The following rebuttal by the Oregon Forest & Industries Council is submitted for the record in response to incorrect and misleading statements provided on March 26, 2019 by Rep. Marty Wilde on HB 3044. Interested parties are encouraged to contact Kristina McNitt or Sara Duncan at 503.371.2942 or visit www.ofic.com for more information.

Wilde Testimony HB 3044 March 26, 2109

Thank you, Mr. Chair, I am Marty Wilde I represent HD 11.

Chair and Colleagues, I've heard from a lot of folks in the industry about this bill. I've heard that aerial spraying is necessary to forestry despite the federal government does not allow it.

> **RESPONSE**: USFS does allow aerial application. Per Shawna Bautista, Pesticide Use and Invasive Plant Program Manager for the Pacific Northwest Region of the USFS, "aerial application is, indeed, utilized by USFS, along with other methods, to suppress invasive species and contribute to forest and grassland health. Aerial application is also used on serious outbreaks of native forest pests. It remains a vitally important tool to respond to outbreaks of serious forest pests, like gypsy moths…"
> Additionally, "the USFS sometimes uses aerial application to treat large or inaccessible infestations of invasive plants."
> Bautista continues, "due to our current forest management practices, it is unlikely that we would propose any aerial herbicide applications [west of the Cascades], but there is no specific prohibition on that application method." (see attached press release)
> Furthermore: on April 4, 2017, Oregon Public Broadcasting (OPB) issued a correction to a 2015 story that disproves the argument that aerial application is banned on federal forests.
> The now-corrected OPB story reads, "A previous version of this article stated that aerial herbicide spraying was banned on Forest Service lands. The practice was banned temporarily in the 1980s after legal challenges but the agency later regained a more limited use through a mediated agreement." http://www.opb.org/news/article/blm-investigates-after-company-sprays-pesticide-on-public-land-without-license/.

I've heard that this is just city slickers imposing their will on rural residents. Well I didn't grow up in the city, I grew up on Horton Rd. in Triangle Lake in the coast range, one of the poorest zip codes in the state.

> **RESPONSE**: The zip code for Triangle Lake, 97412, ranks 14th percentile for the state of Oregon.

Most of our parents built little water systems that caught water from surface streams for house hold use.

> **RESPONSE**: ORS 537.130 requires a permit to divert surface water for beneficial use, including household drinking water.
>
> In the fall of 2011, the Department of Environmental Quality took 36 drinking water samples as part of the Oregon Health Authority Triangle Lake Public Health Assessment. Nineteen of the samples were from wells and 17 were from springs. The samples were analyzed for over 100 chemicals. Only one of the samples contained a trace of a pesticide used in forestry (hexazinone). The concentration was thousands of times lower than health-based comparison values. The report concluded that "The

measured levels were too low to harm the health of people who drink the water, including sensitive population such as children." (see attached: Highway_36_PHA_final_10-17-2014)

My neighborhoods first experience with aerial spraying was when the ridge behind Rayor(?) residence was sprayed after a clear cut on High Pass Road. My friend Ben and his parents were picketing in front of their house in futile effort to protest it. After spraying the ridge, the helicopter saw them, turned towards their house and deliberately sprayed them. Every living thing on their property died, other than them. They were lucky just to get sick. Surely, this is the exception, right?

RESPONSE: Under ORS 634.900, these actions would be considered "gross negligence or willful misconduct" and be subject to civil penalties. No event of this nature was reported to the Department of Agriculture for an investigation.

Yet in 2015 we saw video evidence of AppleBee Aviation spraying one of its own workers with Atrazine. They were fined and suspended but continued to fly despite the suspension, earning another fine. It wasn't a new thing for them, they'd over sprayed Atrazine the year before. When they inspected AppleBee, ODA found 16 spray violations, including 4 involving gross negligence in a single year.

RESPONSE: While Applebee Aviation was cited by ODA for violations in 2015, none of them were due to the spraying of a worker. After investigating the video and claims from a former employee, ODA found no validity to the claim that an employee was sprayed. Violations issued were due to lack of worker training and inadequate PPE. These violations are serious and were rightfully levied by ODA, but they are very different than the accusations about directly spraying an employee. Applebee subsequently lost their establishment license and were unable to perform pesticide applications in Oregon for a year.

Please see attached 150406_Case_Detail for more information.

*The federal government is required to prevent spraying in small streams in the coast range since 1988 yet we still do it losing federal governed **[inaudible 13:00-13:04]** small communities.*

RESPONSE: Under OAR 629-620-0400: Protection of the Waters of the State and Other Resources When Applying Chemicals, the following buffers are required:
Fish and domestic Streams- receive a 60ft buffer, unless applying fertilizer.
Non-fish streams with surface water present- No spray in water open water- Follow chemical label for specific setbacks
Non-fish streams with no water present- no buffer

My friend Ben was fortunate not to get cancer, others were not so fortunate. You see, at the junction of High Pass Road and Horton Road in Triangle Lake, a few boys live with their families, including my friends Hunter Midal and Ryan Duberg(?). Their spring was sprayed. Hunter, Jason Shell and Chris Tatum all drank from the spring and died from cancer. Two pregnant women Nancy O'Ryan and Sue Gorgen miscarried after drinking from the spring. My best friend Ryan was lucky, he didn't get his cancer until his 40s. I was even more fortunate, my dad was an organic farmer so when they clear-cut the woods above our spring, he threatened to sue the company if they sprayed and contaminated our farm. They backed down and did it by hand, saving the springs.

There are alternatives that are safer and frankly provide more jobs. They just cost more money.

> **RESPONSE**: Aerial application is often the safest, fastest, most efficient and cost-effective way to apply herbicides, especially on remote, steep and rough forest terrain.
>
> Aerial application requires one pilot in a protected cockpit to apply herbicides. The alternative, ground-based application, uses a team of workers--- walking through dangerous and often unsafe terrain.
>
> According to Oregon's Employment Department, Forest sector-related employment in Oregon totaled 61,100 in 2017, which accounted for 3 percent of Oregon's workforce. Forest-related jobs paid relatively well, with an annual average wage of $54,200, roughly 6 percent more than $51,100 for all jobs covered by unemployment insurance in 2017.

I wish that was the end of the story. 11 years ago, Weyerhaeuser clear cut and sprayed behind Triangle Lake High School, leaving not even a 10-foot buffer. Testing of the school water later showed the forestry herbicide Imazapyr. Nevertheless, spraying continued unabated in the neighborhood and 8 years ago samples from people living in Triangle Lake showed elevated levels of Atrazine, another forestry herbicide and endocrine disruptor, and then Governor Kitzhaber declared a moratorium on aerial spraying within 2 miles of home.

> Imazapyr was the only pesticide detected in the Triangle Lake School water out of the 500 tested for pesticides. It was found at 48 parts per trillion (ppt). There is no drinking water standard for Imazapyr in the US, but in Australia it is 9,000,000 ppt. The US EPA says that a 22 pound child could safely drink 136,000 gallons of water per day with the levels of Imazapyr found in the school's water.
>
> Self-collected community data found the presence of atrazine, but only 52% of those samples had the necessary chain of custody documentation. In contrast, the samples collected by OHA which had the full chain of custody documented found no atrazine in any of the 66 samples taken from Triangle Lake residents.
>
> Governor Kitzhaber never declared a moratorium on aerial applications of pesticides. Activists from Triangle lake petitioned the Governor to do so, but he never thought it was appropriate given the evidence.
>
> See attached May 26, 2011, letter from Blachly School District to parents, guardians, students, community members:
>
> See attached OHA study from October of 2014 "Public Health Assessment Highway 36 Corridor Exposure Investigation"

So, when opponents say that their industry is safe, I point to the evidence; the evidence in our children's bodies. When they say aerial spraying is harmless, I point to Hunter Midal, Jason Shell, Chris Tatum and Ryan Duberg (?). I point to the pregnancies lost.

> **RESPONSE**: Ample scientific evidence demonstrates aerial application of pesticides in forestry does not negatively impact water quality.

“The largest number of pesticide detections occurred during spring storm surveys and primarily were associated with urban stormwater drains. Urban sites also were associated with the highest concentrations, occasionally exceeding 1 microgram per liter. Many of the compounds detected at urban sites were relatively hydrophobic (do not mix easily with water), persistent, and suspected of endocrine disruption. In contrast, forestry compounds were rarely detectable in the McKenzie River, even though forest land predominates in the basin and forestry pesticide use was detected in small tributaries draining forested lands following application.

Results from this analysis indicate that urban pesticide use is potentially an important source for pesticides of concern for drinking water, not limited exclusively to storm conditions. Forestry pesticide use is not considered a likely threat to drinking water quality at the present time (2012).”
Reconnaissance of Land-Use Sources of Pesticides in Drinking Water, McKenzie River, Oregon: USGS/EWEB, 2012

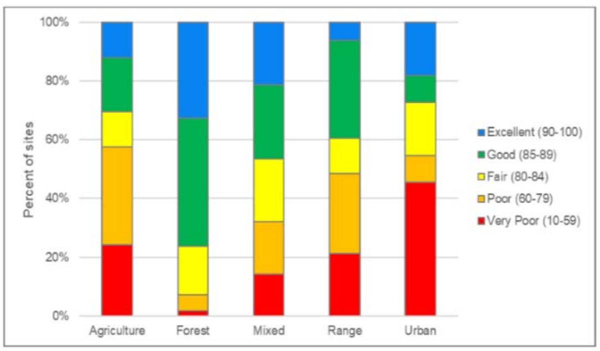

Figure 3. Influence of land use on water quality.

https://www.oregon.gov/deq/FilterDocs/WQI2018DataSummary.pdf

Drinking Water Source Monitoring Project: DEQ

“In this report, we will summarize the results of the analytes detected. In the surface water sources sampled, the insecticide DEET was found at 85 percent of the sites, the herbicides Atrazine and Diuron were found at 43 percent of the sites and Fluometuron was detected at 28 percent of the sites. Overall, pesticides were present in 29 percent of surface water source samples, but **the highest concentrations were at levels below the state’s water quality criteria for aquatic life, health-based levels, or drinking water standards** (where available). Diethylphthalate and Bis(2-ethylhexyl)phthalate were found at 57 percent of the sites. Metal compounds were identified in almost half of the sites sampled. The highest number of detections included aluminum (at 100 percent), barium and manganese (at 57 percent). Since most metals in Oregon waters are from natural sources and attach to suspended clays in streams, it is not unusual to find high concentrations in source waters. Where the secondary maximum contaminant levels were exceeded for aluminum and manganese, the levels are likely significantly reduced by the drinking water treatment facility. Conventional treatment processes reduce turbidity and suspended solids from the source water with filtration. Finished drinking water samples at these public water systems met the established federal drinking water standards.”

https://www.oregon.gov/deq/FilterDocs/dwpSourceMonPhase1-2Rpt.pdf (emphasis added)

When they say it's precise, I would ask if they have ever repelled out of a helicopter to see for themselves. I have, in the army. I would tell you there is nothing precise about what happens under a helicopter.

> **RESPONSE**: Modern aerial application utilizes cutting-edge technology, including research done in wind tunnel simulations to determine the best nozzle size, nozzle angle and droplet size to guarantee areas such as waterways, neighbor boundaries, and other no-spray areas are adequately buffered and protected.
> See attached Aerial Applicators Manual.
>
> When he repels, the helicopter is hovering, so all rotor wash is straight down. Agricultural helicopters do not spray while in hover – they spray moving horizontally. Once a helicopter has gone through transitional flight (moving from a hover into forward flight) it moves air in the same manner as a fixed wing aircraft. The wake vortices from both a fixed wing aircraft and a helicopter push spray down and away from the aircraft and into the target canopy.
> See attached newsletter article (pages 4-5) from University of Illinois for more details.

I have no objection to responsible forestry. I hear the concerns of my constituents who claim they can not economically practice their business without aerial spraying. They claim that it can be done safely. They claim that the irresponsible actors who killed my friend and poisoned my hometown are no longer in business and that data would show that aerial spraying is safe. ***[inaudible 14:59-15:00]*** *up on their offer.*

I served as a colonel in the Airforce and investigated aircraft crashes. Modern aerial systems track location by GPS and monitor weather conditions electronically. It is easy to upload that data to a database to confirm what they claim. It's easy to provide that information to the public electronically.

> **RESPONSE**: Per attached testimony from Terry Harchenko, Owner of Industrial Aviation Services, Inc. "Some of the information required to be recorded during the application requires what is known as AIMMS equipment (Aircraft Integrated Meteorological Measurement System.) In my communication with the manufacturer of the AIMMS equitpment, it was determined to be questionable as to the accuracy of the recorded data with regard to the intent of HB 3044. There is also the issue to gain FAA approval for the installation on each individual aircraft and at great expense.
>
> I would like to give an example of how burdensome it would be to compile the required information required by HB 3044, to format it, and for DEQ to analyze the data. Last Thursday (3/21/2019), I flew an application for a family farm that had 45 separate field locations. Imagine four of our company aircraft working the same day, not counting all the other aerial applicators throughout the state. This would overwhelm the DEQ. The record keeping requirement of the Bill are already required by the Oregon Department of Agriculture."

An industry that does not overspray has no fear of notification requirements. An industry that does not overspray has no fear of fines for doing so. My challenge to them in this bill is to walk *the talk. I would be delighted to see them proven right. I agree with them, that we should make data driven decisions in the legislature. That's what this bill is. I hope you will forward the bill with the do-pass recommendation. Thank you.*

RESPONSE: It is illegal to apply herbicides off target, and if someone thinks they've been harmed, they should seek immediate medical attention and report the incident to start an investigation and properly identify those who violate the law. Oregon has a transparent process for reporting concerns and suspected violations.

Over the last 8 years, the forestry compliance rate for pesticide use has been 92%, the highest compliance rate of all pesticide use categories. For the past 3 years there have been zero violations or civil penalties levied against aerial forestry pesticide applications. Nearly every year, aerial forestry pesticide applications have the lowest complaint count.

In 2015 the industry recognized that a few high-profile cases have unfairly created the perception of a problem and, as a result, came to the table to seek common ground on improving the use of herbicides. The industry came together with a broad group of interested parties, including environmental groups and lawmakers, to find ways to improve our practices in a way that gives the public more confidence. The process resulted in:

- Codifying **60ft buffers around dwellings or schools for forestry aerial applications**, which went into effect on January 1, 2016.
- Updates to the ODF Forestry Activity Electronic Reporting and Notification System (FERNS), to provide **a no-cost public portal with access to forestry activity notifications**.
- **Investing significantly in new investigators, case reviewers, administrative help, and laboratory capacity** at Oregon Department of Agriculture (ODA) pesticide investigation division. ODA has hired four new investigators and a Citizen Advocate & Liaison.
- Creating a **dedicated hotline for people to call** who are concerned that they, or their property, have been exposed to pesticides. Concerned citizens can now call 211 to file a complaint or get information about a pesticide application.
- **An increase in pesticide registration fees from $160 to $320**. This additional revenue helps fund the new ODA positions and the new 24/7 pesticide hotline.
- Requiring Pesticide Analytical Response Center (PARC) to adopt standard operating procedures (SOPs) for use by PARC member agencies to use when responding to pesticide incidents. **All PARC agencies now have in place SOPs for pesticide complaints**.
- **Doubling of civil penalties** associated with a violation of Oregon pesticide laws.
- Authorizing **ODA to require applicator retesting** in the event of misapplication of pesticides, and suspension of license if the applicator fails the test.
- **Loss of an applicator license** if a violator fails to timely pay civil penalties.
- Requiring **aerial applicators to obtain a separate aerial applicator certificate**. The certificate requires 50 hours of aerial training, a national test, and ongoing education requirements.

