation" on Figure 1. Additional testing measured dieldrin and other VOCs in eight of the 10 Corry Station public supply wells and in Escambia County Utilities Authority West Pensacola Well #1. Water distributors filter groundwater from all these public supply wells through granular activated carbon units to remove volatile organic compounds (VOCs) and (in some cases) pesticides prior to distribution.

Follow-up testing to identify a source of groundwater contamination targeted existing irrigation and monitoring wells in the neighborhoods north of the Corry Field and Escambia public supply wells. Marcus Bayou borders the study area (Figure 1) on the north, New Warrington Road and mobile Highway on the east, Jackson Branch on the south, and 65th Avenue on the west. DEP's contractor installed monitoring wells in areas suspected as point sources.

While testing has not identified point sources, DEP's contractor found higher levels of organochlorine pesticides in the neighborhoods north of the public supply wells, which indicates that the Corry Field area is unlikely to be the source of contamination. Lakewood Homes and Pen Haven Homes constructed residential developments in the apparent source areas, beginning in 1953. Farmers grew crops in these areas prior to that time. Therefore, the organochlorine

pesticides measured in groundwater may have been applied as agricultural pesticides prior to development or as termiticides at the time of residential construction.

Although dieldrin was the chemical most often measured above its health-based screening level, five wells with traces of dieldrin also contained pesticides (above their screening levels). Two had hexachlorocyclohexane isomers (one had alpha and one had beta), and three had heptachlor epoxide. Many wells showed only traces of these chemicals (meaning that the levels measured were so low, the measured levels are unlikely to be reproducible with additional testing).

The pesticides measured above their screening values are denser than water and would sink relative to the surrounding water once they reached the water table. These pesticides also tend to adhere to organic particles. None of the analytical measurements showed organochlorine pesticides at levels greater than 1 microgram per liter (ug/L) or 1 part per billion (ppb) in groundwater.

Most of the properties northwest of the intersection of New Warrington Road and Navy Boulevard in Pensacola *(and north of Corry Station)* are residential, although a few are commercial. All receive municipal water and sanitary sewer service. In addition to the 10 Navy supply wells and seven municipal supply wells, the Northwest Florida Water Management District (NWFWMD) has permitted approximately 200 residential and commercial irrigation wells in the study area. The FDEP asked the FDOH to assess the public health implications of using groundwater from these irrigation wells.

In 2000, an estimated 11,611 people lived in the study area. Approximately 77% were white, 13% were black, 4% were Asian, and 4% were Latino or Hispanic. American Indian and Alaskan Native, Native Hawaiian and Other Pacific Islander, and all other racial/ethnic groups made up about 1% of the population (Bureau of the Census 2000). Within the study area are the West Pensacola School, the Myrtle Grove School, and Escambia High School and the Sherwood School.

Community Health Concerns

At this time, neither the Escambia County Health Department nor the FDEP has reported any community health concerns to the FDOH. NWDEP district staff have shared individual irrigation well sampling results with each well-owner. Because properties may have changed hands in the last few years, the NWDEP district office will work with FDOH to share the conclusions and recommendations of this Health Consultation with residents who live in the New Warrington and Navy groundwater study area"

Discussion

The FDOH evaluated available groundwater data to assess the public health implications of using groundwater from irrigation wells. The purpose of irrigation wells is to water plants. Incidental exposures people may have like skin contact, spray inhalation, or incidental ingestion, while possible, are not significant exposure routes to the very low levels of persistent organochlorine pesticides and pesticide breakdown products in unfiltered irrigation well water. FDOH does not know if, whether, or how many people may be growing homegrown produce. Therefore, ingestion of homegrown fruits and vegetables watered with irrigation well water ***is a potential exposure pathway.*** FDOH modeled exposure to irrigation water contaminants via

homegrown produce using the Oak Ridge National Laboratory Risk Assessment Information System (RAIS) on-line software†.

Figure 1 (Appendix A) shows the approximate final boundaries of the groundwater investigation. As wells were sampled and found to contain trace amounts of dieldrin, wells further upgradient, to the north, northeast and northwest were sampled. Figure 2 (Appendix A) shows the locations and types of the wells that were sampled. These wells included irrigation wells, public supply wells and monitoring wells. We refer to Table 3 (Appendix B) that lists the maximum concentrations and detection frequencies for each groundwater contaminant of concern. Table 3 summarizes information from the following groundwater-sampling efforts (in which researchers had their samples analyzed for organochlorine pesticides):

- Between **1991** and **2001**, NWFWMD staff sampled the 10 public supply wells on Corry Field U.S. Naval Reservation 49 times. They measured dieldrin in well water samples at levels exceeding the 0.002 ppb screening level in 33 of the 49 samples. They found the highest levels of dieldrin in Corry #8. This well is in the northeastern quadrant of Corry Station and pulls water from the main producing zone of the Sand and Gravel Aquifer.
- NWFWMD staff modeled the 40-year capture zone for Corry#8. This capture zone extended 1 mile north of Corry #8. The NWFWMD investigated the capture zone by sampling 24 irrigation wells in **1995**. They measured dieldrin in well water samples at levels exceeding 0.002 ppb in 21 of the 24 samples. They found the highest levels of dieldrin in an irrigation well approximately 3000 feet north of Corry #8.
- DEP's contractor, PSI, attempted to locate point sources for organochlorine pesticide contamination by reviewing historical records and testing groundwater samples from relevant areas. They investigated groundwater quality north of Corry Station by installing and sampling 18 temporary "microwells", primarily in road right-of-ways. They also sampled 61 existing wells: 50 private irrigation wells and 11 leaking underground storage tank monitoring wells. PSI finalized their report describing this study in **2004**. PSI had all groundwater samples analyzed for organochlorine pesticides by EPA Method 8081. PSI staff also had the permanent well elevations surveyed and they measured the depths to the groundwater at these wells to estimate groundwater flow directions.

