Air Monitoring for Pesticides in Hastings, Florida December 2006:

Results Summary and Recommendations

Pesticide Action Network North America
April 2007

Pesticide Action Network North America

works to replace hazardous pesticide use with ecologically sound and socially just alternatives. As one of five PAN Regional Centers worldwide, we link local and international consumer, labor, health, environment and agriculture groups into an international citizen action network. This network challenges the global proliferation of pesticides, defends basic rights to health and environmental quality, and works to ensure the transition to a just and viable society.

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Full *Technical Report* available

This abbreviated *Results Summary and Recommendations* report accompanies a 52-page *Air Monitoring in Hastings, Florida, December 4-16, 2006: Technical Report*, available at www.panna.org/campaigns/DCHastingsFL06.dv.html. The *Technical Report* provides a fully referenced, detailed description of the sampling and analysis methods used in the study and also provides additional background information on toxicity of the pesticides found and summaries of other air monitoring studies relevant to the project.

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Views and analyses are those of the authors and Pesticide Action Network North America, and do not necessarily reflect the views or opinions of our funders.

Air Monitoring for Pesticides in Hastings, Florida, December 2006 Results Summary and Recommendations

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In the fall of 2006, two science students from Pedro Menendez High School in St. Augustine, Florida decided to do a science fair project involving air monitoring for pesticides. They hoped to monitor the air at South Woods Elementary School, which is located adjacent to fields of Chinese cabbage in an agricultural area in Hastings, Florida. Pesticide Action Network North America (PANNA) agreed to help them with their study, and with a grant from the Environmental Youth Council, provided the Drift Catcher air monitoring equipment and the training for the teacher and students. This document summarizes the results of this air monitoring study and our recommendations for reducing exposures at the school. The accompanying *Technical Report*[1] provides a fully referenced, detailed description of the sampling and analysis methods used in the study and also provides additional background information on toxicity of the pesticides found and summaries of other air monitoring studies relevant to the project.

The original intent of the study was to monitor pesticides in air on the school grounds; however, repeated requests to locate the Drift Catcher at the school were denied. Instead, the Drift Catcher was placed in the back yard of a house located next to the school (the "Brown House" on the map on p. 4). The Drift Catcher was placed in this location because it equaled the distance between the playground at South Woods Elementary School and the field where Chinese cabbage was cultivated directly east of the school. The location of the sampling site relative to cabbage fields and that of the school relative to cabbage fields were similar with respect to prevailing winds, which were primarily from the northeast (blowing from the field towards the school and the house) during the course of the eight days of monitoring, December 6–14, 2006.

Results

Monitoring was conducted near the school (see picture below) for eight days, and three pesticides were identified in the samples: the insecticides endosulfan and diazinon, and the herbicide trifluralin. Pesticide applications were observed on December 6 and 13, and a field worker indicated that the pesticides applied on the 13th were "diazinon" and "thionex." Thionex is a trade name for endosulfan.

The data presented here should be viewed as exposure estimates that may or may not represent worst-case exposure scenarios, and do not necessarily represent the precise exposure individuals may experience. Variability in actual exposures and the effects that may be experienced by individuals are governed by breathing rates and activity levels, time spent in areas where

[1] Downloadable at www.panna.org/campaigns/DCHastingsFL06.dv.html.

pesticide exposure can occur, and individuals' ability to detoxify chemicals. Inhalation may not be the sole exposure source, and total exposures from all routes (air, skin, diet) may be higher.

Google satellite map showing prevailing wind direction, Drift Catcher site and South Woods Elementary School.

Endosulfan

Endosulfan is an organochlorine insecticide that is applied in the US in greatest quantities to cotton, potatoes, and apples, and used in lesser amounts on a variety of vegetable and fruit crops. Residential uses of endosulfan were terminated in 2000. Endosulfan is acutely neurotoxic to both insects and mammals and a suspected endocrine disruptor. Symptoms of acute poisoning include hyperactivity, tremors, convulsions, lack of coordination, staggering, difficulty breathing, nausea/vomiting, and diarrhea. Studies have found associations between chronic exposure and delayed sexual maturity in boys and increased incidence of birth defects of the male reproductive system. Skin irritation and brain damage have been noted among adults exposed to endosulfan occupationally. Nationwide from 1987–1997, US Environmental Protection Agency (US EPA) estimated that average annual use of endosulfan was 1.38 million pounds. Endosulfan products are a mixture of two isomers, α-endosulfan and β-endosulfan.