Further Dialog on Measure 21-177 – Aerial Spraying of Forestlands

Fact Check: Aerial Spraying in Federal Forests
Key Argument for Measure 21-177 Proven False

The Coalition to Defeat Measure 21-177 is releasing new information correcting false statements by proponents of the Measure that the aerial spraying of pesticides is banned in local forests managed by the U.S. Forest Service (USFS).

On April 4, 2017, Oregon Public Broadcasting (OPB) issued a correction to a 2015 story that disproves a central argument used by proponents of Measure 21-177 to justify an aerial spray ban in Lincoln County.

Repeatedly, and via multiple mediums (including the County Voters' Pamphlet), proponents have made the false claim to voters that that aerial pesticide application is banned on federal lands managed by US Forest Service (USFS).

The now-corrected OPB story reads, "A previous version of this article stated that aerial herbicide spraying was banned on Forest Service lands. The practice was banned temporarily in the 1980s after legal challenges but the agency later regained a more limited use through a mediated agreement." (Schick)

Clarifying statements from the USFS further delineate that aerial pesticide application IS NOT banned, outlawed, or otherwise prohibited on federal lands managed by the USFS in the Pacific Northwest, or any other region of the country (Bautista).

Shawna Bautista, Pesticide Use and Invasive Plant Program Manager for the Pacific Northwest Region of the USFS, explains, "aerial application is, indeed, utilized by USFS, along with other methods, to suppress invasive species and contribute to forest and grassland health. Aerial application is also used on serious outbreaks of native forest pests. It remains a vitally important tool to respond to outbreaks of serious forest pests, like gypsy moths…"

Additionally, "the USFS sometimes uses aerial application to treat large or inaccessible infestations of invasive plants."

Bautista continues, "due to our current forest management practices, it is unlikely that we would propose any aerial herbicide applications [west of the Cascades], but there is no specific prohibition on that application method."

The Coalition to Defeat 21-177 would like to thank the USFS for its role in natural resource stewardship on 172,000 acres of Siuslaw National Forest in Lincoln County.

You can learn more about their timber management and forest stewardship at: https://www.fs.usda.gov/main/siuslaw/home

Voters are encouraged to get the facts about this Measure and how forestry practices benefit both forests and public health at: http://www.protectfamilyfarmsandforests.org/

Sources:

Schick, Tony. “BLM Investigates After Company Sprays On Public Land Without A License. “
OPB, 27 Oct. 2015, http://www.opb.org/news/article/blm-investigates-after-company-sprays-pesticide-on-public-land-without-license/. Accessed 5 Apr. 2017.

Bautista, Shawna. Pesticide Use and Invasive Plant Program Manager for the Pacific Northwest
Region of the USFS. “Re: Aerial Spraying on USFS Land.” Received by Alan Fujishin, 23 Mar. 2017.

BLACHLY SCHOOL DISTRICT #90
Triangle Lake Charter School K-12
20264 Blachly Grange Road
Blachly, OR 97412
Phone: 541-925-3262 • Fax: 541-925-3062
www.blachly.k12.or.us

"A community is known by the schools it keeps"

May 26, 2011

Dear Parents, Guardians, Students, Community Members,

The Blachly School District Board of Directors, superintendent and staff want to assure you that we are concerned about the safety of our students and your children. Our drinking water is safe despite rumors you may have been provided. Recently members of the Pitchfork Rebellion brought a single unidentified page of a water report to the public Board meeting and said that an analysis showed imazapyr in our well water at 48 ppt. (parts per trillion). They accused us of poisoning and killing the children. The Board thanked them for the information and said we would investigate. However, we were presented with only one page of a four page report with no identification of the lab, no date or location of the sample, and no assurance that a chain of custody of the water sample had been maintained nor that testing protocol had been followed by a reputable lab.

Our last water test, on August 30, 2010, which follows government standards and the schedule we must follow showed no detectable amounts of any substances that are of concern in water quality and safety including no atrazine and no 2,4 D. Those two are the pesticides that have raised concern in this valley recently because amounts were found in the urine test of 22 adults. However, the required government testing does not cover testing for imazapyr.

Immediately, I began checking with authorities to determine if we had an issue with water safety due to the detection of imazapyr. . Unofficially I was told we were well below the safety concern level at 48 ppt.

I also spent a great deal of time tracking down the entire USDA report and finally obtained all four pages. Even this report said we had no detectable atrazine nor 2,4 D in our drinking water..

Below are three important pieces of information, translated to practical language, regarding the risk of exposure to imazapyr as provided by officials Jae P. Douglas, Ph.D, principal investigator of the Oregon Public Health Division and Kenneth W. Kauffman, Environmental Health Specialist and Environmental Toxicology Program of the Oregon Department of Human Services who are charged with Public Water Safety.

1. The pesticide imazapyr was detected in the school's drinking water at a concentration of 48 parts per trillion (pp)t. It was the only pesticide detected out of 500 pesticides that were tested for. By way of comparison to the concentrations detected in our water, food products in the U.S. are allowed to contain the following levels of imazapyr: Meats, fats, dairy products – 50,000 ppt; Edible shellfish meat – 100,000 ppt; Edible finfish meat – 1,000,000 ppt.

2. The U.S. does not have a drinking water standard for imazapyr. Australia has a drinking water standard which is 9 parts per million (ppm). This is equivalent to 9,000,000 ppt. TLCS sample of water contained only 48 ppt.

3. The U.S. Environmental Protection Agency and Health Canada have agreed that a child weighing 22 pounds could safely drink 136,000 gallons per day of water with the levels of imazapyr that were found in the school's water.

The District will have an additional water test performed on our well water in the next two weeks to verify the findings and to offer additional reassurance of its safety and of our concern about the safety of our students drinking our water.

As an additional clarification, we have received some inquiries about the testing of children's urine as a result of a mass mailing by the Pitchfork Rebellion. That is their plan, not Blachly School District's.

If you have questions, please call Superintendent LeAnne Raze at 541-925-3262 X 106 or contact her at lraze@blachly.k12.or.us or Board Chair Derek Pennel at 541-964-3456 or contact at dpennel@blachly.k12.or.us.

Sincerely,

LeAnne Raze

LeAnne Raze, Superintendent
Blachly School Board of Directors

Final

Public Health Assessment
Highway 36 Corridor Exposure Investigation
October 2014

Prepared by the

Environmental Health Assessment Program
Oregon Health Authority; Public Health Division

Funded under a cooperative agreement with the
Agency for Toxic Substances and Disease Registry. (Grant no. 280603)

Foreword

The Oregon Health Authority (OHA), in cooperation with state and federal partners, prepared this Public Health Assessment (PHA). The Agency for Toxic Substances and Disease Registry (ATSDR) and its Oregon cooperative agreement partner, the Environmental Health Assessment Program (EHAP), conduct public health assessments to evaluate environmental data and community concerns. Contained within this PHA are the results of the Highway 36 Corridor Exposure Investigation (EI). The EI was conducted in response to resident's concerns about potential exposures from pesticide applications occurring on forestlands near their homes and schools.

At an April 2011 Board of Forestry meeting, several residents announced the results of a community-led, urine sampling effort. The results showed elevated levels of atrazine and 2,4-D in their urine. The Oregon Department of Forestry (ODF) notified the Pesticide Analytic and Response Center (PARC) of the results. As co-chair of PARC, OHA joined a multi-agency workgroup to develop the Highway 36 Corridor Exposure Investigation (EI) in order to determine if people are being exposed to pesticides in the Highway 36 corridor, and if so, the health implications of these exposures.

For the purposes of this document, the following definitions apply:

Public Health Assessment (PHA):
A PHA is an evaluation tool of choice when a site contains multiple contaminants and multiple, potential pathways of exposure. PHAs are conducted in an effort to determine whether a community is being exposed to environmental contaminants at levels that could harm human health. PHAs are not the same as medical exams, community health studies[1], or epidemiological studies[2]. A PHA is focused on a specific site or community and its findings are not intended to be generalizable to other sites or communities. **Sometimes critical data needed for a PHA are missing or not available. In such cases, ATSDR may conduct an Exposure Investigation (EI).**

Exposure Investigation (EI):
An EI is one approach used to better characterize past, current and possible future human exposures and to evaluate both existing and possible exposure-related health effects. An EI involves the collection and analysis of environmental data and, when appropriate, biologic data (such as urine or blood). The goal of an EI is to determine whether people have been, or are being, exposed to hazardous substances. An EI is one of several possible approaches to characterize past, current and possible future human exposures to environmental contaminants. An EI is not an epidemiological study or experiment. As such, some components of other types of studies, such as control groups, are not included in an EI.

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[1] A community health study (CHS) requires careful methods of measuring exposure and illness. Diseases can be caused by many different factors. It may be difficult to determine if a disease is caused by exposure to contaminants and not due to these other factors. A CHS presents many challenges and they are rarely conducted in small communities.

[2] Epidemiology (epi) is the study of the incidence, distribution and determinants of disease. Various methods can be used to carry out epi investigations, including descriptive studies used to study distribution and analytical studies to study determinants. The four most common types of epidemiological studies are 1) a cohort study, 2) a case-control study, 3) an occupational epi study, and 4) a cross-sectional study.

This PHA reports on the results of the Highway 36 Corridor EI to date. It contains an analysis of information and data (qualitative, biologic and environmental) collected between April 2011 and September 2012. The EI findings are nested within the broader public health assessment process that ATSDR uses. Therefore, it is important to note that this PHA is the tool used to communicate the EI findings.

OHA serves as the lead agency for coordinating and implementing this investigation. Three other state agencies (which are members of PARC), and two federal agencies are involved in this effort. These agencies are:

- Oregon Department of Agriculture (ODA); Administrator of PARC
- Oregon Department of Forestry (ODF); PARC Member Agency
- Oregon Department of Environmental Quality (DEQ); PARC Member Agency
- Centers for Disease Control and Prevention (CDC)
  - Agency for Toxic Substances and Disease Registry (ATSDR) headquarters (Atlanta, GA) and Region 10 office (Seattle, WA)
  - National Center for Environmental Health (NCEH) laboratory (Atlanta, GA)
- U.S. Environmental Protection Agency (EPA)
  - EPA Region 10 (Seattle, WA)
  - EPA Office of Pesticides Programs (Washington, DC)
- PARC consultants from the Oregon Health and Science University (OHSU) and Oregon State University (OSU) also provide technical assistance and consultation for this investigation.

This group of agencies has provided input into the EI according to their areas of expertise and legal authority. For example, DEQ and EPA were responsible for collecting environmental data, and were key partners when writing pieces of the report related to the environmental samples. Each agency has reviewed the report and provided input, feedback and edits to the sections relevant to their agency. In addition, the group as a whole met several times to discuss issues as they arose and arrived at agreement on how to report the EI results. Funding and other staff resources used to conduct this EI was contributed by all state and federal agencies involved.

OHA Public Health Division (OHA/PHD) houses the Environmental Health Assessment Program (EHAP), which is the ATSDR-cooperative agreement program funded to carry out ATSDR's work in Oregon. EHAP staff are the primary authors of this report.

Purpose and Statement of Issues

This PHA reports on the available information and data collected to date for the Highway 36 Corridor EI. The Highway 36 Corridor is located in western Lane County, Oregon. The EI is a multi-agency response to several community members' requests to investigate possible exposures to pesticides and herbicides used in industrial forestland applications near their residences and schools. The purpose of the EI is to fill important data gaps by collecting and analyzing available information and environmental, biologic and qualitative data to answer the following questions:

1. Are residents in the Highway 36 Corridor being exposed to pesticides from local application practices?
2. If residents are being exposed:
    a. To what pesticides are they being exposed?
    b. To what levels are they being exposed?
    c. What are potential source(s) of the pesticides to which they are exposed?
    d. What are potential routes (pathways) of residents' exposures?
    e. What health risks are associated with these exposures?

As described in the "Background" and "Community Concerns" sections of this report, several Highway 36 Corridor residents are concerned about how these herbicide applications may be affecting their health. Therefore, this EI focuses on collecting and evaluating data on herbicides that are used in this area. Because "pesticide" is a more inclusive and commonly understood term, we use "pesticide" from this point forward to refer to herbicides, insecticides, fungicides, rodenticides and similar products regulated under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA).

Table of Contents

Tables and Figures

List of Abbreviations and Acronyms

2,4-D – 2,4-dichlorophenoxy acetic acid
ATSDR – Agency for Toxic Substances and Disease Registry
BE – Biomonitoring equivalent
CDC – Centers for Disease Control and Prevention
CS&R – Central Shipping and Receiving (at Emory University)
DACT – Diaminochlorotriazine, a metabolite of atrazine
DAAM – Di-dealkylated atrazine mercapturate, a metabolite of atrazine
DEA – Desethyl atrazine, a metabolite of atrazine
DEET -- N,N-diethyl-meta-toluamide is common ingredient in insect repellent
DEQ -- Department of Environmental Quality
EI – Exposure Investigation
EPA – U.S. Environmental Protection Agency
HOD – Health outcome data
g -- gram
L – liter
ODA – Oregon Department of Agriculture
ODF – Oregon Department of Forestry
OHA – Oregon Health Authority
OHSU – Oregon Health & Science University
OSU – Oregon State University
ng – nanogram
NCEH – National Center for Environmental Health
NHANES – National Health and Nutrition Examination Survey
µg – microgram
mg -- milligram
mL – milliliter
PARC – Pesticide Analytical Response Center
PHA – Public Health Assessment
PHLAN – PeaceHealth Laboratory Accession Number
ppb – parts per billion
ppm -- parts per million
PR – Pitchfork Rebellion
RfC – Reference Concentration
RfD – Reference Dose
SWG – Siuslaw Watershed Guardians

Summary

The Oregon Health Authority (OHA), in cooperation with state and federal partners, prepared this final report as part of an ongoing Exposure Investigation (EI) for the Highway 36 Corridor. OHA prepared this report under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR).

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. OHA prepared this report in accordance with ATSDR's approved methods, policies and procedures existing at the date of publication.

Questions

The purpose of this EI is to answer the following questions:

1. Are residents in the Highway 36 Corridor being exposed to pesticides from local application practices?
2. If residents are being exposed:
    a. To what pesticides are they being exposed?
    b. To what levels are they being exposed?
    c. What are potential source(s) of the pesticides to which they are exposed?
    d. What are potential routes (pathways) of residents' exposures?
    e. What health risks are associated with these exposures?

As reported in this PHA, most of these questions have been answered to a limited degree. However, the investigation was not completed as planned, and uncertainties and data gaps remain. We recognize that the samples included in this report represent a snapshot in time and that air has not been adequately tested. In addition, most samples were collected during the time of year when pesticide use in the area was presumably at its lowest levels. The original plan was to conduct additional urine and environmental sampling immediately after known pesticide applications occurred, in order to capture exposure conditions when pesticide levels in the environment (and presumably in people) would have been at their highest. The EI team was unable to do this additional sampling because of logistical challenges, which included the location of planned areas of application relative to residences, the difficulty in collecting samples within 24-48 hours of an application and other issues. Because of the need for more data, and to overcome some of the logistical challenges, EPA is developing a passive air sampling method that will help answer questions about sources and routes of exposure (questions 2. c and d.). When the results of EPA's air monitoring become available, OHA will analyze, describe and report out on their public health significance.