To evaluate groundwater data for the study area, FDOH determined which wells had chemicals measured above their health-based screening criteria†, determined which values were likely to be reproducible (meaning they were above the Practical Quantitation Limit (PQL $^{\Omega}$)) and plotted them with the well screen depth, and sample date. These chemicals are all heavier than water, and sink once they reach the water table. Figure 3 shows that the higher measured dieldrin values correspond to shallow groundwater depth indicated by the second value in the callout boxes, which give depth of the well screen‡ relative to sea level, where that information is available. FDOH plotted and contoured dieldrin values to characterize the dieldrin plumes (Figure 3). This is consistent with the nature of these organochlorine chemicals to sink because they are heavier than water. The contours on Figure 3 may be inexact because in areas we compare data measured

† The RAIS web-site and models are sponsored by the U.S. Department of Energy (DOE), Office of Environmental Management, Oak Ridge Operations (ORO) Office through a contract with Bechtel Jacobs Company LLC for use at all DOE sites.
† For all these chemicals, the health-based screening level was the ATSDR Cancer Risk Evaluation Guide (CREG) for 1 excess cancer case in 1 million people.
Ω The PQL is the level at which the instrument measuring the chemical can reliably reproduce the measured value.
‡ The well screen is the portion of the well casing that has holes in it to allow water to flow into the bottom of the well.

nine years apart, although for wells sampled multiple times, we contoured the most recently measured levels.

FDOH only has sampling data over time for some of the Public Supply Wells on Corry Field. The sampling dates and intervals are inconsistent: 11/94, and or 6/95; and between 1 and 5 times throughout 2001. Of the 50 samples from 10 wells, only 12 measured dieldrin values from three wells were above the Practical Quantitation Level. Of those three wells, the dieldrin levels measured in two upgradient wells seem to have decreased over time (Corry #8 and #7, Figure 2) and the dieldrin levels measured in a downgradient well seems to have increased over time (Corry #11, Figure 2). However, data from each well also shows fluctuations in the opposite direction, and only one value from Corry #11, the downgradient well, was above the PQL.

We plotted the five other organochlorine pesticide values exceeding their screening values on another map (Figure 4). These occurrences are apparently isolated (separated by many wells that did not measure exceedences for that chemical) and are therefore unlikely to be related either to each other or to the dieldrin plume[ξ]. We did not contour these unrelated values on Figure 4.

We identified dieldrin, the alpha- and beta-hexachlorocyclohexane (HCH) isomers, and heptachlor epoxide as the contaminants requiring further investigation with respect to public health implications for private irrigation well owners.

Quality Assurance and Quality Control

FDOH used existing environmental data in this health consultation. We assume these data are valid. The completeness and reliability of the referenced environmental data determine the validity of the analyses and conclusions drawn for this health consultation. Laboratory method detection levels for dieldrin (0.02 ppb) are higher than the Cancer Risk Evaluation Guideline (CREG) 0.002 ppb (for a 1 in 1 million excess cancer risk—0.002 ppb is also the Groundwater Cleanup Target Level (GCTL) in Florida). Both the dieldrin CREG and GCTL are lower than the PQL (0.1 ppb). However, the inability of the instrumentation to measure to these target levels does not hinder our ability to estimate the increased cancer rate from exposure to groundwater contaminants via irrigation of homegrown produce. This is because even the highest measured levels in the study area were unlikely to significantly increase cancer risk due to the doses we calculated using the model assumptions.

Groundwater Pathways Analyses

Chemical contaminants in the environment can be harmful to public health, but only if people are exposed to them. It is essential to determine or estimate the frequency of exposure people could have with hazardous substances in their environment to assess their public health significance.

In subdivisions, people are likely to use irrigation well water because it is an inexpensive source of water for grass and other landscaping plants in their yards. Residents may also use irrigation wells to water fruit, vegetable, and herb gardens. Some residents may occasionally drink water from their irrigation wells or use irrigation well water to clean fish and food contact surfaces, like knives, cutting boards, or grills. The NWFWMD permitted approximately 200 private irrigation wells in the study area and 50 were sampled for this study.

ξ Water from four of these five wells also contained dieldrin above the PQL and are noted on Figure 3. The well labeled 0.22 HE -5 ’03 is the only well that did not have dieldrin above the PQL, although it did contain dieldrin above the CREG.

Public Health Implications

FDOH evaluates chemical exposures by estimating daily doses for children and adults (Tables 3 and 4). A dose is an amount of chemical per body weight. FDOH uses estimated doses to compare potential exposure levels to amounts having known health effects from animal studies or from human medical reports. We use the units of milligrams (mg) of contaminant per kilogram (kg) of body weight per day (mg/kg/day). A milligram is 1/1,000 of a gram (a gram weighs about as much as a small raisin or paper clip); a kilogram is approximately 2 pounds.

For all of the organochlorine pesticides measured above their screening values, Florida DOH calculated dose estimates for both children and adults, and for four exposure pathways. The estimated doses for other exposure pathways provide a frame of reference for comparison with estimated doses from ingestion of irrigated fruits and vegetable. All irrigation (ingestion) dose estimates were lower than the calculated groundwater ingestion and dermal exposure doses. The skin and showering exposures are relevant because they show negligible risk for daily exposure; therefore, someone contacting irrigation spray would be even less likely to be at risk.