Endosulfan was found in 100% of the eight samples collected between December 6 and 14. All samples contained quantifiable levels of α-endosulfan, and all but one contained quantifiable levels of β-endosulfan.[2] Thirty eight percent of the samples were above the 24-hour acute and sub-chronic 1-year-old child Reference Exposure Level (REL) of 340 ng/m^{3}., calculated from US EPA's inhalation No Observed Adverse Effect Level (NOAEL), as shown in the **Calculations** section of the *Technical Report*. A REL represents a level of concern for inhalation exposure analogous to the Reference Dose that US EPA uses to assess levels of concern for dietary exposure (see **About Air Monitoring** below). Twenty-five percent of the samples were above the 7-year-old REL of 500 ng/m^3. The highest 24-hour concentration of total endosulfan observed was 626 ng/m^3 (1.8 times the 24-hour acute 1-year-old REL and 1.2 times the 7-year-old REL) on December 6, 2006. The average concentration for the sampling period was 278 ng/m^3. Results are summarized in Figure 1 and Table 1.

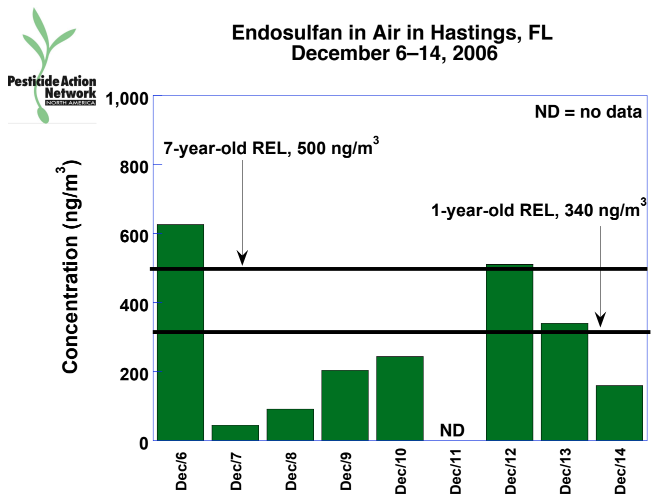

Figure 1: Endosulfan concentrations in Hastings, FL December 6–14, 2006. REL = 24-hour Reference Exposure Level calculated from US EPA's "acceptable" daily dose for acute and sub-chronic exposures.

Diazinon

Diazinon is an organophosphorus insecticide applied in the US to a wide variety of fruits, nuts, and vegetables. Diazinon is neurotoxic to both insects and mammals, inhibiting cholinesterase, an enzyme essential for the proper transmission of nerve impulses. Citing unacceptable risks to children and the environment, US EPA banned all residential uses of diazinon effective 2004; however, agricultural use continues. Symptoms of acute poisoning include headache, nausea and vomiting, dizziness, weakness, drowsiness, agitation, difficulty breathing, twitching, excessive salvation and sweating, watery eyes, pinpoint pupils, confusion, inability to concentrate, and memory loss. Asthma, gestational diabetes, and certain types of cancer have been linked to chronic diazinon exposure. Nationwide in 2001, US EPA estimated that 4-7 million pounds of diazinon were used.

[2] Equivalent to an air concentration of 4.6 ng/m^3 (total endosulfan) for a 24-hour sample at a 2.00 L/min flow rate and using a 2.00 mL solvent extraction volume.

Diazinon was found in quantifiable amounts in 88% of the eight samples.[3] Sixty-three percent of the samples were above the 24-hour acute and sub-chronic 1-year-old child REL of 145 ng/m^3, and 50% were above the 7-year-old REL of 220 ng/m^3 (see the **Calculations** section of the *Technical Report*). Twenty-five percent of samples were above the adult REL of 335 ng/m^3. The highest 24-hour concentration of diazinon observed was 897 ng/m^3 (6.1 times the 24-hour acute 1-year-old REL and 4.1 times the 7-year-old REL) on December 12, 2006. The average concentration for the sampling period was 311 ng/m^3. Results are summarized in Figure 2 and Table 1.