Methods

OHA and its agency partners used qualitative and quantitative methods to carry out this EI. OHA analyzed information gathered from community meetings, interviews with residents, correspondences, and reviews of news stories and media coverage to describe the broad themes of community concerns.

OHA and its agency partners also collected samples of urine, drinking water, soil, and homegrown foods from residents in the area during August and September of 2011.

In July and August of 2011, OHA recruited participants at community meetings and through phone calls, direct mailings, flyers, a toll-free number and a listserv. To be eligible to participate, volunteers were required to:

- live within 1.5 miles of a timber unit that had been harvested in 2010 or 2011,
- not be working as a pesticide applicator, and
- live within the defined exposure investigation area.

Homegrown foods, drinking water and soil samples were collected and analyzed for a list of pesticides that were being used in the area. All samples collected by OHA and partner agencies were intended as "baseline" samples, collected during the time of year when pesticide applications in the investigation area were presumably at their lowest levels.

Some members of the community living in this area conducted sampling of urine, surface water, and ambient air, independently of government agency oversight and at their own expense. The community-led urine sampling effort was carried out in the spring of 2011, and the water and air samples were collected at various times throughout 2011. Community-collected urine samples were sent to Dr. Dana Barr's laboratory at Emory University in Atlanta, GA, where they were analyzed for 2,4-D and atrazine. Community-collected air and water samples were analyzed by Anatek laboratory in Moscow, ID. Because these samples were collected by community residents and analyzed by non-governmental entities, OHA examined the quality control procedures of the sample collection and analysis and compared them with standards used by OHA and its agency partners. The quality control procedures for the sample collection by the community and the analysis by the labs were determined to meet the standards used by OHA and its agency partners for inclusion in this report. Therefore, the conclusions and recommendations expressed here are based on data generated by both the EI team and the affected community members themselves.

Urine samples were analyzed for the presence of 2,4-dichlorophenoxy acetic acid (2,4-D)[3] and atrazine[4]. These are two pesticides used in forestry practices, for which there are laboratory methods developed to detect their presence in urine. Results of laboratory analyses for the urinary levels of 2,4-D were compared to data on 2,4-D levels found in the general US population, from the 2003-2004[5] National Health and Nutrition Examination Survey (NHANES). NHANES is a national survey designed to assess the health and nutritional status of the non-institutionalized US population. It is conducted by the federal Centers for Disease Control and Prevention (CDC).

No national comparison data are available for atrazine, because NHANES does not monitor for atrazine. The potential for health effects from the levels of 2,4-D detected in urine samples was determined by comparison against the acute and chronic biomonitoring equivalents (BE). The BE is the concentration of pesticide metabolites in urine that corresponds to the daily oral dose at which there is no known harm to health. No BE is available for atrazine.

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[3] For more information about 2,4-D see Appendix F of this document.
[4] For more information about atrazine, see Appendix F of this document.
[5] 2003-2004 are the most recent years of NHANES data that are publicly available

Water, soil and food samples were analyzed by the Oregon Department of Environmental Quality (DEQ) laboratory and the Oregon Department of Agriculture (ODA) laboratory. OHA compared measured concentrations of pesticides in water, soil, and homegrown foods against established health-based comparison values.

Results

Urine samples:
Urine samples collected by the community in the spring of 2011 were tested for 2,4-D and atrazine, the only two pesticides for which there are methods developed to test for in urine. The samples showed levels of 2,4-D that were statistically higher than the general U.S. population. In addition, all community-collected samples collected in the spring of 2011 contained detectible levels of atrazine metabolites.

The 66 urine samples collected by the investigation team in the fall of 2011 had levels of 2,4-D that were not statistically higher than levels found in the general U.S. population. None of the samples collected by the investigation team in the fall of 2011 contained detectable levels of atrazine metabolites. These samples were collected during baseline conditions, when 2,4-D and atrazine use in the area was presumably at its lowest levels.

In all samples, levels of 2,4-D were below the biomonitoring equivalent (BE) for 2,4-D. A BE is the concentration of a chemical in urine (or other biological sample such as blood) that corresponds to the daily oral dose at which there is insignificant risk of harm to health. There are no national reference values for atrazine metabolites available for the general population, and there is not a BE established for atrazine. Therefore, it is not possible to compare the levels of atrazine metabolites found in the community-collected urine samples to levels that are expected to harm human health.

Drinking water samples:
Three of the 36 drinking water samples collected had detectable amounts of DEET, fluoridone, or hexazinone. DEET is a commonly applied product found in bug repellants. Fluoridone is an aquatic pesticide used to control weeds in ponds and hexazinone is a broad-spectrum pesticide used to control weeds.

Soil samples:
Three of the 29 soil samples collected had detectable amounts of 2,4-D and/or glyphosate (the active ingredient in the weed killer Roundup®). The concentrations of pesticides found in both soil and water samples were not at levels high enough to cause harm to human health, including for children and other population groups who may be especially sensitive to pesticide exposure.

Homegrown and wild grown food samples:
No pesticides were detected in any of the homegrown or wild grown food products sampled in the fall of 2011.

Air samples:
One out of 16 air samples collected by community members in May of 2012 contained a low but detectable amount of clopyralid. Clopyralid is a pesticide commonly used to control weeds and woody brush on forestlands and areas next to rights of way.

Community Concerns:
OHA has identified several causes of stress and conflict within the Highway 36 community. These include: concern and anxiety about health and safety; differing beliefs about pesticide use; the lack of adequate spray notifications; difficulty in obtaining records of pesticide applications; anger and distrust of government agencies; and what is viewed as the protection of large timber and chemical company interests above community rights. Some community members are confident that governmental requirements for pesticide labeling and use are protective of health. Others are skeptical and want the government to do more to protect their health. Some community members have requested an aerial spray buffer zone be established around homes and schools, while others are calling for a complete moratorium on all uses of pesticides. Community conflict, stemming from these divergent views, has escalated to a level where community cohesion has been negatively affected.

Conclusions

As a result of this EI, OHA reached *twenty-two* important conclusions addressing the questions that serve as the framework for this investigation about the presence, type and source of exposure to pesticides in the Highway 36 investigation area.

OHA reached *one* conclusion related to the question:
Are residents in the Highway 36 Corridor being exposed to pesticides from local application practices?

> **Conclusion 1:** This investigation found evidence that residents of the investigation area were exposed to pesticides or herbicides in spring and fall 2011. However, it was not possible to confirm if these observed exposures occurred as a result of local application practices or were from other sources.
> *Basis for Decision:* The urine sample analysis showed exposure to 2,4-D and atrazine. Environmental sampling in fall 2011 identified low levels of additional herbicides and DEET in soil and some water samples. Only one of the pesticides measured in fall 2011 environmental sampling (2,4-D) was the same as the pesticide measured in urine. Concentrations of 2,4-D measured in fall environmental samples were too low to explain concentrations measured in urine. In Spring 2011, there were no environmental samples that could be used to definitively link urine concentrations to specific pesticide applications.

OHA reached *four* conclusions related to the question:
To what pesticides are they being exposed?

> **Conclusion 2:** Residents in the Highway 36 investigation area had urinary biomarkers for exposure to 2,4-D in spring and fall 2011, and atrazine in spring 2011. We were unable to

determine if participants in the investigation had urinary biomarkers for exposure to pesticides other than 2,4-D and atrazine in spring or fall 2011.
Basis for Decision: OHA was unable to identify a laboratory that had the technical capability to test human urine samples for pesticides that are used in the area other than 2,4-D and atrazine.

Conclusion 3: Some Highway 36 investigation area residents may have been exposed to very low levels of DEET, fluoridone, or hexazinone in their drinking water.
Basis for Decision: DEQ detected very low concentrations of DEET, fluoridone, or hexazinone in three out of the 36 drinking water samples collected.

Conclusion 4: Some Highway 36 investigation area residents may have been exposed to very low levels 2,4-D or glyphosate in their soil.
Basis for Decision: ODA detected 2,4-D and/or glyphosate in three out of 29 soil samples collected.

Conclusion 5: Some Highway 36 investigation area residents may have been exposed to very low levels of clopyralid in the air.
Basis for Decision: One out of 16 air samples collected by community members in May of 2012 contained a low but detectable amount of clopyralid.

OHA reached *three* conclusions related to the question:
To what levels are they being exposed?

This investigation documented the presence of 2,4-D and atrazine in the urine of residents. There was a drop in those levels between the spring and fall 2011 for reasons that are currently unknown. There were no recorded applications of 2,4-D or atrazine in the months leading up to collection of these fall 2011 urine samples. However, 13 of the spring 2011 urine samples were also collected prior to any recorded 2,4-D or atrazine application and yet contained 2,4-D and atrazine metabolite concentrations significantly higher than the fall 2011 samples.

Conclusion 6: In the **spring of 2011**, Highway 36 investigation area residents had higher levels of 2,4-D exposure than the general U.S. population.
Basis for Decision: The concentrations of 2,4-D measured in the urine of participating Highway 36 investigation area residents in spring 2011 were statistically higher than those measured in the NHANES population. The NHANES population is representative of the general, non-institutionalized population of the United States.

Conclusion 7: In the **fall of 2011**, Highway 36 investigation area residents had urinary 2,4-D levels that were not statistically higher than the general U.S. population.
Basis for Decision: The concentrations of 2,4-D measured in the urine of participating Highway 36 investigation area residents in fall 2011, during the time of year when there were no reported 2,4-D or atrazine applications, were similar to those of the NHANES population. Measured concentrations were within the expected range as expressed by the NHANES 95th percentile. However, there was a slightly greater than expected number of participants whose urinary 2,4-D levels were in the upper quartile of the expected range. When compared to the NHANES 75th percentile the concentrations of 2,4-D in the urine of participating Highway 36 area residents

were slightly higher with a difference that approached, but did not attain, statistical significance (p=0.06).

Conclusion 8: In the spring of 2011, urine samples from Highway 36 investigation area residents also had detectable levels of atrazine metabolites, but it is unknown how these levels compare to the general U.S. population.
Basis for Decision: The CDC did not test NHANES populations for the same metabolites of atrazine measured in participants of this EI. Without a reference population, it is not possible to determine how Highway 36 investigation area residents compare with other people with respect to urinary atrazine metabolite levels.

OHA reached *two* conclusions related to the question:
What are potential source(s) of the pesticides to which they are exposed?

Aerial and ground applications of 2,4-D, atrazine and other pesticides did occur in the investigation area in 2011. However, this investigation found that additional, unknown sources were a major contributor to the pesticides detected in participants' urinary 2,4-D and atrazine metabolite levels. In nine participants, four documented aerial applications possibly contributed additional increases in urinary atrazine metabolites, but not 2,4-D.

Conclusion 9: There are additional sources of 2,4-D and atrazine in the investigation area that are not accounted for in the pesticide application records available to the investigation team.
Basis for Decision: For the spring 2011 samples, there was no statistical difference in 2,4-D and atrazine metabolite levels between the 13 urine samples collected before any known applications and the 26 urine samples collected after any known pesticide applications. As a group, the 39 spring 2011 urine samples had statistically higher 2,4-D and atrazine metabolite levels than the 64 fall 2011 urine samples, which were all collected three months after the last known forestry application of 2,4-D or atrazine. The spring 2011 samples, including the 13 pre-application samples, were also statistically significantly higher than the U.S. population as represented by NHANES.

Conclusion 10: Statistical associations suggest that four local aerial applications of atrazine and 2,4-D to forestland may have contributed to an increase in urinary atrazine metabolite levels in samples collected from nine participants within 24 hours of those applications.
*Basis for Decision***:** The EI team did not collect any environmental samples around the time of spring 2011 urine sampling. However, urine samples collected from nine participants within 24-hours of four aerial applications of 2,4-D and atrazine to forestland had statistically higher levels of atrazine metabolites compared to the remaining 30 spring 2011 urine samples, but not 2,4-D. The four aerial applications took place within 2-4 miles of the residences of the nine EI participants with elevated atrazine metabolite levels. Because the investigation team did not have concurrent environmental samples detailing atrazine's persistence and distance traveled, we were unable to confirm that the known aerial applications were the source for the elevated atrazine metabolites that were detected in the nine residents' urine.

OHA reached *five* conclusions related to the question:
What are potential routes (pathways) of residents' exposures?

Low but detectable levels of DEET, fluoridone, or hexazinone were found in 8% of the drinking water samples. Glyphosate and/or 2,4-D were found in 10% of the soil samples. This suggests that in some cases incidental swallowing or absorption of pesticides from water or soil may be a path of exposure. No pesticides were found in the homegrown foods sampled, suggesting that this is an unlikely route of exposure.

> **Conclusion 11:** We were unable to determine whether air is a pathway of exposure to pesticides in the Highway 36 investigation area.
> *Basis for Decision:* Neither OHA nor the EI team members have had the funding or the staffing, logistical, technological or funding capacity to actively monitor air for the pesticides used in the area. Community-collected air samples were too few in number to provide the basis for eliminating or confirming air as a relevant exposure pathway.
>
> **Conclusion 12:** Drinking water was eliminated as an exposure pathway for 2,4-D and atrazine in the fall of 2011.
> *Basis of Decision:* No 2,4-D or atrazine - or their breakdown products - were detected in any of the water samples collected in the fall of 2011 at a time when there were no reported applications of these pesticides.
>
> **Conclusion 13:** Soil sampled in the fall of 2011 was eliminated as an exposure pathway for the 2,4-D and atrazine detected in Highway 36 investigation area residents' urine.
> *Basis for Decision:* Concentrations of 2,4-D measured in two soil samples were far too low to explain the levels of 2,4-D found in Highway 36 investigation area residents' urine. In addition, most EI participants had detectable 2,4-D in their urine but no 2,4-D detectable in their soil.
>
> **Conclusion 14:** Wild or homegrown food products sampled in the fall of 2011 were eliminated as an exposure pathway in the fall of 2011.
> *Basis of decision:* No pesticides were detected in any of the wild or homegrown food samples collected.
>
> **Conclusion 15:** Concentrations of pesticides in drinking water, soil and homegrown foods in the spring of 2011 and other seasons and years are unknown.
> *Basis of Decision:* Drinking water, soil and homegrown food samples were only collected in the fall of 2011, at a time of year when there were no reported 2,4-D or atrazine applications.

OHA reached *five* conclusions related to the question:
What health risks are associated with these exposures?

This investigation documented the presence of 2,4-D and atrazine metabolites in the urine of residents. However, the levels of 2,4-D found in residents' urine are below the levels currently known to be harmful to health. OHA cannot determine whether measured atrazine metabolite levels pose a health risk to residents. The levels of the pesticides found in the water, soil and food samples were at levels below which we would expect to see harmful health effects.

Conclusion 16: The levels of 2,4-D measured in Highway 36 investigation area residents' urine in spring and fall 2011 were below levels expected to harm people's health.
Basis for Decision: The concentrations of 2,4-D measured were lower than the biomonitoring equivalent (BE) for 2,4-D. The BE is a calculated urine concentration that corresponds to an oral dose of 2,4-D associated with no harm to health.