The comparison doses listed in Table 3 assume children and adults might drink the irrigation well water (as their source of drinking water, which they are not) or might use it indoors for showering (which is also highly unlikely). The doses on Table 4 are calculated from a model that assumes adults eat 1.8 oz. fruit and 0.7 oz. of vegetables and children eat 0.5 oz. fruits and vegetables, 250 days a year, irrigated for three months with water containing the highest measured levels of organochlorine pesticides. To calculate daily doses, Florida DOH uses standard assumptions about body weight, ingestion and inhalation rates, and duration of exposure. The values we calculated and the additional assumptions we used in these calculations are listed in Tables 3 and 4, and reference ATSDR 2005a, and 2005b. Again, the doses on Table 3 are unlikely to ever be realized in an exposure because these are irrigation wells. We calculated the doses on Table 3 only to show that levels of exposure to contaminated groundwater via irrigation of homegrown produce (Table 4) are much lower than if the water were used for drinking and other indoor purposes.

We list the doses we calculated for ingestion of irrigated fruits and vegetables, by chemical, in Table 5, along with a discussion about how these calculated doses compare with the lowest levels associated with health effects from medical reports or animal studies. **These comparisons indicate the chemicals measured are unlikely to cause non-cancer health effects and are unlikely to increase the risk of cancer significantly**.

We discuss historic use of these pesticides in the following paragraphs.

Alpha- and Beta-hexachlorocyclohexanes (HCH)

In the past, HCH was known as benzene hexachloride (BHC). An isomer is a chemical with the same atoms, but in the case of HCH, the hydrogen atom can be attached to the main cluster of chemicals in different positions (referred to as the alpha through gamma isomers). The hydrogen position affects how easily the body processes the chemical, so it affects the chemical's toxicity. Therefore, each HCH isomer has a different health-based screening value. Groundwater testing only measured the alpha-isomer above its screening level in one well, and the beta-isomer above its screening level in one other well.

HCH is a white solid that can evaporate as vapor. US chemical companies have not produced it since 1976, but it is imported in dust, powder, liquid and concentrate forms. HCH is an agricultural insecticide and is still used to treat people for head lice and scabies. According to the

toxicological profile, virtually all of the insecticidal properties reside in the gamma-isomer (also known as Lindane, ATSDR 2005b). In the past, technical grade HCH contained the alpha, beta, delta, and epsilon forms, with roughly 10—15% gamma-HCH.

Dieldrin

Dieldrin is a white or tan powder that slowly evaporates into the air. From the 1950s until 1970, farmers used it extensively as an insecticide on crops like corn and cotton. Although the US Department of Agriculture cancelled its use on crops in 1970, the EPA approved its use as a termiticide in 1972. The manufacturer voluntarily cancelled dieldrin's termiticide registration in 1987 (ATSDR 2002).

Heptachlor Epoxide

Heptachlor is both a breakdown product and a component of the pesticide chlordane. Chlordane was approximately 10% heptachlor by weight. From 1953 until 1974, farmers used heptachlor as an insecticide, and builders used heptachlor and chlordane to prevent termites from colonizing residences. Although its registration as a termiticide ended in the late 1980s, heptachlor is still registered for use against fire ants in underground power transformers. While heptachlor was (and is) used as a pesticide, it is readily broken down into heptachlor epoxide by bacteria and other exposed living systems. Heptachlor epoxide is a white or tan powder that does not burn or explode easily and does not readily dissolve into water (ATSDR 2005c).

Child Health Considerations

ATSDR and FDOH recognize the unique vulnerabilities of infants and children demand special attention (ATSDR 2005a). Children are at a greater risk than are adults are, for some hazardous substance exposures. Because children are smaller than adults are, their exposures can result in higher doses of chemical per body weight. If toxic exposures occur during critical growth stages, the developing body systems of children can sustain permanent damage. Probably most important, however, is that children depend on adults for risk identification and risk management, hygiene awareness, and access to medical care. Thus, adults should be aware of public health risks in their community, so they can guide their children accordingly. In recognition of these concerns, ATSDR developed the chemical screening values for children's exposures that FDOH used in preparing this report.

Other susceptible populations may have different or enhanced responses to toxic chemicals than will most people exposed to the same levels of that chemical in the environment. Reasons may include genetic makeup, age, health, nutritional status, and exposure to other toxic substances (like cigarette smoke or alcohol). These factors may limit a susceptible person's ability to detoxify or excrete harmful chemicals or may increase the effects of damage to their organs or systems.

Conclusions

Groundwater in portions of the study area contains dieldrin, alpha- and beta-hexachlorocyclohexane (HCH) isomers, and heptachlor epoxide (organochlorine pesticides) above each chemical's health-based screening level. FDOH found that the use of this shallow groundwater for irrigation of edible fruits and vegetables was acceptable, as the amounts children or adults might ingest on homegrown produce were unlikely to cause illness or significantly increase theoretical cancer risks.

Recommendations

Irrigation well water may be used to water fruits, vegetables or herbs in the study area. Nevertheless, because of the risk of contamination of irrigation wells with bacteria, FDOH generally recommends people should not use irrigation water for drinking or to clean food or food contact surfaces. This is a general recommendation that is applicable throughout the state.

Photolysis and biodegradation break down HCHs, dieldrin and heptachlor epoxide although under certain conditions these processes may proceed slowly. Bennet et al. (1974) found that 10% of the original dieldrin remained 21 years after the application of dieldrin to the foundation of a house at the application rate commonly used for termite control, primarily in the upper 6 inches of the soil. If the conditions in the study of Bennet et al. are applicable to the conditions in this investigation, the concentrations of pesticides could much higher in treated soil than in groundwater. Probably the best precautions gardeners can take would be to refrain from growing fruits or vegetables near buildings on their properties that may have been treated for termites.

Public Health Action Plan

Because we did not find any risk from using water with low levels of organochlorine pesticides to water homegrown produce, no special precautions need to be taken to reduce any existing health hazards or to prevent any from occurring in the future. FDOH, Bureau of Community Environmental Health staff will continue to work the Florida Department of Environmental Protection and Escambia County Health Department staff to protect public health throughout Florida.