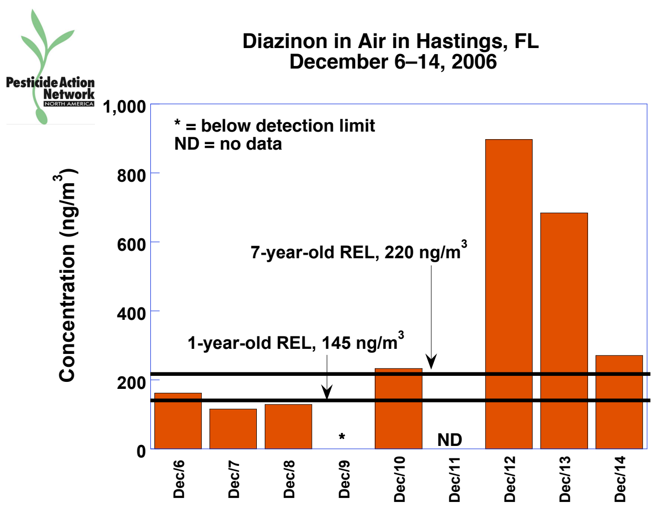

Figure 2: Diazinon concentrations in Hastings, FL December 6–14, 2006.
REL = 24-hour Reference Exposure Level calculated from US EPA's "acceptable" daily dose for acute and sub-chronic exposures.

Trifluralin

Trifluralin is a dinitroaniline herbicide used to control annual grasses and broadleaf weeds on cotton, soybeans, peanuts, leafy greens, cole crops, peppers, tomatoes, and fruit trees. It is currently permitted for residential use on lawns and for use on golf courses. It is not acutely toxic, but it is listed by the EPA as a "Possible" carcinogen. Epidemiological studies of farm workers and pesticide applicators have linked trifluralin exposure to increased incidence of stomach cancer and birth defects, and animal studies show increases in urinary bladder tumors, renal pelvis carcinomas, and thyroid gland tumors. US EPA estimated that 12-16 million pounds of trifluralin were used in the US in 2001.

Trifluralin was detected in all but one sample, and found in amounts high enough to quantify in 50% of the eight.[4] The highest 24-hour concentration of trifluralin was 376 ng/m^3 on December 6, 2006. The average concentration for the sampling period was 84 ng/m^3. Acute and sub-chronic

[3] Equivalent to an air concentration of 18 ng/m^3 for a 24-hour sample at a 2.00 L/min flow rate and using a 2.00 mL solvent extraction volume.

[4] Equivalent to an air concentration of 45 ng/m^3 for a 24-hour sample at a 2.00 L/min flow rate and using a 2.00 mL solvent extraction volume.

RELs could not be calculated, because US EPA has not determined an acute or sub-chronic NOAEL for trifluralin since this herbicide has relatively low acute toxicity to mammals. Results are summarized in Figure 3 and Table 1.

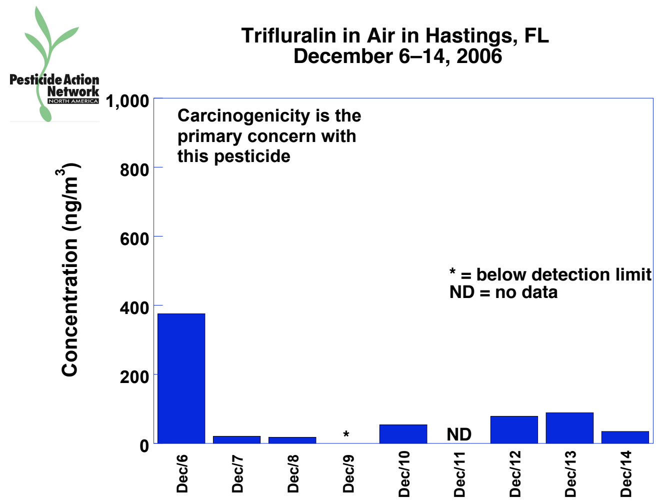

Figure 3: Trifluralin concentrations in Hastings, FL December 6–14, 2006. No acute or sub-chronic REL has been determined for this pesticide.