Conclusion 17: We cannot determine whether the levels of atrazine metabolites measured in Highway 36 investigation area residents' urine in spring 2011 could harm people's health.
Basis for Decision: Unlike 2,4-D, there is no BE for atrazine metabolites. Without a BE against which to compare urinary atrazine metabolite levels, it is not possible to determine how measured urinary concentrations relate to doses that cause harm to health.

Conclusion 18: Drinking or contacting domestic water with the concentrations of pesticides detected in some Highway 36 investigation area properties in fall 2011 is not expected to harm people's health.
Basis for Decision: Three of 36 drinking water samples collected in fall 2011 within the Highway 36 investigation area had detected concentrations of pesticides. The concentrations measured at the time of sampling were thousands of times lower than health-based comparison values. The measured levels were too low to harm the health of people who drink the water, including sensitive populations such as children.

Conclusion 19: Contact with soil containing pesticides at the concentrations detected in the fall of 2011 in some Highway 36 investigation area soil is not expected to harm people's health.
Basis for Decision: Three of 29 Highway 36 investigation area soil samples had measurable amounts of pesticides at the time of sampling. The concentrations measured at the time of sampling were thousands of times lower than health-based comparison values. Measured concentrations were too low to harm the health of people contacting the soil, including sensitive populations such as children.

Conclusion 20: Handling or consuming garden vegetables, berries, eggs, milk, or honey collected from the Highway 36 EI participants' homes in fall 2011 will not lead to harmful health effects related to pesticide exposure.
Basis for Decision: No pesticides were detected in any of the wild or homegrown food products sampled in the fall of 2011.

OHA reached *two* additional conclusions related to the impacts to the EI and to the health of community members from community conflict.

Conclusion 21: Divisions and hostility within the community related to pesticide use, property rights and land use are creating significant stressors on many individual community members and on the community as a whole.
Basis for Decision: OHA staff and other members of the EI team have observed, documented and responded to a high volume of complaints from a broad range of Highway 36 community members who express anger, frustration, mistrust, and fear. Community members express

concerns about the intentions, motives and actions of others with opposing views on land use, pesticide use and property and human rights within and outside of their community.

Conclusion 22: Leadership activity within the community has been oriented toward debating issues of land use, pesticide use, and property rights. No formal or informal leader has yet emerged who has a mediating influence on these differences. Formal mediation services for the Highway 36 community may be necessary for both the successful completion of the EI and for the important progress needed to reduce community stress and improve community cohesion in the longer term.
Basis for Decision: Many community members have expressed frustration and concern about the degree and persistence of the conflict within their community and toward public agencies, timber industry practices and pesticide use. Regardless of the outcome of the EI, resolving these differences may be necessary to restore community cohesion.

Uncertainties and Limitations

As with any scientific investigation, there are uncertainties and limitations to our conclusions about exposure and health risks.

- **Fall 2011 environmental and urine samples were collected at a time when there were no reported 2,4-D or atrazine applications.** The EI team was not able to collect environmental or urine samples immediately after pesticide applications as planned due to unanticipated logistical challenges.
- **Household dust has not been evaluated as an exposure pathway.** Many pesticides are rapidly degraded in outdoor environments where they are exposed to sunlight, water and soil microbes. Indoor environments can shelter chemicals from these degrading forces, and pesticides may persist much longer indoors. Contaminants in soil tracked indoors on shoes can become part of household dust and persist much longer than would be predicted outdoors. This pathway has not been evaluated.
- **While community-collected urine and environmental samples are of sufficient quality to include in this PHA, these samples were not collected or analyzed with the same level of oversight as the fall 2011 samples collected by government agencies.** This difference in oversight resulted in some difficulties obtaining information about how and why participants were recruited, how and why sampling locations and times were selected, and what the creatinine levels in urine samples were. Creatinine is a natural component of urine that is used by doctors and scientists as a basic measure of kidney function. Creatinine levels fluctuate depending on how concentrated a person's urine is at the time of the sample. The samples OHA collected in the fall were adjusted for this difference, while the community-collected, spring samples were not.
- **Conclusions can only be drawn about the pesticides that were tested for in urine and environmental samples.** The urine samples collected in spring and fall 2011 were only tested for atrazine metabolites and 2,4-D. There were other pesticides used in the investigation area during the sampling times, but the only pesticides for which there are laboratory methods to test for in urine are 2,4-D and atrazine. The environmental samples collected in fall 2011 were tested for a wider range, but not an exhaustive panel, of pesticides. We cannot determine if, how and

how much people were exposed to other pesticides at the time of sample collection. We also do not know what the health implications of any unknown pesticide exposures may be.

- **Conclusions about exposure and health risks only apply to the times and places where samples were collected by community members or the investigation team.** All urine and environmental samples represent a snapshot in time and space. Because 2,4-D and atrazine rapidly clear from the body, the levels of these chemicals in urine can only be used to assess recent (within 24-48 hours) exposures. The levels of pesticides detected in environmental samples only indicate the amounts present at the time of sampling, and do not indicate whether these levels have changed over time. We also cannot conclude if Highway 36 Corridor residents had past exposures to pesticides, if past or current exposures were from acute (short-term) or chronic (long-term) contact with pesticides, or if residents have had repeated exposures to pesticides over time.
- **It is not known if the EI resulted in changes to pesticide application practices in the investigation area, and therefore if exposure conditions have changed for Highway 36 Corridor residents.** It is unknown if pesticide applicators changed their pesticide application practices (i.e., application methods, locations, or types of pesticides used) after the EI was initiated. Any changes in local application practices will also change exposure conditions within the investigation area, and will make it difficult to fully answer the EI questions.
- **There is insufficient scientific evidence to determine the effect of exposure to multiple pesticides at low doses.** There is a limited but growing body of scientific evidence on the health effects from exposure to multiple pesticides; however, current methods do not allow for a determination of risk resulting from exposure to multiple chemicals.

Next Steps

Pertaining to the results of this EI, OHA recommends that:

1. US EPA work with the EI team on developing a sampling and analysis plan designed to evaluate exposures to pesticides in air and to address gaps in the data needed to answer EI questions. At the time of publication of this report, passive air monitoring over several application seasons appears to be the best option to collect community-wide air data.
2. ODA and ODF continue to provide pesticide application data as needed to interpret air sampling (or other) data collected as part of this investigation.
3. State and federal agencies involved in the ongoing EI develop an implementation plan that includes identification of necessary resources to carry out activities appropriate for each agency's role in this effort.

Pertaining to broader and/or longer-term issues identified by the EI, OHA recommends that:

1. State agencies continue to collaborate on determining best practices that would protect human populations from pesticide exposures.
2. ODA and ODF work with pesticide applicators to develop consistent pesticide application record-keeping processes to ensure that application record data are accurately maintained and usable.
3. State agencies explore the feasibility of implementing a system that would allow people to be notified of imminent pesticide applications in such time and with such specificity that they could

take action to avoid exposure to those applications. Such policies could include adoption of systems developed by other jurisdictions or modification of existing regulatory systems designed to monitor pesticides applications.

4. State and federal agencies involved in the ongoing EI develop an implementation plan to address these recommendations, including the identification of resources to carry out activities appropriate for each agency's role in serving the communities of Oregon. That plan should include a recommendation on how the agencies should coordinate, collaborate and share resources.
5. Community members, including local elected officials and other community leaders, consider seeking the assistance of a professional mediation group to address immediate and long-term conflict within the community and identify actions to move this conflict toward resolution.

OHA will:

- Work with state and federal partners, community members, and other stakeholders to implement the recommendations in this report.
- Provide updates through the Highway 36 web page and listserv about findings from:
    - Comparison of application records in any subsequent investigation to application records from 2009 to 2011 to determine if there are noticeable (substantial) changes in pesticide application practices after the EI was initiated.
    - Air sampling data once it is collected by the EPA.

Background

Investigation Area

The EI area includes the following Township-Ranges: 15S 06W, 15S 07W, 16S 06W, 16S 07W, 16S 08W, 17S 07W, 17S 08W, and 17S0 9W (Figure 1). The investigation area covers approximately 286 square miles (182,990 acres) in western Lane County and encompasses most of the communities along the Highway 36 Corridor.

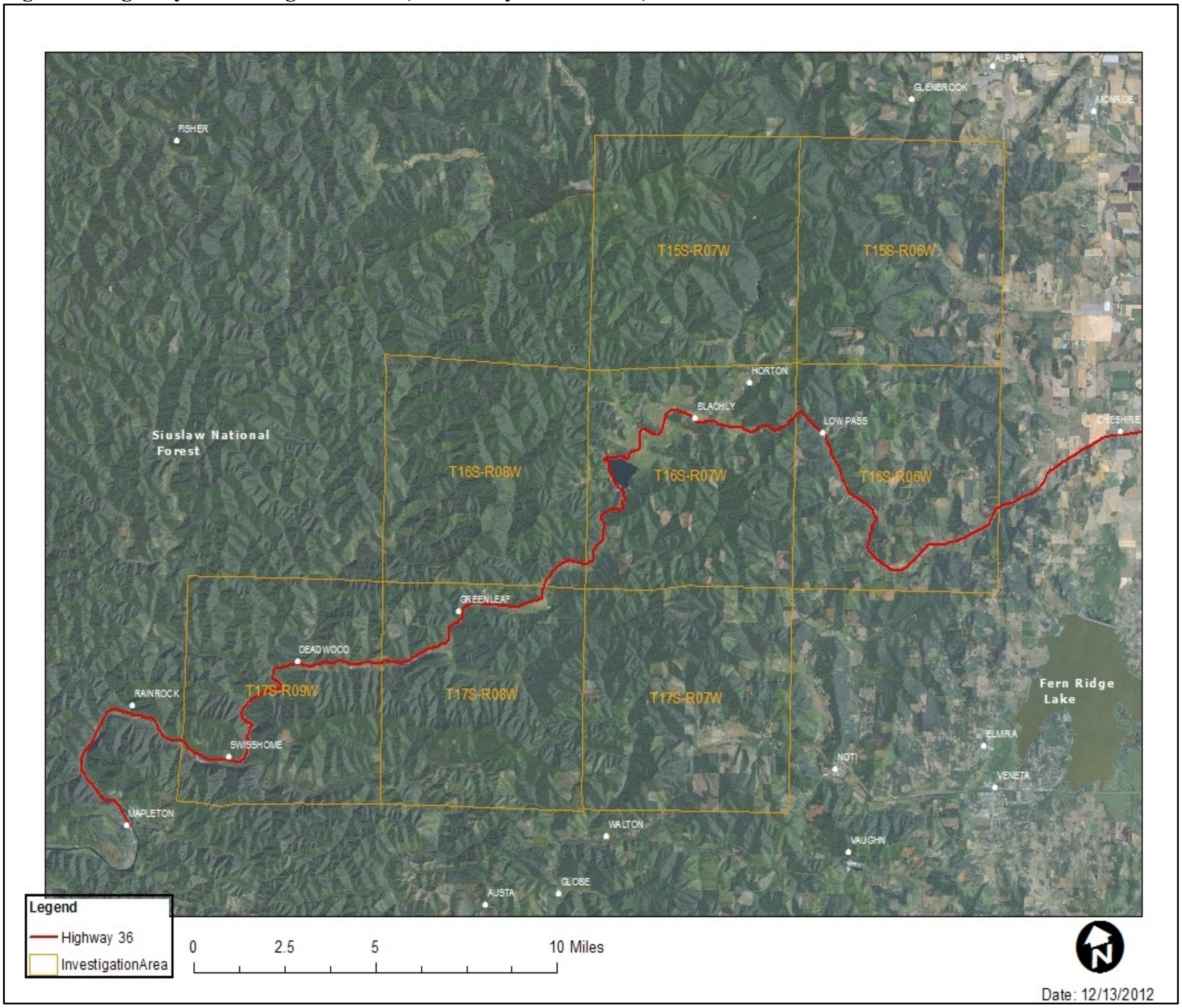
Recruitment Area

OHA established focused participant recruitment areas based on the proximity of residences to timber units that had been harvested in 2010 or 2011. All participants lived within the investigation area and within 1.5 miles of a 2010 or 2011 clear-cut.

Site Description

The investigation area is situated along a portion of Oregon state route 36 (Highway 36 in this report), which is a 52 – mile highway between the towns of Junction City and Mapleton in western Lane County. The Oregon Department of Transportation manages the highway and right of way. The investigation area includes the rural communities of Swisshome, Deadwood, Greenleaf, Triangle Lake, Blachly, Horton, and Low Pass. Approximately 2,161 people live in the investigation area. Approximately 1% (2,505 acres) of land in the investigation area is classified as rural residential. Approximately 5% (7,273 acres) is classified as agricultural land. According to the Oregon Department of Agriculture (ODA), agricultural production in the area includes pasture, hay, Christmas trees, small fruits, vegetables, and tree fruits. Forestry represents the majority of the land use in the investigation area and comprises approximately 95% (173,152 acres) of the classified use. Approximately half of the forestland in the investigation area is publicly owned, 25% is designated as privately owned industrial (ownerships greater than 5,000 acres) land, and the remaining 25% is designated as private non-industrial (ownerships less than 5,000 acres) [1]. Although forestry comprises 95% of the land use within the investigation area, land use percentages outside the investigation area vary dramatically, particularly to the east near Junction City, Eugene, and Harrisburg.

Figure 1. Highway 36 investigation area (shown in yellow outline).



Investigation History

Within the Highway 36 Corridor, there are residential properties located near forest, agricultural, or other residential lands where landowners may use pesticide products to control unwanted vegetation. Since 2005, some Highway 36-area residents have expressed concerns to Oregon state agencies about the human health and environmental effects from pesticide applications on nearby forest and agricultural lands. These residents have been advised by a consulting agronomist that the local geography and climate increase the likelihood of drift and re-volatilization of these pesticide applications to nearby residences and farms [2]. They have expressed a specific concern about aerial pesticide applications on harvested timberlands.

In 2005, a group calling itself the Pitchfork Rebellion (PR) began requesting that ODA address their concerns about alleged pesticide exposures from local application practices. In addition to being the

State's regulatory authority for pesticides, ODA administers the Pesticide Analytical Response Center (PARC). PARC is a multi-agency group with responsibilities to "centralize receiving of information relating to actual or alleged health and environmental incidents involving pesticides" and "mobilize expertise necessary for timely and accurate investigation of pesticide incidents and analyses of associated samples" [3].

In early 2010, PR petitioned the U.S. Environmental Protection Agency (EPA) to "conduct an unbiased study to determine what would be an appropriate aerial spray buffer zone for the specific conditions found along the Highway 36 Corridor in Lane County, Oregon" [4]. During a meeting with EPA Region 10 staff in April 2010, PR members reported instances of illnesses that they attributed to exposure to pesticides applied to forestlands near their homes [5]. In September 2010, EPA Region 10 requested the Agency for Toxic Substances and Disease Registry's (ATSDR) assistance in evaluating and addressing the health concerns raised by these residents and other organizations concerned about aerial pesticide applications on forestlands. In the winter of 2010, ATSDR Region 10 reviewed available information on illness reports and concerns from the area, conducted a site visit, and evaluated options to respond to local health concerns.

In spring 2011, 43 Highway 36 Corridor residents had their urine tested for pesticide metabolites by a researcher from Emory University (Atlanta, Georgia).[6] Based on the residents' assumption that aerial pesticide applications were the source of their health complaints, some community members collected urine samples both before and after aerial pesticide applications near their homes.