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References

[ATSDR] Agency for Toxic Substances and Disease Registry. 2002. (Update) Toxicological profile for aldrin/dieldrin. Update. Atlanta: U.S. Department of Health and Human Services

[ATSDR] Agency for Toxic Substances and Disease Registry. 2005a. Public health assessment guidance manual. Atlanta: U.S. Department of Health and Human Services.

[ATSDR] Agency for Toxic Substances and Disease Registry. 2005b. Toxicological profile for alpha-, beta-, gamma and delta hexachlorocyclohexane. Atlanta: U.S. Department of Health and Human Services

[ATSDR] Agency for Toxic Substances and Disease Registry. 2005c. (Update-draft) Toxicological profile for heptachlor epoxide. Atlanta: U.S. Department of Health and Human Services

[ATSDR] Agency for Toxic Substances and Disease Registry. 2006. Soil and Water Comparison Values. Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services, Atlanta, GA.

Bennet GW. GW, DL Ballee, RC Hall, et al. 1974. Persistence and distribution of chlordane and dieldrin applied as termiticides. Bull Environ Contam Toxicol 11:64-69.

Bureau of the Census, 2000. LandView 5 Software on DVD, A Viewer for EPA, Census and USGS Data and Maps. U.S. Department of Commerce

[DEP] Florida Department of Environmental Protection. 2005. Soil, Groundwater, and Surface Water Cleanup Target Levels (CTLs) for Chapter 62-777, Florida Administrative Code.

Epstein SS, Arnold E, Andrea J, et al. 1972 Detection of chemical mutagens by the dominant lethal assay in the mouse. Toxicol Appl Pharmacol 23:288-325.

Fitzhugh OG, Nelson AA, Frawley JP. 1950. The chronic toxicities of technical benzene hexachloride and its α, β, and γ isomers. J Pharmacol Exp Ther 100:59-66.

Podowski AA, Banerjee BC, Feroz M, et al. 1979. Photolysis of heptachlor and cis-chlordane and toxicity of their photoisomers to animals. Arch Environ Contam Toxicol 8:509-518.

[PSI] Professional Services Incorporated. 2005. New Warrington and Navy Pesticide Study, Pensacola, Escambia County, Florida. FDEP Site No. 432

Smialowicz RJ, Williams WC, Copeland CB, et al. 2001. The effects of perinatal/juvenile heptachlor exposure to adult immune reproductive system function in rats. Toxicol Sci 61(1):164-175.

Thorpe E, and Walker AIT. 1973. The toxicology of dieldrin (HEOD): II. Comparative long-term oral toxicity studies in mice and dieldrin, DDT, phenobarbitone, β-HCH, and γ-HCH. Food Cosmet Toxicol 11:433-442.

Van Velson FL, Danse LHJC, Van Leeuwen FXR, et al. 1986. The subchronic oral toxicity of the β-isomer of hexachlorocyclohexane in rats. Fundam Appl Toxicol 6:697-712

Walker AIT, Stevenson DE, Robinson J, et al. 1969. The toxicology and pharmacodynamics of dieldrin (HEOD): Two-year oral exposures in rats and dogs. Toxicol Appl Pharmacol 25:267-275

[US EPA], United States Environmental Protection Agency, Office of Toxic Substances, 1986. Methods of assessing exposure to Chemical Substances. Volume 8: Methods for Assessing Environmental Pathways of Food Contamination, EPA 560/5-85-008. September 1986

TOXNET. 2005. The Nation Library of Medicine's Website: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