Trifluralin is ranked by US EPA as a "Possible" carcinogen, and concerns with exposure center around the carcinogenicity of the compound, not its acute or sub-chronic toxicity. For trifluralin, we estimated potential lifetime cancer risk for a range of hypothetical exposure scenarios bracketing the concentrations documented in this study. The lifetime cancer risk is defined as the estimated number of cancer cases above the number the medical community considers the norm for a population. Lifetime cancer risks exceeding one in one million represent risks of concern. Table 3 on p. 23 of the *Technical Report* shows the results for trifluralin, none of which exceed levels of concern for even the highest hypothetical exposures. See the **Calculations** section of the *Technical Report* for full details on how these cancer risks were determined.

Factors to Consider When Interpreting Data

Exceedances of the RELs for diazinon and endosulfan are not necessarily anticipated to cause the symptoms of acute poisoning described above; however, the REL does represent a level of concern for inhalation exposure analogous to US EPA's Reference Dose for dietary exposure. It is unknown what exposure levels would produce the chronic effects noted above. Concentrations below the REL do not necessarily indicate that the air is "safe" to breathe. In particular, a number of recent studies evaluating the capacity of different people to metabolize toxic substances show that the variability among different people can be substantially greater than the variability assumed by US EPA in its toxicological analysis. In addition, on all but one day, all three pesticides were found in samples above detection limits. No "acceptable" doses have been established for simultaneous exposures to multiple pesticides. It is possible that additive or synergistic effects may increase the toxicity of one pesticide in the presence of others.

Table 1: Pesticide Concentrations in Hastings, FL, December 6–14, 2006

Sample Name	Start Date	Start Time (p.m.)	Total Time (min)	Total Volume (m^3)	Total Endosulfan[c] (ng/m^3)	Diazinon (ng/m^3)	Trifluralin (ng/m^3)	Comment
Red[a]	12/6/06	4:24	N/A	N/A	0	0	0	This sample is a trip blank. α- & β-Endosulfan, Diazinon & Trifluralin < MDL
Sky	12/6/06	4:36	1355	2.98	626	162	376	Minimum values.[b]
Bird	12/7/06	3:20	1428	3.08	45	116	21	β–Endosulfan & trifluralin < LOQ
Banana	12/8/06	3:18	1759	3.69	92	129	18	Trifluralin < LOQ
Bread	12/9/06	8:44	1237	2.69	204	0	0	Trifluralin & Diazinon < MDL
House	12/10/06	5:28	1511	3.32	244	233	54	
---	12/11/06	ND	ND	ND	ND	ND	ND	No sample taken on this day
Salt	12/12/06	5:24	1547	3.40	511	897	79	
Apple	12/13/06	3:19	1470	3.23	340	684	89	Minimum values.[b]
Mom	12/14/06	3:58	1303	1.82	160	271	35	Trifluralin < LOQ. Minimum values.[b]
8-Day Average					**278**	**311**	**84**	

ND = no data
Method Detection Limits (MDLs): α-endosulfan, 1.8 ng/m^3; β-endosulfan, 2.8 ng/m^3; diazinon, 3.5 ng/m^3; trifluralin, 9.0 ng/m^3. See the *Technical Report* for details.
Limits of Quantitation (LOQs): α-endosulfan, 8.9 ng/m^3; β-endosulfan, 14 ng/m^3; diazinon, 18 ng/m^3; trifluralin, 45 ng/m^3. See the *Technical Report* for details.
[a] Red was a trip blank sample. The tube was cracked on the day and time indicated at the site, transported along with the samples, and analyzed as though it were a sample. It was never attached to the Drift Catcher.
[b] Flow rate changed by >10% during sampling, so the maximum flow rate was used to calculate sample air volume. This will give a conservative estimate of concentration.
[c] Total endosulfan includes the sum of the α and β isomers of endosulfan.

About Air Monitoring Results

What is a Reference Exposure Level?