In April 2011, the researcher and a PR representative reported some of the community-collected urinalysis results at an Oregon Board of Forestry meeting. According to the presenters, the data indicated that:

- All of the submitted urine samples had detectable levels of 2,4-dichlorophenoxy acetic acid (2,4-D) and the atrazine metabolite diaminochlorotriazine (DACT).
- The researcher's presentation slides include a graph that compares purported "pre-spray" and "post-spray" 2,4-D and atrazine levels in participants' urine to the "U.S. population" which indicates higher levels in the local samples compared with the comparison.
- Some individual results showed that the 2,4-D and DACT levels in "post-spray" samples were higher than the levels found in "pre-spray" samples. The presenters ascribed the increase in concentrations to aerial applications on private forestlands. [7]

Shortly after these data were presented publicly, the Oregon Department of Forestry (ODF) notified PARC of information regarding actual or alleged health incidents involving pesticides in the Highway 36 Corridor. PARC agencies (OHA, the Department of Environmental Quality [DEQ], ODA, ODF, PARC consultants), ATSDR Region 10, and EPA Region 10 joined to form the Highway 36 Corridor EI team. The Governor's Office designated OHA as the lead state agency for the EI.

[6] See Appendix D for details on how spring 2011 urine samples were collected and tested. See the community-collected urine data section for OHA's interpretation of these data.
[7] The slides do not indicate the source of the "US comparison group", the total number of samples submitted, the numbers of "pre-spray" and "post-spray" samples, or the dates on which the samples were collected.

At the beginning of the investigation, the EI team did not have access to the biological sampling data presented at the April 2011 Board of Forestry meeting. Although some community members suspected aerial applications to forestlands, the investigation team broadened the investigation to evaluate local pesticide application practices and several potential exposure routes. This decision was supported by the presence of elevated 2,4-D and atrazine levels in all community-collected urine samples and not just those collected after a purported aerial pesticide application on forestland. The data presented in April 2011 suggested that residents could have chronic (or continuous) exposures to pesticides, possibly through contaminated drinking water or another source of exposure. The reported increase in 2,4-D and atrazine metabolites between first and second samples indicated there could also be acute (or short-term) exposures to pesticides after a nearby application. The investigation team chose a methodological approach to evaluate chronic and acute exposures from any local exposure source or pathway.

The EI team also began an extensive effort to open and maintain an active dialog with all of the residents in the investigation area. In keeping with ATSDR's approach to work with affected communities during an investigation, the EI team used a broad range of methods and venues to communicate with community residents, elected officials, industrial landowners, non-governmental organizations, trade organizations, technical experts, and other stakeholders. This communication effort was designed to provide community members with a variety of opportunities to receive information and share their thoughts and concerns about the investigation. It also provided the EI team important access to a broad range of community perspectives, as well as information on factors that could affect the design and implementation of investigation activities.

Discussion

Exposure Pathway Analysis

At the beginning of the EI, OHA conducted an exposure pathway analysis to identify the major pathways by which people could be exposed to pesticides in the Highway 36 Corridor. Exposure, which is defined as contact between a person and a chemical, can only occur if all of the following elements are present:

- a chemical source or released into the environment,
- a way or medium in which the chemicals move in the environment (e.g., water, soil, air, food),
- an exposure point or location where people come into contact with the chemicals,
- an exposure route by which people have physical contact with the chemicals (breathing it in, swallowing it, etc.), and
- an exposed population that comes into contact with the chemicals [6].

Scientists categorize exposure pathways as complete, potential, or eliminated based on their analysis of these five elements. In a complete exposure pathway, all five of these elements are present, indicating a strong likelihood that people could be exposed to a chemical. In a potential exposure pathway, one or more of the elements may be absent, but additional information is needed before eliminating or confirming the pathway. In an eliminated exposure pathway, exposure to a chemical is unlikely because at least one of these elements is absent. Scientists also attempt to determine if exposures occurred in the past, present, and/or future.

At the beginning of the EI, OHA identified five potential pathways by which Highway 36 Corridor residents could be exposed to pesticides in the environment (Table 1). OHA considered these "potential" pathways because at the outset of the investigation there were no environmental data to identify or rule out possible sources or pathways. OHA did not evaluate exposure to pesticide residues on food from retail grocery stores. While this is a valid and probable exposure pathway for many Highway 36 Corridor residents, it does not represent a unique local pathway that distinguishes this group from the general U.S. population. OHA also did not evaluate exposures to pesticides that occurred outside the investigation area. It is likely that many residents leave the study area periodically, which could cause them to be exposed to pesticides from uses other than those common to the investigation area.

Household dust is an additional potential exposure pathway that was not originally considered or evaluated in the EI. Many pesticides are rapidly degraded to less toxic byproducts in outdoor conditions where they are exposed to sunlight, water and soil microbes. In indoor environments, pesticides may be sheltered from these degrading forces and persist much longer [7], [8]. Studies have demonstrated that 2,4-D applied outdoors can be tracked indoors[9], [10]. The lack of indoor sampling standard methods and other logistical challenges makes it difficult to evaluate this pathway.

Table 1: Potential Exposure Pathways at the beginning of the Highway 36 Exposure Investigation.

Pathway	Source/Release*	Transport in environment (Media)	Point of Exposure	Route of Exposure	Exposed Population	Time
Air-borne particles	Aerial applications of pesticides and pressured ground sprays	Movement (drift) of chemicals off application sites (Air)	Outdoor air, indoor air	Breathing in chemicals in air	People who live or work near application areas	Past, present, future
Volatilized chemical vapors	Applications of pesticides	Volatilization of chemicals from soil to air (Air)	Outdoor air, indoor air	Breathing in chemicals in air	People who live or work near application areas	Past, present, future
Surface Soil	Applications of pesticides	Deposition of chemicals on surface soil (Soil)	Soil in gardens, yards	Swallowing, absorbing through skin	Gardeners, farmers, outdoor workers who have contact with surface soil	Past, present, future
Home-grown foods	Applications of pesticides	Deposition on, or uptake of, chemicals in garden vegetables, milk, eggs, etc. (Food)	Garden vegetable, milk, eggs, etc.	Eating	People who eat home-produced foods	Past, present, future
Drinking water	Applications of pesticides	Movement of chemicals through soil to groundwater or over land to surface water (Groundwater, surface water)	Tap	Drinking	Residents and other people who drink water from private ground/surface water sources	Past, present, future

*Aerial applications are primarily used on industrial forestlands in the Highway 36 Corridor. Ground applications include backpack spraying, “hack and squirt” applications, or roadside spraying by industrial or commercial landowners, government agencies, or private individuals.

Investigation Design

The EI team developed an investigation plan to evaluate the five potential exposure pathways and answer the EI questions. The EI team proposed to collect data during at least two sampling events: one in fall 2011 and one in spring 2012. The EI team implemented the fall 2011 sampling plan [11]; this report discusses the corresponding methods and results. The EI team was unable to implement the spring 2012 sampling plan for reasons discussed in the "Spring 2012 Sampling" section below.

The EI team designed the fall 2011 sampling protocol to collect information about pesticide sources and exposure pathways, except air, under baseline or low pesticide use conditions. The spring 2012 sampling plan was intended to evaluate the air exposure pathway during spring aerial or ground spray pesticide applications. As part of the spring 2012 phase, the EI team planned to collect urine samples before and after a nearby aerial or ground spray pesticide application and collect air monitoring data during one or more pesticide applications.

A note about EIs: EIs are not the same as epidemiological health studies and lack some key features commonly associated with epidemiological studies. For example, EIs are intentionally biased to seek out and test those individuals (or locations) expected to be most highly exposed (or contaminated). EIs are not randomized studies. EIs also do not identify or test control groups for comparison. This focuses all sampling resources on individuals at highest risk for exposure to and/or harm from environmental chemicals. EI results are not generalizable to populations outside of the ones tested in the investigation.

Fall 2011 Sampling

In August and September 2011, OHA, ATSDR, EPA and DEQ collected urine and environmental samples to evaluate if residents were being exposed to pesticides through drinking water, soil, and homegrown food. OHA recruited 66 participants from 38 households using the following methods [11]:

- During a public meeting on July 14, 2011, OHA provided attendees with a flyer containing information on how to volunteer for the Fall 2011 sampling event. OHA sought assistance from local community members to circulate this flyer through several informal community networks and post it at prominent public locations throughout the community.
- OHA contacted people who signed in at the July meeting by phone and email. OHA also encouraged community members to give our contact information to other interested residents.
- OHA established a toll-free hotline dedicated to the recruitment of volunteers.
- OHA established a listserv to announce updates on the EI and to recruit more volunteers.

The criteria for participation in the EI were that volunteers lived inside the boundaries of the investigation area, lived within 1.5 miles of a timber unit that had been clear-cut in 2010 or 2011 and did not work as a pesticide applicator.[8]

ATSDR and OHA staff collected 66 urine samples from 38 households on August 30 and 31, 2011. The samples were immediately frozen on dry ice and then shipped overnight to the Centers for Disease Control and Prevention's (CDC's) National Center for Environmental Health (NCEH) laboratory in Atlanta, Georgia. Samples were tested for 2,4-D and atrazine[9] metabolites. These two pesticides were the focus of the EI's urine analysis for three reasons:

1) these pesticides were used in local agricultural and forestry applications;
2) the CDC has laboratory methods to test for these chemicals and national reference levels against which to compare the results for 2,4-D; and
3) these chemicals were tested in the spring 2011 community-collected urine samples.

EPA and DEQ staff collected drinking water, soil, and homegrown and wild food samples from the same 38 households on September 19 – 22, 2011. DEQ's laboratory in Hillsboro, Oregon analyzed the drinking water samples for a broad range of pesticides (see Appendix C for the complete list). All other environmental samples, including food and soil, were analyzed at the ODA laboratory in Portland, Oregon for pesticides used in both agricultural and forestry applications. DEQ and ODA laboratories used EPA-approved methodologies and quality assurance protocols [12]–[19].

Fall 2011 Urine and Environmental Sampling Results

Urine Results

The urine samples collected in fall 2011 were analyzed for 2,4-D and atrazine metabolites, and the results were compared to data from the CDC's *Fourth National Report on Human Exposure to Environmental Chemicals* [20]. These national comparison data were collected as part of NHANES, a nationwide survey that includes monitoring for environmental chemicals in human blood and urine. NHANES is the best source of biomonitoring reference values for the general U.S. population because it is representative of the civilian, non-institutionalized U.S. population in terms of age, sex, and race/ethnicity. However, NHANES data may not reflect variations due to geographic location, season, or residence in urban versus rural areas [21].

These results were originally reported by ATSDR in the first formal report for the Exposure Investigation, *"Exposure Investigation: Biological Monitoring for Exposure to Herbicides, Highway 36 Corridor , Lane County, Oregon"*[21] released in March 2012. ATSDR's earlier report compared the EI urine results to NHANES values from 2001-2002; these were the most current NHANES data available at the time that report was released. In this current report, we compared the fall 2011 urine results against NHANES data collected in 2003-2004. Our use of 2003-2004 NHANES reference data explains

[8] According to ODF, these units were most likely to be treated with pesticides during the fall 2011 and spring 2012 spray seasons. In the original investigation plan, OHA planned to collect urine and environmental samples from the same participants and households in fall 2011 and spring 2012.
[9] See Appendix E for general information on 2,4-D and atrazine.

the difference between this report's findings and the findings in the separate ATSDR report on the fall 2011 urine samples. The 2003-2004 NHANES values used in this report are slightly higher than the 2001-2002 values.

None of the 66 EI participants had detectable concentrations of atrazine or its metabolites in their urine, indicating there were no recent exposures at the time of testing. Of the 64 EI participants over the age of six[10], 59 (92%) had detectable levels of 2,4-D in their urine. The 95th percentile of the EI participants was not statistically different than the 95th percentiles of the NHANES populations tested in 2003-2004 (Table 2). These samples were collected at a time when no known applications of 2,4-D or atrazine were occurring in the investigation area.

Table 2: Summary of urine results for 2,4-D from fall 2011 sampling.

Units	Mean	Median	Geometric mean	Range	95th percentile of EI (CI)	95th percentile of 2003-2004 NHANES (CI)
µg/L	1.14	0.33	0.37	<LOD -29.98	1.39 (0.98-29.98)	1.63 (1.31-2.37)
µg/g creatinine	1.15	0.37	0.4	<LOD -37.33	1.46 (0.92-37.33)	1.58 (1.24-2.34)
EI – Exposure Investigation; CI = 95% confidence interval; LOD = Limit of Detection (0.1 µg/L for EI); NHANES = National Health and Nutrition Examination Survey; µg/L = micrograms per liter; µg/g; micrograms per gram						

Three EI participants had creatinine-adjusted[11] urinary 2,4-D levels above the 2003-2004 NHANES 95th percentile (Table 3); this number was not statistically significant at the 95% confidence level and suggests that the range of 2,4-D levels is similar to the general population. Twenty-two EI (34.4%) participants had creatinine-adjusted urinary 2,4-D levels above the NHANES 75th percentile. The number of participants above the NHANES 75th percentile is not statistically significant at the 95% confidence level (alpha=0.05) but is significant at the less conservative 90% confidence level (alpha = 0.1). The marginally significant result when comparing to the NHANES 75th percentile indicates that there may be slightly more participants than expected in the upper quartile of the expected range of creatinine-adjusted urinary 2,4-D.

[10] There are no NHANES values for comparison for children under six years old.
[11] Contaminant concentrations in urine are influenced by the hydration status and kidney function of the person who provided the sample. In many studies, these factors are controlled by relating contaminant levels to the amount of creatinine measured in urine. Creatinine is a urinary by-product of protein metabolism that is filtered by the kidney at a known and predictable rate. Urinary creatinine levels can vary greatly from person to person and depend on the individual's age, sex, body mass, and other factors [22].

Table 3: Fall 2011 creatinine-adjusted urine results for 2,4-D compared against NHANES 95th and 75th percentiles.

NHANES percentile level	EI urine results above NHANES percentile		One Sample binomial test	
	Number	Percent	95% Exact CI	Two-sided Exact p-value*
95th	3	4.7%	0 – 9	0.60
75th	22	34.4%	22.7 – 46.0	0.06

CI = 95% confidence interval; NHANES = National Health and Nutrition Examination Survey; EI = Exposure Investigation
*Typically, a p value equal to or less than 0.05 is considered statistically significant.

To evaluate the health significance of the urinary 2,4-D levels in EI participants, we compared the urine results to the biomonitoring equivalent (BE) for 2,4-D. A BE represents the estimated concentration of 2,4-D that would be present in the urine of a person who was chronically exposed to 2,4-D at a dose equal to EPA's reference dose (RfD) for 2,4-D. An RfD is an estimate of the daily oral exposure that people (including sensitive populations) could be exposed to over a lifetime without experiencing harmful health effects. The BE for chronic exposures (lasting more than 7 years) to 2,4-D is 200 µg/L; for acute exposures (lasting one day), the BE is 400 µg/L for women of reproductive age and 1,000 µg/L for the rest of the population [23], [24].