Appendix A—Figures

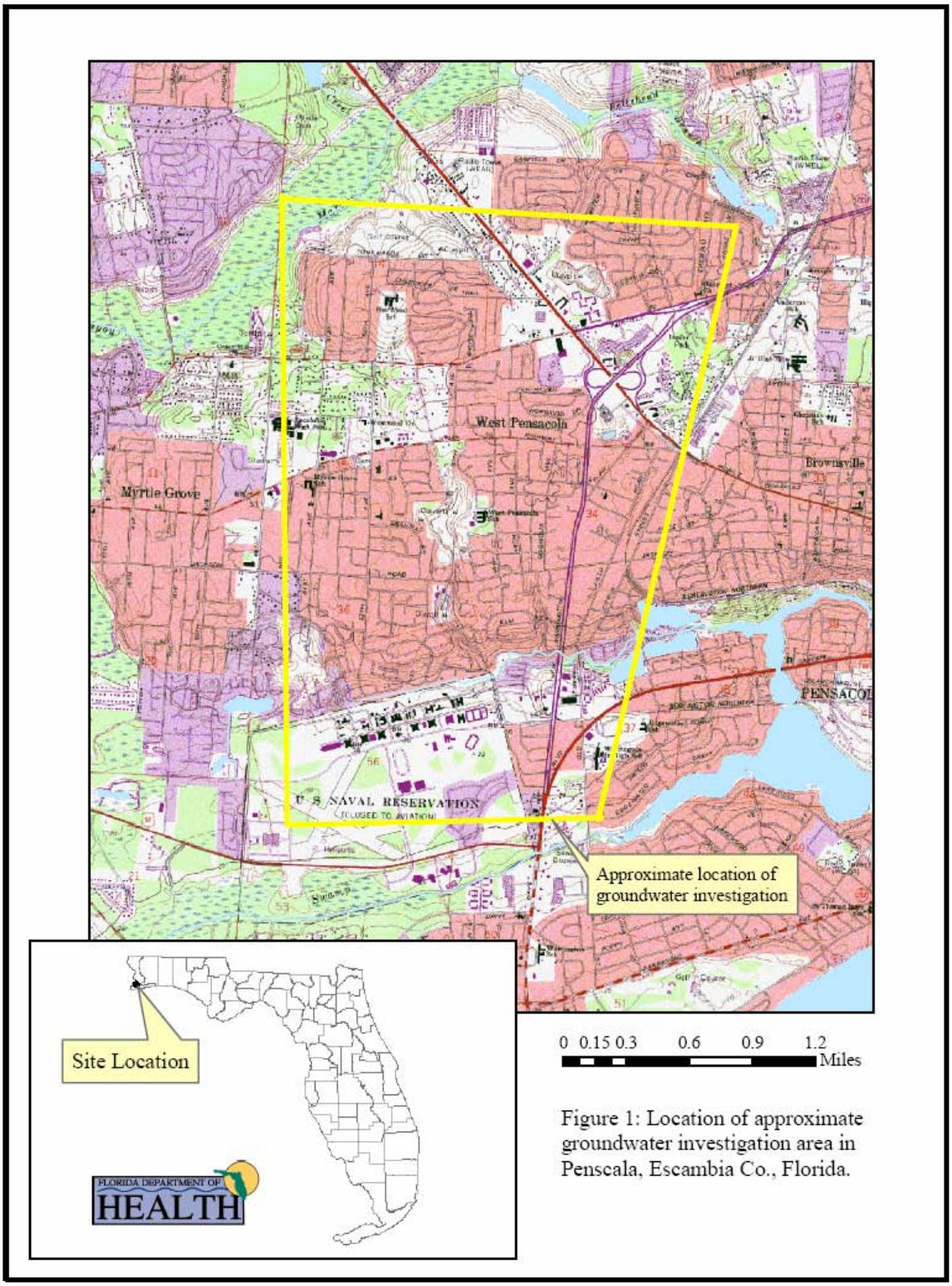

Figure 1: Location of approximate groundwater investigation area in Pensacola, Escambia Co., Florida.

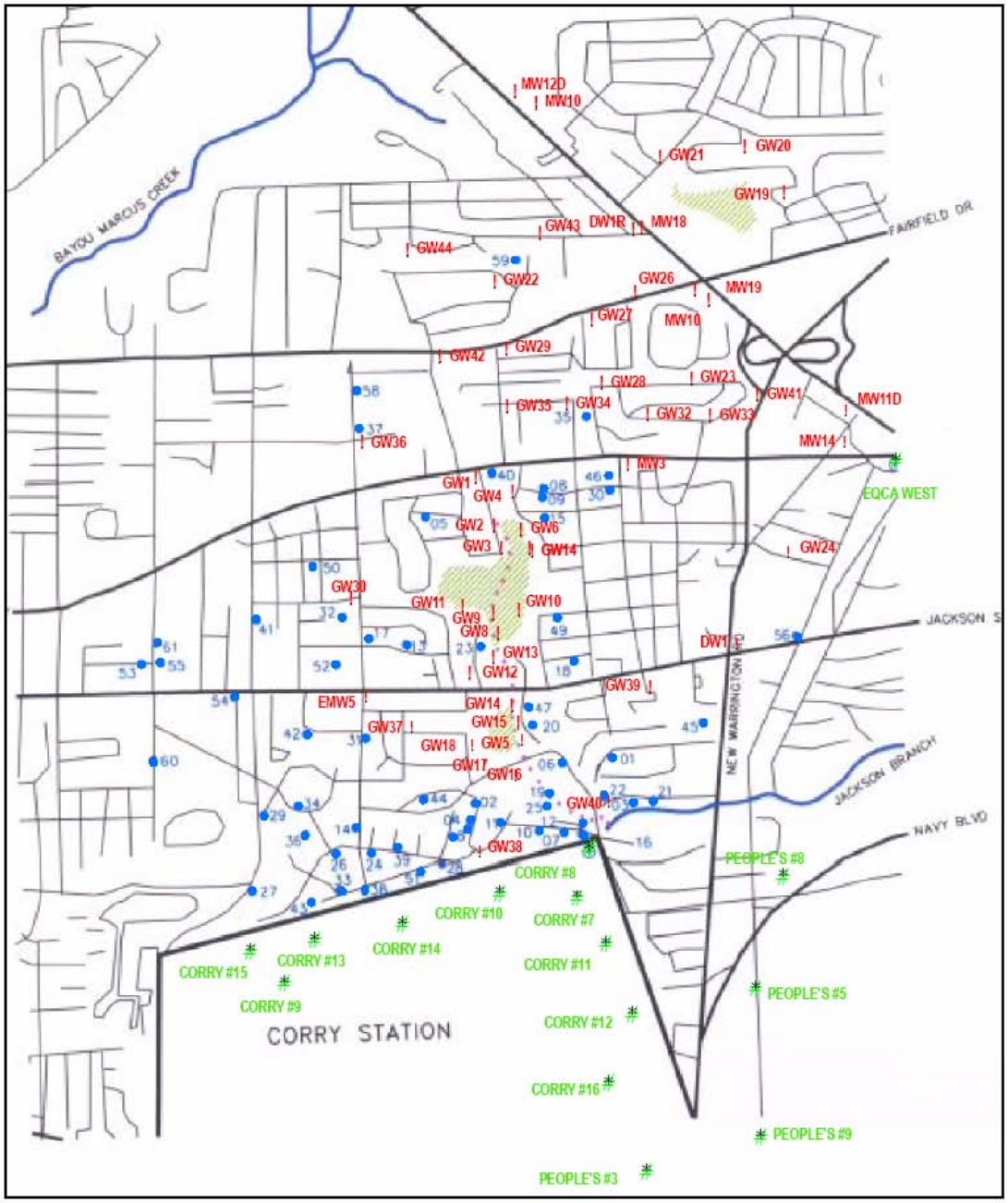

Figure 2: Locations of wells sampled in the study area. The red circles are monitoring wells, the blue circles are irrigation wells and green triangles are public supply wells. Data from a few of the public supply wells were not available for this study because they are located down gradient.