In this air monitoring study, we compare measured air concentrations of pesticides found in a 24-hour air sample to available 24-hour Reference Exposure Levels (RELs) for each pesticide found for two subpopulations: 1-year-old children and 7-year-old children. A REL represents a level of concern for inhalation exposure analogous to the Reference Dose US EPA uses to assess levels of concern for dietary exposure. The REL is a concentration in nanograms of pesticide per cubic meter of air (ng/m^3) equivalent to a dose in milligrams of pesticide per kilogram of body weight (mg/kg) below which no adverse effects are anticipated from exposure to a *single pesticide*. The REL is calculated from a NOAEL determined by US EPA from toxicology studies conducted by the pesticide manufacturer. RELs are used by the State of California's Office of Environmental Health Hazard Assessment as levels of concern for air toxics.

We evaluate whether the measured levels of pesticide in air exceed the REL for two sensitive populations—1-year-olds and 7-year olds—by taking into account the body weight and breathing rate of the average child in each category (see the **Calculations** section of the *Technical Report* for the detailed calculation). Exceedances of the REL are not necessarily anticipated to cause the symptoms of acute poisoning described above but do represent a potential health concern—the larger the exceedance, the higher the probability of adverse effects from pesticide exposure. It is unknown what exposure levels would produce the chronic effects noted above.

The Reference Dose and corresponding REL are not enforceable standards like a water quality standard or a worker protection standard, but in dietary assessments US EPA designates a dose of a pesticide at or above this level as a Level of Concern (LOC). Typically, the agency sets other enforceable rules (e.g. pesticide application rates and pesticide residue limits on food) to ensure that dietary exposures at the 99.9th percentile are below the LOC. This means that if even one-tenth of one percent of the people were found to be exposed to a pesticide in their diet at or above this level, US EPA would take action to reduce risk. Unfortunately, there are regulatory gaps for inhalation exposure—US EPA does not currently assess bystander inhalation exposures for most pesticides (including those found in this study), instead assuming that breathing is not a significant contributor to total exposure. Our Hastings study and others cited in this report indicate that this assumption is flawed.

Are Levels Below the REL "Safe"?

Concentrations below the REL do not necessarily indicate that the air is "safe" to breathe. In particular, a number of recent studies evaluating the capacity of different people to metabolize toxic substances show that the variability among different people can be substantially greater than the variability assumed by US EPA in its toxicological analysis. Additionally, as in this study, people are often exposed to multiple pesticides simultaneously, or are taking a prescription or non-prescription drug, or are exposed to other chemicals, thus reducing their capacity to detoxify the pesticides to which they are exposed. Finally, the pesticide industry's definition of an "adverse" effect doesn't include symptoms like headache, nausea, or malaise because these are not observable symptoms in laboratory animals. These effects are nevertheless uncomfortable and often debilitating for humans, interfering with people's ability to earn a living, perform well in school, take care of their children, or simply be comfortable in their homes.

What Do Air Monitoring Results Tell Us About Exposure?

The air monitoring data presented here may or may not represent worst-case exposure scenarios, and do not necessarily represent the precise exposure individuals may experience. Variables that affect an individual's exposure to airborne pesticides include the amount of time spent in areas with high concentrations of airborne pesticides, body weight and breathing rate. Exposures to the pesticides may also occur through other routes, especially for children. Pesticide drift can contaminate house dust, lawns, playground equipment, pets and toys that children may touch, and eventually they may ingest these residues through hand-to-mouth contact.

The breathing rates used to derive the RELs in this study (see Table 6 on p. 34, and the **Calculations** section of the *Technical Report*) represent the breathing rates of individuals *averaged over the course of 24 hours*. The typical breathing rate of a 10-year-old during resting activity (e.g. sleeping, reading or watching television) is 0.4 m^3/hr, while during moderate activity (e.g. climbing stairs) it is 2.0 m^3/hr, and during heavy activity (e.g. playing sports) is almost ten times greater at 3.9 m^3/hr. The breathing rate of a child at play during recess or exercising during a gym class is best approximated by the moderate or heavy activity breathing rate. Thus, children are outside and maximally exposed to air contaminants precisely when their breathing rates are expected to be highest. The RELs used this report are calculated for 24-hour exposures because that time period is what US EPA uses to asses acute exposures. The REL was calculated using lower-than-moderate breathing rates—the daily averages. During the time children spend in school—particularly the time spent playing outside—they may inhale enough pesticide to exceed the 24-hour reference dose, even though they are at school for only 6 to 8 hours.