The maximum concentration of 2,4-D detected in an EI participant (30 µg/L) was about seven times lower than the chronic BE, and between 13 and 33 times lower than the acute BE for women of reproductive age and the general population respectively. The average 2,4-D concentration measured in EI participants' urine (1.14 µg/L) was 175 times lower than the chronic BE, and more than 350 times lower than the acute BEs. These data indicate that at the time of testing, EI participants were not exposed to 2,4-D at levels known to cause adverse health effects from acute or chronic exposures. The weight of available scientific evidence indicates that the 2,4-D levels measured in EI participants' urine do not pose public health risks.

Environmental Sampling Results

EPA, with assistance from DEQ, collected environmental samples, which included drinking water, soil, and community grown food samples from participating households. Thirty-six drinking water samples were collected from EI participants' homes. Nineteen of these samples were from domestic wells and 17 samples were from springs. A surface water sample was also collected from nearby Little Lake, which is not used as a drinking water source. EPA and DEQ collected 29 soil, 14 vegetation, four berry, four egg, two milk, and two honey samples from participating households. DEQ analyzed each water sample for over 100 chemicals (analytes), and ODA's lab analyzed all other samples for 11 analytes used in agricultural and forestland applications in the area. Appendix C includes the list of analytes tested for in environmental samples.

Pesticides were detected in three (one analyte in each sample) of the 36 drinking water samples (Table 4). The three analytes detected were N,N-diethyl-meta-toluamide (DEET), hexazinone, and fluridone.

DEET was also detected in the sample collected from Little Lake. Each of these detections was below health-based screening values for these three chemicals. DEET is the active ingredient in many personal-use insect repellent products [25]. Hexazinone is an herbicide used to control a broad spectrum of weeds including undesirable woody plants in alfalfa, rangeland and pasture, woodland, pineapples, sugarcane, and blueberries. It is also used on ornamental plants, forest trees, and other non-crop areas [26]. Fluridone is an herbicide used to control aquatic weeds in ponds and lakes. Hexazinone is the only analyte detected that was listed in investigation area forest application notifications between 2009 and 2011.

The ODA lab detected at least one of the eleven pesticides in three of the 29 soil samples analyzed. Glyphosate and 2,4-D were both detected in one soil sample, and only 2,4-D or glyphosate was detected in the two other soil samples. The glyphosate and 2,4-D levels in these samples were below ATSDR's health-based screening values, which are 5,000 ppm for glyphosate and 500 ppm for 2,4-D (Table 4). None of the households with pesticides detected in their soil had any detectable pesticides in their drinking water. No pesticides were detected in any of the vegetation, berry, egg, milk, or honey samples collected in fall 2011.

Table 4: Fall 2011 environmental sampling results – detections in water and soil.

Location	Sample Type	Analytes Detected	Analyte Concentration (ppm)	Health-based Screening Value (ppm)	Source of screening value
Household 1	Domestic well water	DEET	0.0000047	0.2	Derived*
Household 2	Domestic spring water	Hexazinone	0.000183	0.2	HBSL
Household 3	Domestic well water	Fluridone	0.000031	0.4	HHBP
Little Lake	Surface water	DEET	0.0000058	1	Derived*
Household 4	Soil	Glyphosate	0.081	5,000	RMEG
	Soil	2,4-D	0.046	500	RMEG
Household 5	Soil	2,4-D	0.014	500	RMEG
Household 6	Soil	Glyphosate	3.3	5,000	RMEG

ppm = parts per million; DEET = *N,N*-Diethyl-3-methylbenzamide; HBSL = U.S. Geological Survey Health Based Screening Level; HHBP = U.S. Environmental Protection Agency Human Health Benchmark for Pesticides; RMEG = Reference dose Media Evaluation Guide; 2,4-D = 2,4-dichlorophenoxy acetic acid
* Derived using Agency for Toxic Substances and Disease Registry methodology and Reference Dose developed by Minnesota Department of Health (0.33 mg/kg-day)

Survey data

After urine samples were collected on August 30 and 31, 2011, OHA asked EI participants to complete a short survey on their pesticide use at home and place of work (see Appendix D for survey questions). Most EI participants were sent the survey via email and a few without internet access were contacted by phone. Forty-four (67%) of the 66 EI participants responded to the survey. Of the 44 respondents, 26 (59%) reported they did not use pesticides on their own land. Of the 18 who reported using pesticides on their land, a few respondents specified that they used Roundup® (active ingredient glyphosate), Weedmaster® (active ingredients 2,4-D and dicamba) or Crossbow® (active ingredients 2,4-D and triclopyr). Four (9%) survey respondents reported using pesticides at their place of work, and two of these four respondents had not used pesticides at work for the past several months. In the week prior to having their urine collected by ATSDR, none of the 44 survey respondents reported using pesticides at home or at work.

Comparison to Application Record data

OHA reviewed the available 2011 pesticide application data provided by ODF and ODA to determine if any commercial, public or private pesticide applications occurred during the fall 2011 urine or environmental sample collections.[12] The only reported commercial applications using 2,4-D or atrazine occurred in April, May, and early June, approximately three months prior to the urine testing (see Appendix B). Just prior to urine sample collection there were two aerial pesticide applications in the investigation area (August 28 and 29), however neither of these applications included 2,4-D or atrazine as active ingredients and would not have influenced urine sampling results. Two ground-based applications occurred during the urine sample collection (August 30th and 31st) and were as close as 0.3 miles to a participating household. The first application occurred on August 30 and used glyphosate, sulfometuron methyl, metsulfuron methyl, and imazapyr. The second application was a hack and squirt application on August 31 that used imazapyr. Neither of these applications used 2,4-D or atrazine (the chemicals that were tested in urine).

There were 13 reported pesticide applications on the days EPA and DEQ collected environmental samples (September 19-22). Eight applications occurred on September 20th, six of which were aerial applications on forestland. The eight applications on September 20th used the pesticides glyphosate, sulfometuron methyl, metsulfuron methyl, and imazapyr. One of these six aerial applications was as close as 1.1 miles from a participating household; the water, soil and vegetable samples collected from this household on September 22nd did not have pesticide detections. There were three applications of imazapyr on September 21st, one application of imazapyr on September 22nd, and one application of aminopyralid on September 22nd. The applications on September 21st and September 22nd were ground-based and located more than three miles from participating households.

Integration of Fall 2011 Data

Seven individual participants (in six households) who provided urine samples had pesticides detected in either their soil or drinking water (see Table 5). Two of these environmental samples had detections of 2,4-D, which was the only pesticide found in urine. The number of detections in environmental samples

[12] OHA obtained records of pesticide applications in the investigation area from 2009 – 2011, but only evaluated records from 2011 for this report. See Appendix A for additional information on 2011 application record data.

is too small to determine if there is a correlation between the 2,4-D levels measured in soil and the 2,4-D levels measured in urine.

The EI team cannot determine the sources of the pesticides detected in the fall 2011 drinking water or soil samples. In the survey administered by OHA shortly after the urine sample collection, all but one of the seven households with environmental sample detections reported using some kind of herbicide on their own property on a somewhat regular basis. Where specific products were named, Roundup® (active ingredient glyphosate) and Crossbow® (active ingredients 2,4-D and triclopyr) were the two most frequently used. However, none of the participants in these households reported using any pesticide products in the week prior to the urine sample collection. Further, application records indicate that none of the 13 known pesticide applications that occurred when EPA was collecting environmental samples contained the pesticides that were detected in drinking water (DEET, hexazinone, and fluridone). During the time the soil samples were collected, there were eight local pesticide applications that used glyphosate, which was detected in two households' soil samples. These applications were over three miles from these households, but some evidence suggests that under certain conditions some pesticides can travel long distances [28]–[35].

Table 5: Combined Urine and Environmental Data from Fall 2011 sampling.

Household	Participant	Urine 2,4-D (µg/g-creatinine)	Drinking Water (ppm)	Soil (ppm)
Household 1	Participant A	0.29	DEET: 0.0000047	Non-Detect
Household 2	Participant B	0.61	Hexazinone: 0.000183	Non-Detect
Household 3	Participant C	0.24	Fluridone: 0.000031	Non-Detect
Household 4	Participant D	37.3	Non-Detect	Glyphosate: 0.081 2,4-D: 0.046
	Participant E	0.94		
Household 5	Participant F	0.38	Non-Detect	2,4-D: 0.014
Household 6	Participant G	1.12	Non-Detect	Glyphosate: 3.3

µg/g = micrograms per gram; ppm = parts per million; 2,4-D = 2,4-dichlorophenoxy acetic acid; DEET = *N,N*-Diethyl-3-methylbenzamide

Uncertainties/Limitations

All scientific processes involve some uncertainties. This section discusses some of the uncertainties and limitations related to the fall 2011 sampling and results.

- All samples collected in fall 2011 (urine, water, soil, and food) represent snapshots in time, during a period when no known applications of 2,4-D or atrazine had occurred in several months. This is especially true for urine results since 2,4-D and atrazine are cleared rapidly from the body [31], [36], [37]. As such, any conclusions about exposure and health risks based on urine results only apply to the times these samples were collected.

- The results of fall 2011 sampling do not tell us whether EI participants had past chronic, acute, or repeated acute exposures to 2,4-D or atrazine. Chemical exposures are typically more harmful the longer they last. An ongoing (chronic) exposure may be more concerning than a short-term (acute) exposure even if the short-term exposure is more intense (i.e., greater amount of a chemical enters the body).
- We do not know if participants' urine contained other pesticides at the time of sample collection since we were only able to test for 2,4-D and atrazine metabolites in urine.
- Currently, there is little scientific information about the health implications of exposure to multiple chemicals at low doses.

Summary of Fall 2011 sampling

- At the end of August 2011, 59 (92%) of the 64 EI participants over six years of age had detectable levels of 2,4-D in urine.
- Statistical tests on urinary 2,4-D levels indicated that the range of levels was consistent with the general population at the time of sampling. Statistical comparisons at the 75th percentile were marginally significant (p-value=0.06); this indicates that there may be slightly more EI participants than expected in the upper quartile of the expected range.
- Three drinking water samples, one surface water sample, and three soil samples had detectable levels of pesticides (see Table 5).
- The levels of pesticides measured in urine, drinking water, surface water, and soil samples in fall 2011 are not expected to cause harmful health effects.
- There are insufficient data to determine if there is a statistically significant correlation between environmental sampling results and urine sampling results.
- All but one of the participants with pesticides detected in their environmental samples reported occasional or regular home use of herbicides, including those containing glyphosate and 2,4-D.
- None of the participants (including those with pesticides detected in their environmental samples) reported pesticide use in the week prior to urine sample collection.
- None of the known commercial pesticide applications that occurred during the fall 2011 urine sample collection used 2,4-D or atrazine.
- Eight of the 13 known commercial, public, or private pesticide applications that occurred during the fall 2011 environmental sample collection used glyphosate, which was detected in two households' soil samples. However, the applications occurred over three miles away from these households.
- Some evidence suggests that under certain circumstances, pesticides may travel long distances; therefore, it is unclear whether 2,4-D and glyphosate detections in participants' soil samples can be linked to known commercial, public, or private pesticide applications.

Spring 2012 Sampling/Investigation Suspension

In the original investigation plan, urine and air samples were to be collected in spring 2012 to evaluate the only medium (ambient air) not tested in fall 2011. The spring 2012 data would have been used to determine if aerial pesticide applications resulted in measureable levels of pesticides in air and in the urine of residents in the investigation area. OHA and ATSDR planned to collect urine from local residents prior to and immediately following aerial applications of 2,4-D and/or atrazine. EPA and DEQ planned to collect air samples during application events and test these samples for a wider range of pesticides.

The EI team suspended spring sampling on March 8, 2012 because the areas that were slated for spring applications of 2,4-D and/or atrazine were in remote locations that have very few residents. In spite of significant effort, OHA was unable to recruit enough participants for pre/post-application urine sampling. Further, EPA and DEQ were not ready to conduct air monitoring at the time. After suspending the investigation, the EI team reassessed progress on answering the investigation questions, and considered options to fill the remaining data gaps. OHA decided not to pursue additional biosampling because of the technical and logistical challenges involved in a pre/post-application sampling design. These challenges include the limited number of pesticides able to be measured in urine; lack of appropriate comparison data for most pesticides in urine; the relatively short half-lives of 2,4-D and atrazine in urine; and difficulty in obtaining information about the exact timing of planned pesticide applications. EPA is developing a sampling method to passively monitor air for pesticides of interest. However, it is unlikely that air monitoring will occur until late 2014.

Community-Collected Data

ATSDR allows for the inclusion of community-collected data in EIs and provides guidelines for evaluating the quality of these data [6]. According to ATSDR guidelines, data should be weighted based on impartial data quality criteria and not on the credentials or background of the entity that provided or collected the data [6].

In early spring 2012, while OHA was trying to recruit participants for the pre- and post-spray urine sampling, some community members indicated their willingness to share the community-collected urine sample data collected in spring 2011. They also offered to share environmental data (water and air) they had collected at their own expense in the investigation area. The community members requested the EI team evaluate their data for inclusion in the EI. The EI team agreed to evaluate community-collected urine and environmental data for chain of custody, quality control, and their potential implications for exposure and human health.

Community members and the private consultants and laboratories they employed supplied OHA, DEQ, and EPA with all the documentation needed to evaluate the quality of the community-collected data. OHA, DEQ, and EPA reviewed this documentation and agree that the data are of sufficient quality to be analyzed and presented in this PHA (with the exceptions noted in the sections below). Details of our data quality evaluation process are presented in the sections below.

Community-Collected Urine Data

Community members in the Highway 36 Corridor collected urine samples in spring 2011 as part of their own assessment, independent of government agency oversight. Community organizers recruited 43 individuals to participate and organized the collection of 62 urine samples from these participants between February 8 and June 1, 2011. A research professor at Emory University in Atlanta, Georgia tested the urine samples received by her laboratory for evidence of recent pesticide exposures.

In May and June 2012, OHA obtained written informed consent from 29 participants who live in the investigation area to use their spring 2011 urine results for this PHA. OHA obtained these 29 participants' results directly from the Emory University researcher.

Residents' decision to collect samples

OHA contacted the 29 consenting individuals in the investigation area to learn more about the sequence of events that occurred around the time of the spring 2011 urine collection. We asked them to describe what prompted them to collect urine samples at various times between February and June 2011. About half the participants collected samples in February 2011 with the intention of having their urine tested before aerial pesticide applications began for the spring season. Participants used ODF's Notification of Operation system to determine when the spring application season would begin. As one participant stated, "We didn't just assume that there had been no spray. We had no notifications, and it was very much the end of the "no-spray" season. There is a good network of people out here with notifications; nothing had been scheduled for months." Other participants provided their first samples in March and April 2011.

Beginning April 9, 2011, community members started collecting second urine samples in order to capture what they believed were "post-spray" conditions. Over the course of the spring 2011 spray season, ten of the 29 consenting participants collected a second sample that was ultimately used in the EI (See next section for details). The participants' reasons for collecting a second sample vary, but several participants reported collecting a second sample after:

- hearing, seeing, and/or filming an aerial spraying;
- receiving notification by email that a spray was occurring nearby; or
- feeling unwell or reportedly experiencing symptoms they attributed to nearby spraying.

One participant stated, "We were trying to figure out when to go for the 2nd test. But tracking sprays is impossible to do because there is too broad a scope of time between when you get notified and when they spray, so we just started getting sick one day at the same time, and went in to get tested after realizing we couldn't track it."

In May and June 2011, more participants began providing initial urine samples because they either witnessed an aerial spray or experienced symptoms they attributed to nearby spraying.