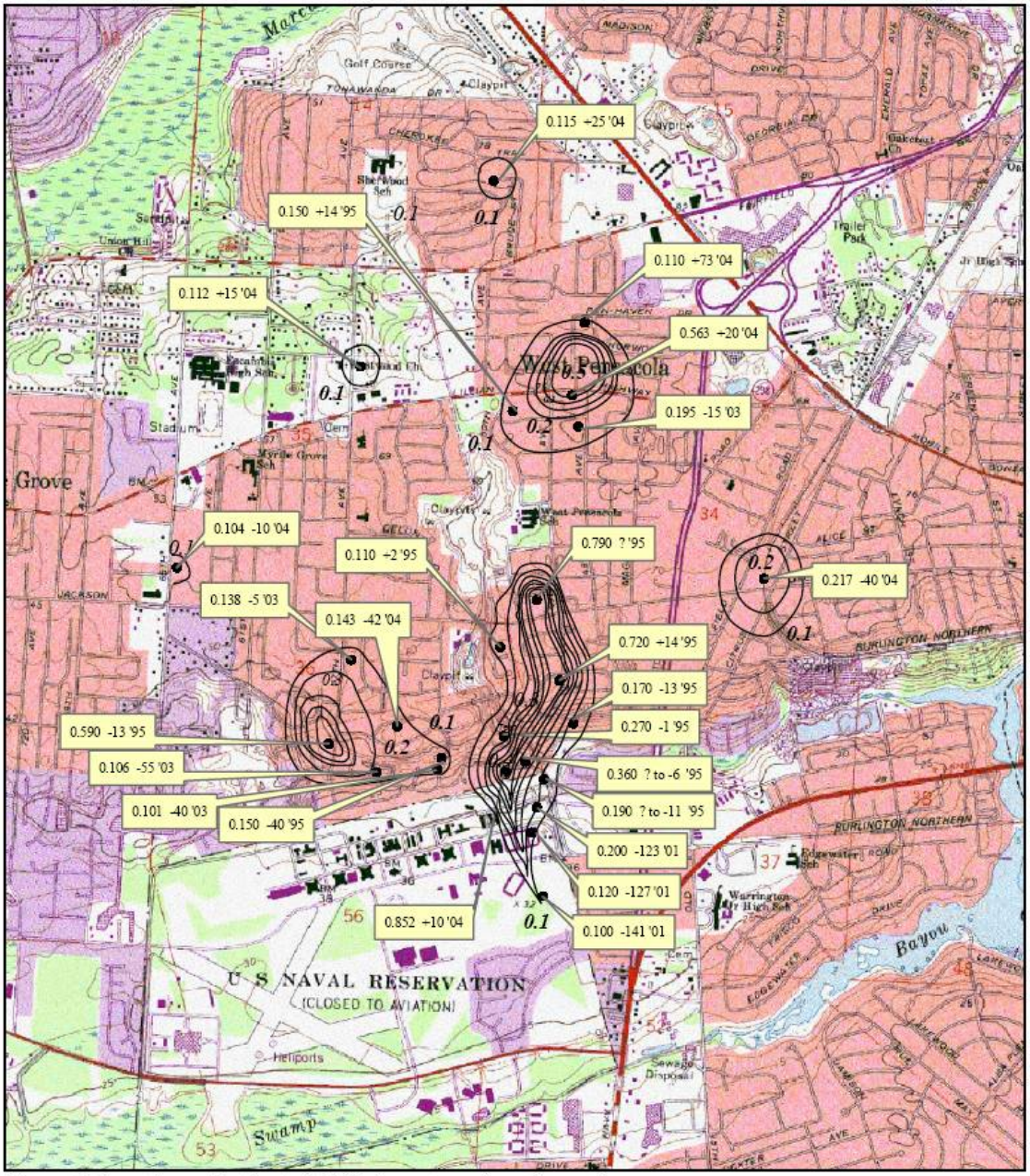

Figure 3: Locations of estimated dieldrin contours based on values measured at or above the practical quantitation level (0.1 ppb). Errors could result from comparing dieldrin values measured nine years apart. First values are dieldrin concentrations in ug/L (parts per billion), second values are the estimated top of the screened interval in the well relative to the 1929 NGVD, and the third value is the sample year. Areas between 0.1 ppb contours had values measured below the 0.1 ppb. For wells sampled multiple times, the most recent values were used.

Figure 4: Location of five wells that contained other organochlorine pesticides (hexachlorocycohexane isomers (HCH) and heptachlor epoxide (HE)) above their screening values. First values in the callout boxes are chemical levels in ppb, second values are the top of the well screen relative to sea level, and the third values are the sample year.

Appendix B—Tables

Table 1. Completed Exposure Pathways

PATHWAY NAME	EXPOSURE PATHWAY ELEMENTS					TIME
	SOURCE	ENVIRON-MENTAL MEDIA	POINT OF EXPOSURE	ROUTE OF EXPOSURE	EXPOSED POPULATION	
Biota	Contaminated groundwater	Home-grown fruits and vegetables	Irrigation wells	Ingestion: In subdivisions, people are likely to use irrigation well water because it is an inexpensive source of water for grass and other landscaping plants in their yards. Residents may also use irrigation wells to water fruit, vegetable, and herb gardens. Some residents may occasionally drink water from their irrigation wells or use irrigation well water to clean fish and food contact surfaces, like knives, cutting boards, or grills.	Residents	Past, present and future

Table 2. Groundwater Concentrations for Contaminants of Concern

Contaminants of Concern	Screening Value (µg/L) ATSDR:	DEP:	Highest Groundwater Concentration (µg/L)	Location of Highest Concentration	Number Water Samples Above Screening Value
alpha-HCH	0.006 CREG	0.006 GTCL	0.020	Irrig-39 Prieto Lane	1/200
beta-HCH	0.020 CREG	0.020 GTCL	0.030	Irrig-61 65th Ave	1/205*
dieldrin	0.002 CREG	0.002 GTCL	0.852	GW-40A	127/205
heptachlor epoxide	0.004 CREG	0.2 GTCL	0.620	Irrig-48 Teakwood Cir.	3/200

CREG—ATSDR's Cancer Risk Evaluation Guide for 1 excess cancer case in 1 million people (ATSDR 1992a).