For most pesticides, only a limited number of monitoring studies are available for comparison, and most of the available studies only provide results for applications conducted according to label instructions and for exposure estimates to a single pesticide. PAN's Drift Catcher project is providing additional monitoring data for comparison, and as we gather more data, a clearer picture of pesticide levels in air near homes, schools, parks and workplaces will emerge.

Notwithstanding that available monitoring data are not comprehensive, the data indicate that many people are routinely exposed to levels of airborne pesticides that exceed both acute and sub-chronic levels of concern.

Recommendations

There are several approaches to reducing airborne pesticide concentrations (and hence children's exposure) near South Woods Elementary School. Here we provide recommendations for action at the federal, state, local and personal levels, as well as suggestions for future research.

Federal Solutions: Recommendations to US EPA

There are clear gaps in US EPA's regulatory and risk assessment frameworks for protecting bystanders from exposure to airborne pesticides through post-application volatilization drift. Currently, US EPA assumes inhalation is not a significant contributor to total exposure, but the data clearly show this not to be true. To best solve the problem of toxic exposures from volatilization drift, we recommend that US EPA:

- Phase out use of highly toxic, drift-prone pesticides with vapor pressures above 10^{-5} mm Hg.

In the interim, US EPA should:

- Provide farmers with information on least-toxic alternative methods of pest control and develop effective methods of communicating this information.
- Include all toxicity information (including neurotoxicity, developmental and reproductive toxicity, carcinogenicity, and ecotoxicity) on the pesticide label, so farmers can make informed decisions about which pesticides are likely to be the least problematic for neighbors.
- Require 48-hour advance neighbor notification when highly toxic, drift-prone pesticides are to be applied. Information on how to contact the applicator and farmer along with descriptions of poisoning symptoms and instructions for what to do in case of exposure should be part of the notification packet.

- Require substantial no-spray protection zones (at least 1,000 feet) between pesticide application sites and other residential, public or commercial property, including state or federally owned parks and wildlife areas.
- Adjust the risk assessment process to be fully protective of children—by increasing uncertainty factors when scientific studies indicate the need and by maintaining the child protection factor of 10 (FQPA factor) for all pesticides with any potential for adverse effects to children.

State Solutions: Recommendations to the Florida Legislature, Departments of Agriculture and Health

- The legislature should provide funding to the Department of Agriculture to develop and implement a transition plan to help farmers move away from highly toxic, drift-prone pesticides and adopt less toxic pest control approaches such as cultural and biologically based methods. Incentives based on land preservation should be explored to help maintain the viability of agriculture in the state.
- The legislature should provide funding to the Department of Health to conduct a comprehensive health study to look at differences in health outcomes for children potentially affected by airborne pesticides compared to a demographically similar group of children who do not live or go to school near agricultural fields.
- The legislature should provide funding to the Department of Health for routine pesticide air monitoring, with a focus on schools in agricultural areas, to pinpoint specific problems and address them quickly.
- The legislature should pass legislation that prohibits the building of new public schools on lands adjacent to chemically reliant agricultural operations. For schools that have already been built adjacent to farm fields, the legislature should require large no-spray protection zones around schools in which only approved organic methods of pest control can be used and require 48-hour advance notification to the school when pesticide applications are to occur.

Local Solutions: Recommendations to the St. Johns County School District

- Involve students, parents and teachers in the process of solving the problem.
- Work with local farmers to negotiate a "good neighbor" agreement to create “no-spray” protection zones between fields and schools
- Ensure that landowners and farmers that own, rent or work land bordering the school agree to notify the school 48 hours before pesticide applications occurso children can be kept away from that part of the school for several days while pesticides dissipate.
- Arrange for appropriately sensitive independent air monitoring to be done at the school for several months during the growing season/school year. Approach such a study with an open mind and be ready to take action to protect the children.
- Keep the children inside during and for the next three days after a highly toxic, drift-prone pesticide application has occurred in the nearby fields. This is not a viable solution on a long-

term basis, which makes it important to also pursue good neighbor, federal and state approaches.