Community urine sample collection, shipment, and laboratory analysis[13]

The 29 consenting participants within the investigation area provided 46 samples for the community urine collection. OHA verified that all 46 samples (100%) had a complete chain of custody from the time the residents had their urine collected at a PeaceHealth facility in Eugene, Oregon to the time PeaceHealth shipped the samples to Emory University (Table 6). OHA confirmed that Emory's Central Shipping and Receiving (CS&R) facility received 33 of the 46 samples (72%), and that the researcher's laboratory received 26 samples (57%). OHA was unable to verify a receipt date for 13 samples at either Emory CS&R or the lab. OHA also found that seven samples received by the lab were apparently not

[13] See Appendix D for detailed information on residents' sample collection, shipment, and laboratory analysis.

tested. In all, the researcher analyzed 39 of the 46 samples for 2,4-D and atrazine metabolites and provided these results to OHA. These 39 samples still represented all 29 individual participants, ten of whom provided samples at two different times. Urine samples were kept frozen throughout transport and in storage until the time of analysis. The researcher used CDC method 6107.01 [38] to analyze urine samples for atrazine metabolites and CDC method 6103.01 [39]to test urine samples for 2,4-D. No field blanks were included with the community-collected samples.

Table 6: Chain of custody for 46 community-collected urine samples.

Number of Samples with Confirmed Collection Documentation at Peace Health	Number of Samples with Confirmed Transport Date by PeaceHealth Courier	Number of Samples with Confirmed Shipment Date from PeaceHealth to Emory	Number of Samples with Confirmed Receipt Date at Emory	Number of Samples with Confirmed Receipt Date at Lab	Number of Samples with 2,4-D/ Atrazine results from Lab
46	46	46	33	26	39
2,4-D = 2,4-dichlorophenoxy acetic acid					

OHA analysis of community-collected urine results

The researcher tested the 39 community-collected urine samples for 2,4-D and three metabolites of atrazine: diaminochlorotriazine (DACT), desethyl atrazine (DEA), and di-dealkylated atrazine mercapturate (DAAM). For ease of analysis and interpretation, we present atrazine results as atrazine equivalents. OHA was not able to adjust the urinary 2,4-D and atrazine results for creatinine because the 39 samples were not tested for creatinine. Results are presented as straight urine concentrations in micrograms per liter (µg/L). Table 7 shows basic descriptive statistics for the 39 community-collected samples.[14]

Table 7: Summary urine results (µg/L) from spring 2011 community-collected samples (N = 39).

Contaminant	Mean* (Range)	25th Percentile	50th Percentile	75th Percentile	95th Percentile
2,4-D	4.9 (0.7-31.7)	2.2	5.0	11.7	25.6
Atrazine equivalents†	5.0 (0.6-62.1)	2.4	4.8	11.4	29.8
*Mean is geometric mean; †Atrazine equivalents reflect the sum of measurements of the metabolites diaminochlorotriazine (DACT), desethyl atrazine (DEA), di-dealkylated-atrazine mercapturate (DAAM) 2,4-D = 2,4-dichlorophenoxy acetic acid					

All 39 samples had detectable levels of 2,4-D and atrazine metabolites. OHA compared the spring 2011 community-collected urine samples to the fall 2011 samples collected by ATSDR (Table 8) using a

[14]OHA used geometric means instead of arithmetic means in order to compare the EI data to NHANES data (which are reported as geometric means). Arithmetic means are calculated by adding up all the results and dividing the result by the number of results (n). Geometric mean is calculated by multiplying all the results and then taking nth root of the product.

statistical test called the Mann-Whitney U Test. For 2,4-D, the geometric mean in spring 2011 samples was significantly higher than the geometric mean in fall 2011 samples. Atrazine metabolites were found in all of the spring 2011 samples, while none were found in fall 2011 samples.

Table 8: Comparison of spring 2011 community-collected samples to fall 2011 ATSDR samples.

Contaminant	Spring 2011 Mean* (µg/L) (N=39)	Fall 2011 Mean* (µg/L) (N=64)	Mann-Whitney U Test (P Value)
2,4-D	4.9	0.37	<0.0001
Atrazine equivalents	5.0	None detected	-
*Geometric mean; µg/L = micrograms per liter; 2,4-D = 2,4-dichlorophenoxy acetic acid			

OHA determined that 20 of the 39 community-collected samples had the necessary documentation to establish a complete chain of custody from the time the samples were collected at PeaceHealth to the time they were delivered to Emory University. The missing documentation for the other 19 samples consisted of the slips confirming receipt at either Emory University's CS&R or the Emory laboratory. However, there was complete documentation confirming that the samples were shipped from PeaceHealth's shipping facility, and the Emory lab had results for these samples. This indicates that these 19 samples were actually delivered to the laboratory at Emory.

OHA conducted an additional statistical analysis to verify that these 19 samples were not statistically different from the rest of the samples. The average levels of 2,4-D and atrazine metabolites in the 19 samples without complete chain of custody were not statistically different from the average levels in the 20 samples with complete chain of custody (Table 9). Therefore, OHA accepted all 39 samples as valid test results, and all 39 were included in the analyses and conclusions presented.

Table 9: Comparison of urinary 2,4-D and atrazine levels by chain of custody, spring 2011.

Chemical	Incomplete custody sample mean* (N = 19)	Complete custody sample mean* (N = 20)	Wilcoxon two-sample P-value
2,4-D (µg/L)	6.2	3.9	0.1477
Atrazine Equivalents (µg/L)	6.6	3.8	0.1363
*Geometric mean; µg/L = micrograms per liter; N = number; 2,4-D = 2,4-dichlorophenoxy acetic acid			

Comparison to Application Record Data

After obtaining the community-collected urine data and the pesticide application records, OHA was able to identify the urine samples that were collected before and after known applications of 2,4-D and/or atrazine. Of the 39 community-collected samples, 13 were collected prior to any reported commercial applications of 2,4-D or atrazine. Of the remaining 26 samples, nine were collected within 24 hours of an application of 2,4-D or atrazine[15] and 17 were collected between 3 and 22 days after an application of 2,4-D or atrazine. The 24-hour time frame is significant because 2,4-D and atrazine are rapidly cleared from urine, so samples are most representative of exposures that occurred within the most recent 24-48 hours [31], [36], [37]. OHA reclassified the samples (independent from the classifications assigned by community members who provided the samples) as being either "pre-application" (N = 13) or "post-application" (N = 26). The subset of the post-application samples collected within 24 hours of a known application were classified as the "24-hour subset" (N = 9).

As previously mentioned, the 39 samples were provided by 29 participants; 10 participants provided two samples each. For each of these 10 participants, their first sample fell into the pre-application sample group, and their second sample fell into the post-application sample group. Therefore, no single participant had more than one sample in either the pre-application (N=13) or post-application (N = 26) sample groups.

For the ten participants with both pre- and post-application samples available, OHA was able to compare urinary 2,4-D and atrazine metabolite concentrations in pre- and post-application samples from the same participants (also known as a "matched pairs analysis"). This comparison was done using a statistical test called the Wilcoxon signed rank test. This test found no statistically significant difference between pre- and post-application urine samples for either 2,4-D ($p = 0.5$) or atrazine metabolites ($p = 0.11$). Out of the ten participants for whom OHA was able to compare pre- and post-application samples, seven collected their second sample within 24-hours of an application. Thus, these second samples were part of the 24-hour subset (N=9). The other three participants with available pre- and post-application samples collected their second samples 3-8 days after the most recent known pesticide application in the area. OHA did another matched pairs analysis of pre- and post-application samples including only those seven participants whose post-application sample was part of the 24-hour subset, using the same statistical test. This test also found no statistically significant difference between pre- and post-application urine samples for either 2,4-D ($p = 0.5$) or atrazine metabolites ($p = 0.3$).

OHA compared the average 2,4-D and atrazine metabolite concentrations of the 13 pre-application samples to the levels found in the 26 post-application samples (Table 10). There was no statistical difference between the two groups. This indicates a source of 2,4-D and atrazine exposure to participants that is not explained by any of the available application records.

[15] In 2011, there were 16 commercial pesticide applications that included the use of 2,4-D or atrazine. Thirteen of these applications occurred in April 2011 and three occurred in May 2011.

Table 10: Comparison of pre-application and post-application levels of 2,4-D and atrazine in urine, spring 2011.

Chemical	Pre-application sample mean* (N = 13)	Post application sample mean* (N = 26)	Exact Wilcoxon two-sample P-value
2,4-D (µg/L)	5.4	4.7	0.63
Atrazine Equivalent (µg/L)	5.3	4.8	0.72
*Geometric mean; µg/L = micrograms per liter; N = number; 2,4-D = 2,4-dichlorophenoxy acetic acid			

OHA also compared the average 2,4-D and atrazine metabolite concentrations of the nine 24-hour subset samples against those of the other 30 spring 2011 samples (Table 11). The levels of 2,4-D were statistically similar between the two groups. However, the levels of atrazine metabolites were significantly higher in the nine 24-hour subset samples.

Table 11. Comparison of urinary 2,4-D and atrazine metabolite levels between 24-hour subset and all other samples, in spring 2011.

Chemical	All samples not within 24 hours of application mean* (N = 30)	24-hour subset sample mean* (N = 9)	Exact Wilcoxon two-sample P-value
2,4-D (µg/L)	4.4	7.2	0.2312
Atrazine Equivalent (µg/L)	4.0	10.0	0.0450**
*Geometric mean; µg/L = micrograms per liter; N = number; 2,4-D = 2,4-dichlorophenoxy acetic acid ****Indicates a statistically significant finding (p < 0.05)**			

The higher levels of atrazine found in the 24-hour subset samples suggest that these samples were collected at a time when there were relatively higher levels of atrazine exposure among participating community members. Four known applications (three on one day and one on another) of atrazine were associated with the nine 24-hour subset samples. All four applications were aerial and co-applied with 2,4-D. These four applications were located between 2 and 3.8 miles from the homes of participants who provided these samples with the average distance being 2.65 miles.

There were no environmental monitoring data associated with these four applications, which could have provided confirmatory site-specific information about the movement of atrazine from the application site to participants' homes. There is evidence from other studies that suggest aerially applied pesticides in general [29], [30], [32]–[35], and atrazine in particular [31], can travel long distances from the application site. Therefore, it is possible that local aerial atrazine applications contributed, alone or in part, to the relatively elevated levels of urinary atrazine metabolites detected in the nine 24-hour subset samples. However, it is also possible that the apparent increase reflects concurrent fluctuations in unknown sources of atrazine exposure in the environment.

2,4-D

NHANES tracks 2,4-D nationwide but it does not track the atrazine metabolites measured in the community-collected urine samples. Therefore, we were only able to compare the spring 2011 urine results to NHANES data for 2,4-D results. All of the samples (N=39) had 2,4-D concentrations greater than the 2003-2004 NHANES 75th percentile (0.58 µg/L). Eighty-five percent (84.6%) of all spring 2011 samples (N = 39) had 2,4-D concentrations higher than the NHANES 95th percentile (1.63 µg/L). All of these differences were statistically significant (Table 12). This means that at the time the samples were collected, the 2,4-D levels in participants' urine were statistically higher than the levels found in the general U.S. population.

Table 12: Comparison of 2,4-D levels in community-collected urine samples (N = 39) to 2003-2004 NHANES* data.

	Values above NHANES 75th percentile (0.58 µg/L)		One Sample Binomial Test	Values above NHANES 95th percentile (1.63 µg/L)		One Sample Binomial Test
Samples	Number	Percent	Two-sided Exact p-value	Number	Percent	Two-sided Exact p-value
Total (N = 39)	39	100	<0.0001	33	84.6	0.025
µg/L = micrograms per liter; NHANES = National Health and Nutrition Examination Survey; N = number						

We also compared the community-collected spring 2011 urine results to published studies measuring urinary 2,4-D levels in pesticide applicators. The community-collected results were most similar to two studies of 2,4-D exposures among farm applicators [40], [41] that found average pre-application 2,4-D levels of 7.8 and 3.8 µg/L, respectively.

To assess the potential health risks from the levels of exposure seen in community-collected urine samples, we compared the spring 2011 urine results to the biomonitoring equivalent (BE)[16] for 2,4-D. The BE was six times higher than the highest urinary 2,4-D concentration measured in spring 2011 samples (31.7 µg/L). OHA does not expect that the levels of 2,4-D exposures seen among participants in the spring 2011 urine assessment were high enough to pose risks to public health. Current scientific evidence indicates that none of the 2,4-D levels measured in Highway 36 Corridor residents in spring and fall 2011 indicate exposures that are expected to cause adverse health effects.

[16] See Fall 2011 Urine results for additional information on the 2,4-D biomonitoring equivalent.

Atrazine

In the case of atrazine, there are no national reference values against which to compare the spring 2011 urine results. Therefore, OHA searched peer-reviewed literature for smaller studies where the same atrazine metabolites were measured in human urine. Table 13 summarizes these studies. The levels of atrazine metabolites measured in spring 2011 urine samples were in the higher range of those found in pregnant women in France [42], lower than those found in turf applicators, and in the range of those measured in non-occupationally exposed individuals [43]. In fall 2011, no atrazine or atrazine metabolites were detected in any of the participants, indicating that atrazine exposures were higher in spring than in fall.

Table 13: Atrazine metabolite equivalents measured in peer reviewed literature.

Study	Population	Median atrazine equivalents (µg/L)	Metabolites measured	Range (µg/L)
French women's study [42]	Pregnant women in Brittany region of France (N = 579)	1.2$^{\pm}$	DEA, DACT, DIA, atrazine mercapturate	ND – 17.1
Barr study [43]	Individuals with occupational* exposures (N = 8)	Not reported	DEA, DIA, DACT, DAAM, ATZ, ATZ-OH, DEA-OH	100-510
	Individuals with non-occupational exposures (N = 5)	Not reported		10-235

µg/L = micrograms per liter, DEA = Desethyl atrazine, DIA = desisopropyl atrazine, DACT = Diaminochlorotriazine, DAAM = Didealkylated atrazine mercapturate, ATZ = atrazine, ATZ-OH = hydroxy atrazine, DEA-OH = hydroxy desethyl atrazine, N = number, ND = non-detect
$^{\pm}$ Median among detected values; *Commercial lawn care applicators

Unlike 2,4-D, there are no published BEs for atrazine metabolites, so it is not possible to compare these results against toxicity-based threshold values. Therefore, it is not possible at this time to determine if the levels of atrazine metabolites found in the spring 2011 urine samples could be associated with adverse health effects.

Uncertainties/Limitations

- The spring 2011 community urine samples were collected as part of an independent assessment. Aside from the application records provided by regulated pesticide applicators in the area, we do not have information on other potential sources of exposure that could explain the higher than expected levels of 2,4-D and atrazine metabolites found in these participants' urine samples.
- Contaminant levels in urine are influenced by the hydration status and kidney function of the person who provided the sample. In many studies, these factors are controlled by measuring the amount of creatinine (a urinary by-product of protein metabolism that is filtered by the kidney at a known and predictable rate) and relating contaminant levels to the amount of creatinine. Urinary creatinine levels can vary greatly from person to person, depending on the individual's age, sex, body mass, and other factors [22]. Because the spring 2011 urine samples were not tested for creatinine, we were not able to control for the variables of hydration status or kidney function in our analyses.