GTCL—Florida DEP's Groundwater Target Cleanup Level

Irrig-39 well is screened at 80-100' depth

Irrig-48 well is screened at 80-120' depth

Irrig-61 well is screened at 113-123' depth

GW40A well is screened at 15-20' depth

*205 samples were taken, from 145 wells, so 27 wells were sampled twice. Of the 145 different wells sampled, one set of 18 samples had no detections, so the actual detection level may have been too high in that laboratory. For all the wells sampled, none of the method detection levels (MDL) achievable by the laboratories were as low as the CREG and GTCL (the sample method cannot currently achieve this level). Of the 145 wells sampled, dieldrin was only measured above the practical quantitation level (PQL) in 23 wells. The DEP lab manager has a good analogy for understanding the difference between the PQL and MDL. He compares the level of chemical to a radio wave source. For a weak source, you may be able to recognize a few words, but you will not be able to understand the meaning of the broadcast, this is analogous to chemical levels between the MDL and the PQL. At a certain radio signal strength, you will understand the meaning of the broadcast, this is analogous to a high enough level of chemical (the PQL) that repeated analysis should measure the same chemical level, time after time. For these reasons, the PQL is the reporting limit under Florida Statute 62-777, the statute that lists media Cleanup Target Levels. This statue and others all point to Florida Statute 62-168 which defines how data are to be reported.

Table 3. Calculated Dose for Residential Exposure to Groundwater
For comparison only of ingestion of irrigated fruits and vegetables with drinking, skin contact in a shower-like setting, and inhalation of vapors from showering or shower-like activities, (in an enclosed setting, because continued inhalation of vapors is calculated).

Contaminant of Concern	Maximum Groundwater Concentration (µg /L)	Oral MRL Guideline (mg/kg/day)	Estimated Groundwater Ingestion Dose (mg/kg/day)		Dermal		(Inhalation CREG TWA mg/ m^3)	Estimated Groundwater Vapor Inhalation Dose (mg/m^3)
			Child	Adult	Child	Adult		Child & Adult
alpha-HCH	0.02	Chr. 0.008	0.000001	0.0000006	0.0000004	0.0000003	0.0000006	0.0002
beta-HCH	0.03	Acute 0.2 Int. 0.0006	0.000002	0.0000009	0.0000008	0.0000006	0.000002	0.0003
dieldrin	0.852	Int. 0.0001 Chr. 0.00005	0.000006	0.00002	0.00004	0.00002	0.0000002	0.0001[#]
heptachlor epoxide	0.62	None	0.00004	0.00002	0.00009	0.00006	0.0000004	0.007

Scenario Time frame: Future
Land Use Conditions: Residential
Exposure Medium- Groundwater
Exposures Point-On-site tap water or vapor from shower
Receptor Population-Adults and children
[#]mg/kg/day
We calculated these doses using Risk Assistant Software Version 1.1 (Hampshire Research Institute) and standard values for groundwater consumption, shower inhalation exposure, and dermal exposure parameters (EPA, 1991).
MRL - Minimum Risk Level for non-cancer illnesses
mg/kg = milligrams per kilogram
mg/m^3 = milligrams per cubic meter

mg/kg/day = milligrams per kilogram per day

We calculated the doses above using the using the following values:
Acute = exposure is 1- 14 days
Intermediate = exposure is 15-364 days
Chronic = exposure is 365 and longer
Adult body weight- 70 kg
Adult water consumption- 2 liters daily
Child body weight- 15 kg
Child water consumption- 1 liter daily
Inhalation breathing rate is 1.6 (adults) and 2 (children) cubic meters per hour.

Table 4. Calculated Dose for Residential Exposure to Groundwater (from eating irrigated plants)

Contaminant of Concern	Maximum Groundwater Concentration (µg /L)	Oral MRL Guideline (mg/kg/day)	Estimated Dose, (mg/kg/day), assuming adults eat 1.8 oz. fruit and 0.7 oz. of vegetables and children eat 0.5 oz. fruits and vegetables.	
			Child	Adult
alpha-HCH	0.02	Chr. 0.008	0.000000002	0.000000002
beta-HCH	0.03	Acute 0.2 Int. 0.0006	0.000000004	0.000000003
dieldrin	0.852	Int. 0.0001 Chr. 0.00005	0.00000009	0.00000007
heptachlor epoxide	0.62	None	0.000000007	0.000000005

ug/kg = micrograms per kilogram
mg/kg/day = milligrams per kilogram per day
Scenario Time frame: Future
Land Use Conditions: Agricultural
Exposure Medium- Groundwater
Exposures Point-Irrigation of edible plants
Receptor Population-Adults and children

We calculated these doses on the Oak Ridge National laboratory Risk Assessment Information System website. The dose equations utilized by this tool are based on guidance in Risk Assessment Guidance for Superfund: Volume 1, Human Health Evaluation Manual (Part A - Baseline Risk Assessment) (RAGS, Part A), Risk Assessment Guidance for Superfund: Volume 1, Human Health Evaluation Manual (Part B - Development of Risk-based Preliminary Remediation Goals) (RAGS, Part B) (EPA, 1991).

The models used the following values:
Adult body weight- 70 kg Child body weight- 15 kg
Irrigation occurs for 3 months a year, and the irrigation rate is 3.62 liters per cubic meter per day. Children's exposures are for six years and adults exposures are for 24 years

Table 5: Comparison of doses calculated from highest measured values to most sensitive effects (effects occurring at the lowest doses in animal and human medical studies). Shaded doses are above sensitive dose or minimum risk level. Please note toxic effects are not limited to those discussed, as chemicals regulated at very low levels are often toxic to many organs and systems, we just discuss those effects described for the lowest dose.