- Make sure that air intake vents for the heating/air conditioning system at the school are equipped with charcoal filters that are changed on a regular basis to increase the likelihood that the indoor environment is safe for the children.

Personal Solutions: Recommendations for Parents and Residents of Agricultural Areas

- Hold your school district accountable. Require transparency and opportunities to provide input into solutions as they are developed. Work with other parents and teachers to demand action from the school district to eliminate pesticide drift at South Woods Elementary School.
- Call your legislators and urge them to develop legislation to eliminate pesticide drift as a source of toxic exposure for children attending schools in agricultural areas (see **State Solutions**, above). Be persistent and don't take no for an answer.
- Work with other parents and teachers to keep a "health diary" for you and your children to determine if illnesses may be related to pesticide applications.

Comments on the MACTEC Air Monitoring, South Woods Elementary School, Spring 2007

At the request of the St. Johns County School District, MACTEC, an environmental consulting and remediation firm, tested the air and soil at South Woods Elementary School for the same three pesticides found in the study described in this report. One outdoor and one indoor air sample were collected on each of three days (for a total of six samples), and three soil samples were collected from the playground and softball field. Each was analyzed for diazinon, α- and β-endosulfan, endosulfan sulfate, and trifluralin.

It is unclear from the published report whether the analytical methodology employed by MACTEC would have detected pesticides other than those targeted. A total of 65 pesticide active ingredients are legally allowed to be used on cabbage; MACTEC tested for only three. Pesticide applications were observed in adjacent fields on two of the days when air samples were collected; however, it is not known if endosulfan, diazinon, or trifluralin were applied, or whether the wind was blowing in a direction that would have carried pesticide drift into the area where the air samples were collected.

The MACTEC study did not detect the target pesticides in any of their air samples; however, as shown in Table 2, the detection limits of the methodology employed were almost 1,000 times higher than ours, which means that the target pesticides could not have been detected at the levels observed our study. In other words, the methodology used by MACTEC was not sensitive enough to detect the quantities of pesticides described above in the **Results** section and Table 1. Therefore, the results of the MACTEC air testing in no way contradict results reported in this study: MACTEC did not detect endosulfan, diazinon, or trifluralin in concentrations greater than 3,300, 2,100, and 8,300 ng/m^3, respectively, nor did this study.

Table 2: Detection Limits of PANNA and MACTEC Methodology

Analyte	Maximum Observed Concentration in PANNA Study (ng/m^3)	8-Day Average Observed Concentration in PANNA Study (ng/m^3)	PANNA Detection Limit (ng/m^3)	MACTEC Detection Limit (ng/m^3)
Endosulfan (total)	626	278	4.6[a]	3,300
Diazinon	897	311	3.5	2,100
Trifluralin	376	84	9.0	8,300

[a] Sum of MDLs of α- and β-Endosulfan.

Not detecting pesticides on three days of sampling—even if appropriately sensitive methodology had been used—would not necessarily indicate that the air at the school is always free of pesticide contamination. As the MACTEC report correctly concedes, "[t]he results of the testing of the three chemicals performed may not be representative of the concentrations at other times." Likewise, the pesticide levels detected in our study from December 6 to14 are not necessarily representative of pesticide levels for the rest of the year. The levels of pesticides in the air after an application can vary dramatically based on factors such as: the physical properties of pesticide, the application method and rate, the length of time between the application and sampling, wind direction and speed, temperature, humidity, and factors such as how carefully the application was conducted.

The "Applicable Standards" that MACTEC cites in their report are the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits and the National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limits. These standards are intended to protect an *adult* worker who is being paid to accept some degree of risk, and are not intended to protect the health of children and pregnant women from involuntary environmental exposure to toxic chemicals. Children breathe more air per unit body weight than adults, and therefore their exposures are proportionately higher than those of adults. Furthermore, children are not simply small adults. They can be—and frequently are—more susceptible to the effects of toxic chemicals than adults, since their bodies are still growing. This is especially true of the developing fetus (see details about the health effects in the sections on each individual pesticide in the *Technical Report*).

US EPA is required by the Federal Food Quality Protection Act of 1996 to accommodate the special sensitivity of vulnerable sub-populations, and accordingly treats them differently in their risk assessment methodology. For example, when calculating "acceptable" dietary exposures of pesticides for children and women of childbearing age, the EPA often incorporates additional uncertainty factors that are not used for adult men. For these reasons, RELs derived from studies selected by US EPA are the appropriate benchmarks to which the air levels observed in this study should be compared, although because of the simultaneous occurrence of multiple pesticides, even these RELs (which were developed based on animal exposure to a *single* chemical) may not be sufficiently protective. See the **Calculations** section of the *Technical Report* for a discussion of the derivation of the RELs used in this study.

MACTEC was given a file containing a preliminary version of our results, which are officially released in this report, and asked to provide comments. The MACTEC report made four comments about these results, summarized below:

(1) MACTEC representatives were present at all times during the collection of their samples, while the sampling conducted by PANNA/the Pedro Menendez High School students was not attended. “This reflects a loss in the chain-of-custody of the samples.”

(2) Field and laboratory blanks were not mentioned in the report provided to MACTEC, therefore “there was no way to assess if samples had been previously contaminated prior to testing.”

(3) The RELs used for comparison in the project are for infants and are “not applicable to adults or children.”

(4) The “lower [detection] limits [cited in the project] were achieved by deviating from the laboratory methodology and collecting samples over a longer period of time [than allowed by the methods, NIOSH 5600 and OSHA 2023].”

The implication of Comment 1 is that, since the students’ sampling was not attended over the duration of the study, we cannot guarantee that the samples were not tampered with and contaminated with pesticides. We note that is common practice to leave samplers unattended if they are in a secure location, as ours was. The California Air Resources Board, California Department of Pesticide Regulation, and the US Geological Survey all do this routinely. Environmental consulting firms sampling for longer than a few hours will also secure their samplers and leave the site; otherwise, it would be prohibitively expensive (and hazardous to personnel) to conduct any kind of long-term air monitoring with a full-time “watch-person” on duty.

In response to Comment 2, field blanks were indeed collected. One was analyzed in the same batch as the samples, and no pesticides were detected (see results for sample “Red” in Table 1, above). Solvent blanks were also analyzed and no pesticides were detected (see the **Quality Assurance-Quality Control** section of the *Technical Report*). Prior contamination of the sample tubes, the extraction solvent, and all other components of the analytical equipment can therefore be confidently ruled out.

Regarding Comment 3, we use a 1-year-old child as one of the more sensitive (but not the most sensitive) groups to compare our results to. The unborn child is the most sensitive and can be exposed if there are pregnant women working at the school. Infants and the fetus are among the most sensitive members of any population, and any benchmark used as a level of concern should be protective of all members of the population, hence our selection of RELs for 1-year-old children, as opposed to RELs for adults or older children (although we have included these levels in the report for comparison). The RELs for other ages are easily calculated (see the **Calculations** section of the *Technical Report*). If the breathing rate and body weight of an average 7-year-old are used to derive RELs, then the acute and subchronic REL for endosulfan for a 7-year-old would be 500 ng/m^3 and that for diazinon would be 220 ng/m^3. The observed pesticides air levels are also above these 7-year-old child RELs on several days during the study; in fact, the observed diazinon levels even exceeded the adult REL of 330 ng/m^3 on two days. Note that average breathing rates were employed in the calculation of RELs used in this report. Had breathing rates corresponding to moderate or heavy activity been employed (such as might occur with children playing on the school grounds), the calculated RELs would be lower.

Finally, in regard to Comment 4, we note that using sampling periods longer than those recommended by NIOSH 5600 in order to attain more sensitive detection limits is not a violation of the method. Instead, it is a standard practice employed by many air pollution researchers in academia and government. For example, Table 4 on page 28 of the *Technical Report* shows results from trifluralin studies where a single sample was collected over periods of 24-hours, seven days, and even 30 days to enhance the sensitivity of the method.