Chemical	Doses are in mg/kg/day and are calculated using the highest measured level			
	children's dose	adult's dose	children's theoretical increased cancer risk	adult's theoretical increased cancer risk
alpha-HCH (0.02 µg/L)	Ing veg 0.000000002	Ing veg 0.000000002	Ing veg—< 1 : 1,000,000	Ing veg—< 1 : 1,000,000
Hexachlorocyclohexanes, Update (ATSDR 2005b)	Ingestion doses: Child and adult vegetable ingestion doses are 4 million times less than the chronic minimum risk level (MRL) of 0.008 mg/kg/day. The MRL is based on a No Observed Adverse Effect Level (NOAEL) of 0.8 mg/kg/day dose and a LOAEL Lowest Observed Adverse Effect Level (LOAEL) of 3.5 mg/kg/day dose showing adverse liver effects in a rat study (Fitzhugh et al. 1950). ATSDR calculated this MRL by applying an uncertainty factor of 100 (10 for extrapolation from animals to humans and 10 for human variability). Liver effects included cell atrophy, fatty degeneration, and focal necrosis. ATSDR did not locate any inhalation studies for the α-isomer. Associated cancers: Chronic exposure studies in rats and mice have linked alpha-HCH ingestion to liver cancer, although researchers reported cancers at much higher doses (2 to 90 mg/kg/day).			
beta-HCH (0.03 µg/L)	Ing veg 0.000000004	Ing veg 0.000000003	Ing veg—< 1 : 1,000,000	Ing veg —< 1 : 1,000,000
Hexachlorocyclohexanes, Update (ATSDR 2005b)	Ingestion doses Child and adult vegetable ingestion doses are 150 to 200 thousand times less than the intermediate minimum risk level (MRL) of 0.0006 mg/kg/day based on a LOAEL 0.18 mg/kg/day dose for liver effects in a rat study (Van Velsen et al. 1986). ATSDR calculated this MRL by applying an uncertainty factor of 300 (3 for use of a minimal LOAEL, 10 for extrapolation from animals to humans and 10 for human variability). Liver effects included hyalinization of centrilobular cells, focal cell necrosis, and increased mitosis). ATSDR did not locate any inhalation studies for the β-isomer. Associated cancers: Chronic exposure studies in mice have linked beta-HCH ingestion to liver cancer (at 34 mg/kg/day, Thorpe and Walker1973).			

Chemical	Doses are in mg/kg/day and are calculated using the highest measured level			
	children's dose	adult's dose	children's theoretical increased cancer risk	adult's theoretical increased cancer risk
Dieldrin (0.852 µg/L)	Ing veg 0.00000009	Ing veg 0.00000007	Ing veg—< 1 : 1,000,000	Ing veg—< 1 : 1,000,000
ATSDR 2002 (Update) (irrigation well)	Ingestion doses Child and adult vegetable ingestion doses are 55 to 71 thousand times less than the No Observed Adverse Effect Level dose (0.005) associated with adverse liver effects in rats chronically exposed via their food (Walker et al. 1969). ATSDR used the results of the Walker et al. 1969 rat study to derive a chronic oral MRL of 0.000005 mg/kg/day. They divided the NOAEL by an uncertainty factor of 100, 10 for extrapolation from animals to humans and 10 for human variability. The child dose is 55 times less than the chronic MRL (0.00005) and the adult dose is 71 times lower. Associated cancers: Chronic exposure studies in mice have linked dieldrin ingestion to liver cancer at doses varying form 0.33 to 1.3 mg/kg/day. The dose we calculated are much lower than those associated with cancer, and indeed the cancer risks we calculated for these exposures are insignificant. We report this cancer dose and type for informational purposes only.			
Heptachlor Epoxide (0.62 µg/L)	Ing veg 0.000000007	Ing veg 0.000000005	Ing veg—< 1 : 1,000,000	Ing veg—< 1 : 1,000,000
ATSDR (2005c) Update	Health effects data on exposures to heptachlor epoxide are limited. However, bacterial and animal metabolic processes break heptachlor down into heptachlor epoxide within a few hours. Because animal studies have shown that heptachlor epoxide is more toxic than heptachlor and so few heptachlor epoxide studies have been carried out, we used the information on heptachlor toxicity for this report†. At the lowest levels of exposure showing adverse health effects, heptachlor affects reproduction, development, and neurological processes, while higher doses show adverse gastrointestinal and liver health effects. Ingestion doses Child and adult vegetable ingestion doses are 14 to 20 thousand times less than the MRL (0.0001) set for immune system effects measured in an intermediate duration rat study involving heptachlor (Smialowicz et al. 2001). ATSDR divided the LOAEL dose of 0.03 by 300 (3 for use of a minimal LOAEL, 10 for extrapolation from animals to humans, and 10 for human variability) to calculate this MRL. Cancer association: Female mice exposed to heptachlor developed liver cancer (hepatocellular carcinoma): among workers at pesticide manufacturing facilities, the Standard Mortality Ratio for bladder cancer was of borderline statistical significance; however, these workers had exposures to heptachlor epoxide and other pesticides.			

† Data on the toxic effects of heptachlor epoxide following inhalation exposure are limited to several mortality studies of pesticide applicators or manufacturers. Data on the toxicity of heptachlor epoxide following oral exposures are limited to animal studies that determined what dose was lethal to 50% of the study animals (Podowski et al. 1979), and the reproductive effects of exposing one parent (and not the other, Epstein et al., 1972).

Certification

The Florida Department of Health, Bureau of Community Environmental Health prepared this Health Consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. Florida DOH followed approved methodologies and procedures existing at the time the health consultation was begun. The Cooperative Agreement Partner completed editorial review.

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

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