Summary of community-collected urine data

- All 39 samples from 29 participants in the community urine collection had detectable levels of 2,4-D and atrazine metabolites.
- The levels of 2,4-D measured in the urine of 39 Highway 36 Corridor residents in spring 2011 were statistically higher than those found in the general U.S. population and statistically higher than the levels measured in Highway 36 Corridor residents in fall 2011. The levels of atrazine metabolites measured in spring 2011 were higher than the levels found in fall 2011.
- For the ten participants with both pre- and post-application samples available, OHA found no statistically significant difference between pre- and post-application urine samples for either 2,4-D or atrazine metabolites.
- OHA compared the average 2,4-D and atrazine metabolite concentrations of the 13 pre-application samples to the levels found in the 26 post-application samples. There was no statistical difference between the two groups.
- Higher than expected 2,4-D and atrazine metabolite levels in urine samples collected both before and after the start of known pesticide applications in the area indicate that there is an unknown source of these pesticides that is not accounted for in the application records available to OHA. It is possible that these results were influenced by environmental conditions, which fluctuate seasonally.
- The urinary levels of 2,4-D measured in spring 2011 were several times lower than the BE for 2,4-D (200 µg/L), and do not indicate a public health risk.
- We cannot determine if the levels of atrazine metabolites measured in spring 2011 pose health risks because there is no toxicity-based threshold for atrazine concentrations in urine.
- The levels of atrazine metabolites in community-collected urine samples were significantly higher in samples collected within a day of a known application of atrazine compared to samples that were not collected within a day of a known application. While the local applications of 2,4-D and atrazine may have contributed, in full or in part, to these increased concentrations, there is no concurrent environmental sampling data on atrazine's persistence or distance traveled from the application site to confirm that this is the case. There is conflicting evidence regarding whether the distance of two miles from the point of application to the participants' homes is sufficiently protective; in addition, we do not know if there were concurrent fluctuations in the unknown sources of atrazine exposure in the environment.

Community-Collected Environmental Data

Water (POCIS) Data

Some members of the community, called the Siuslaw Watershed Guardians (SWG), conducted surface water sampling within the investigation area, in the spring and summer months of 2011, independently and at their own expense. This section describes their work and results.

Methods

The SWG used Polar Organic Chemical Integrative Samplers (POCIS), which are designed to absorb organic chemicals that have dissolved in water. POCIS samplers are typically positioned in a stream and left for up to 28 days. Because of the long deployment time and continuous sampling, POCIS allows for measurement of very low concentrations of chemicals, in fact much lower than could be detected using traditional water sampling methods. However, results from POCIS samplers cannot be used to evaluate human exposure. This is because it is impossible to obtain the two pieces of information needed to calculate the concentration of a contaminant in water: the volume of water sampled by the POCIS (i.e. liters per day) and the associated uptake rate of the chemical (i.e., micrograms or milligrams of a contaminant). Therefore, POCIS results are mainly qualitative in nature and are reported as an amount of chemical per individual POCIS sampler (e.g., nanograms per POCIS or ng/POCIS) [44]. In other words, we can describe the presence and amount of a chemical found in the POCIS sampler, but not the exact concentration in the water. POCIS data are often used to compare relative amounts of contaminants at one time or location with another time or similar location. For example, POCIS data can be used to compare contaminant levels in two tributaries or to monitor seasonal variations in contaminant levels in a particular stream.

The SWG deployed POCIS samplers at five locations shown in Table 14. Most samplers were deployed from April to May of 2011, but one was deployed from June to July of 2011. Duplicate samples were collected at two sample locations: Fish Creek (near the mouth) and Nelson Creek (downstream from Almaisie Creek). The SWG POCIS samplers were analyzed by Anatek labs in Moscow, Idaho for seven analytes: 2,4-D, atrazine, desethyl atrazine, desisopropyl atrazine, hexazinone, trichloropyridinol, and triclopyr. Desethyl atrazine and desisopropyl atrazine are breakdown products of atrazine.

With the permission of the community, Anatek Labs sent data and data quality assurance/control reports to DEQ for independent review. DEQ reviewed the raw lab data and Anatek' s quality assurance/control procedures. DEQ also compared the SWG sampling results to POCIS data collected by DEQ in other parts of the state. DEQ found that the SWG used valid sampling methods and that the analysis performed by Anatek Labs was appropriate and valid for the purposes of the study. DEQ provided OHA with a summary of their findings.

Results

The SWG POCIS samples contained atrazine, hexazinone, and desethyl atrazine (Table 14). Two of these contaminants, atrazine and hexazinone, are typically found by DEQ in waters throughout the state. However, streams where DEQ tends to find atrazine and hexazinone are larger than the ones tested by the SWG and tend to drain lands with more uses, including agriculture. The only documented pesticide applications upstream of the POCIS samplers were forestry related. Desethyl atrazine is not measured in DEQ's statewide Toxics Monitoring Program; therefore, we do not know if the presence of this chemical in SWG's samplers is unusual. DEQ frequently detects 2,4-D and triclopyr as part of its statewide POCIS monitoring, but neither of these chemicals were detected in the SWG samplers. Because these POCIS sampling results cannot be expressed as concentrations in water, OHA was not able to further evaluate these data by comparing them to health-based CVs for contaminants in water.

Uncertainties

There was no information about stream flow rate provided, and this creates some uncertainty in comparing results from one stream or location with another.

Table 14: Community POCIS data for surface water.

			Analytes (ng/POCIS)						
Sample Location	Deployment Dates	Lab Analysis Date	2,4-D	Atrazine	Desethyl Atrazine	Desisopropyl Atrazine	Hexazinone	Trichloropyridinol	Triclopyr
Fish Creek Near Mouth	4/17/2011-5/15/2011	9/8/2011	ND	52.3	15.9	ND	64	ND	ND
Fish Creek Near Mouth (Duplicate)	4/17/2011 - 5/15/2011	5/15/2012	NR	93	26.7	NR	81	NR	NR
Lake Creek Upstream of Fish Creek	4/17/2011 - 5/15/2011	9/8/2011	ND	15.8	0.9	ND	9.3	ND	ND
Congdon Creek a quarter mile from mouth	4/23/2011 - 5/21/2011	9/8/2011	ND	1.9	ND	ND	3.6	ND	ND
Unnamed drainage to Congdon Creek	4/23/2011-5/21/2011	9/8/2011	ND	ND	ND	ND	ND	ND	ND
Nelson Creek downstream of Almaisie Creek	6/3/2011 - 7/3/2011	9/8/2011	ND	ND	ND	ND	13.6	ND	ND
Nelson Creek downstream of Almaisie Creek (duplicate)	6/3/2011-7/3/2011	5/15/2012	NR	ND	ND	NR	16.8	NR	NR
ng = nanograms; POCIS = Polar Organic Chemical Integrative Samplers; ND = Not detected; NR= Not reported; 2,4-D = 2,4-dichlorophenoxy acetic acid									

Air Data

Highway 36 community members also conducted air sampling within the investigation area and submitted the results to OHA for review and inclusion in this PHA (Table 15).

Methods

Community members provided data on 16 air samples in the investigation area. Eleven samples were collected in October 2011, one sample was collected in March 2012, and four samples were collected in May 2012. Community members collected samples around Fish Creek, Triangle Lake, and private residences in the valleys below private timberlands. The 11 October samples and one March sample were intended as baseline data, meaning that no known pesticide applications were occurring when the samples were collected. The May 2012 samples were collected during and immediately following a pesticide application on nearby forestland.

Samples were collected using Tisch Environmental, Inc. Te-PUF Polyurethane foam high volume active air samplers according to the manufacturer's instructions.[17] Field blanks accompanied and were analyzed along with each of the samples. Each sample was collected over approximately 12 hours resulting in total collected air volumes ranging from 77 – 147 m^3. The samples were sent directly to Anatek Labs in Moscow, Idaho for analysis. Anatek labs analyzed each sample for 27 chemicals: clopyralid; 2,4,5-trichlorophenoxyacetic acid (2,4,5-T); 2-(2,4,5-Trichlorophenoxy)propionic acid (2,4,5-TP or Silvex); 2,4-dichlorophenoxy acetic acid (2,4-D); 4-(2,4-dichlorophenoxy)butyric acid (2,4-DB); dacthal; dalapon; dicamba; dichloroprop; dinoseb; 2-methyl-4-chlorophenoxyacetic acid (MCPA); picloram; atrazine; chlorsulfuron; desethyl atrazine; halosulfuron; hexazinone; imazapyr; imazosulfuron; iodosulfuron; metsulfuron methyl; nicosulfuron; prosulfuron; rimsulfuron; sulfometuron methyl; triasulfuron; and tiflusulfuron methyl.

Results

Most of the air samples were non-detect for all 27 chemicals tested. Six of the 11 samples collected in October tested positive for 2,4-D. The field blanks associated with four of these six samples also tested positive and contained similar amounts of 2,4-D. This indicates that these four samples were likely contaminated and must be classified as non-detects. One of these field blanks also tested positive for picloram, but picloram was not detected in the main sample. Because of these contamination issues, OHA and DEQ do not consider the October air sample results to be valid.

One of the four samples collected in May, which was collected during an observed pesticide application to nearby forestland, had a positive detection of clopyralid at 0.37 ng/m^3. This appears to be a valid result, as the field blank was clean. OHA does not currently have access to the pesticide application records that correlate to the observed application. However, clopyralid was one of the pesticides listed on the notification record associated with that harvest unit.

[17] This type of active sampling is different from the passive air sampling methods that EPA is working to develop. Active sampling requires a power source and tight coordination with pesticide applicators to know exactly when to start the 12-hour sample collection window. Passive sampling would not require a power source or this type of coordination.

There is no established health-based screening level for clopyralid in air. However, there is a standard method for converting an oral reference dose (RfD) into a reference concentration (RfC) [45]. An RfC is an estimate of a continuous inhalation exposure concentration that is likely to be without risk of harmful effects during a lifetime of exposure. An RfC builds in safety margins that are intended to be protective of the most sensitive populations.

Appling this method to clopyralid's RfD (150 µg/kg-day) [46] yields an RfC of 525,000 ng/m^3. The level of clopyralid measured in the community-collected air sample (0.37 ng/m^3) is over a million times lower than the calculated RfC. This indicates that the level of clopyralid measured at this time and location is unlikely to pose a public health risk.

Table 15: Community-collected air data – valid detections.

Collection Date	Detections /Valid Samples	Analytes Detected	Maximum Analyte Concentration Detected (ng/m^3)	Health-based Screening Value (ng/m^3)	Source of screening value
May 2012	1/4	Clopyralid	0.37	525,000	Derived RfC*

ng/m^3 = nanograms per cubic meter; 2,4-D = 2,4-dichlorophenoxy acetic acid; RfC = Reference Concentration
*Derived from the U.S. Environmental Protection Agency's oral reference dose for clopyralid

Uncertainties

- Each of these samples was collected over an approximate 12-hour time period, and the results represent a snapshot in time. Therefore, it is unknown whether the results are typical for the locations or times sampled.
- The derived RfC for clopyralid is based on chronic or long-term exposure. It is not ideal to compare a 12-hour sample to a chronic RfC. However, no short-term or acute inhalation toxicity values for clopyralid are currently available. In general, short-term and acute toxicity values are higher than chronic toxicity values. Therefore, comparing a short-term sampling result to a chronic RfC is a conservative approach that is protective of health.
- The method for extrapolating an RfC from an oral RfD is not as precise or as valid as an RfC derived from actual inhalation toxicology studies. Some chemicals have different toxicities and endpoints depending on the route of exposure (i.e., inhalation vs. ingestion). The calculated RfC does not account for inhalation-specific toxic effects. Chemicals may come into contact with different organs when inhaled as opposed to ingested. This can lead to differential toxicity based on the sensitivity of the organ that comes into contact with the chemical. Therefore, this calculated RfC might be more or less protective than a traditionally derived RfC. However, clopyralid would have to be over a million times more toxic via the inhalation route than the ingestion route for the measured concentration to pose a public health risk. While many chemicals are more toxic via the inhalation pathway than the ingestion pathway, it is unusual for the difference in toxicity to be as great as a million fold.

Evaluation of Health Outcome Data

ATSDR requires its cooperative agreement partners to consider if health outcome (i.e., mortality and morbidity) data (HOD) should be evaluated in a PHA [6]. The main requirements for evaluating HOD are: the presence of a completed human exposure pathway; a known time period of exposure; a quantified population that was (or is being) exposed; sufficient contaminant levels and time to result in health effects; and the availability of systematically collected HOD for the health outcomes associated with chemicals in the pathway [6].

The Highway 36 Corridor investigation does not meet the requirements for including an evaluation of HOD as part of this assessment. There are two main reasons we did not evaluate HOD. First, we do not know how many people have been (or are being) exposed to pesticides in the Highway 36 investigation area. Second, there has been no systematic measurement HODs related to pesticide exposure. Further:

- The environmental data collected in fall 2011 indicate that people were not being exposed to pesticides in drinking water, soil, or homegrown foods at levels that could harm human health.
- The levels of 2,4-D measured in community members' urine in spring and fall 2011 were below levels of health concern.
- For community residents who had atrazine detected in their urine in spring 2011, we do not know if they were exposed at levels that could result in health effects and if enough time has passed for these health effects to develop. We also do not know which effects to look for because there is limited scientific evidence on the health effects associated with atrazine exposure. Atrazine is a known endocrine disrupter that has been associated with hormonal and reproductive effects in animals and humans. However, there is currently not enough evidence to identify the specific effects associated with low-level exposures to atrazine in humans (See Appendix F).

Children's Health Considerations

OHA and ATSDR recognize that infants and children may be more vulnerable to exposures than adults in communities faced with contamination of their air, water, soil, or food. This vulnerability is a result of the following factors:

- Children are more likely to play outdoors and bring food into contaminated areas.
- Children are shorter, resulting in a greater likelihood to breathe dust, soil, and heavy vapors close to the ground.
- Children are smaller, resulting in higher doses of chemical exposure per body weight.
- The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages.
- Children are more likely to swallow or drink water during bathing or when playing in and around water.
- Children are more prone to mouthing objects and eating non-food items like toys and soil.

Because children depend on adults for risk identification and management decisions, ATSDR is committed to evaluating their special interests in the Highway 36 Corridor. In this PHA, children were identified as the most vulnerable to health problems caused by pesticides. OHA has designed conclusions and recommendations that, if followed, will protect children from these potentially dangerous chemical exposures.

Community Concerns

This section of the report describes Highway 36 community concerns related to forestland and agricultural pesticide applications, chemical exposures, and the EI. Understanding community health concerns related to a site or environmental contamination is an important component of the public health assessment process and ATSDR's overall mission. It is important to gather this information early and continuously through the investigation process [6]. ATSDR embraces the philosophy that community involvement requires earnest, respectful, and continued attention. Furthermore, ATSDR believes that one of the keys to the success of the public health assessment process lies in the ability to establish clear expectations, communicate effectively, and place the community at the center of its response [6]. A community's perspective provides a vital link to science by ensuring that our work is relevant.

The term "community" as used in this section of the report includes individuals who reside in the investigation area. However, because of the dynamic nature of social interactions individuals may belong to multiple communities at any one time. A person may be a member of a community by choice or by virtue of their innate personal characteristics, such as age, gender, race, or ethnicity [47]. Therefore, when initiating community engagement efforts, we make every effort to be aware of these complex associations [48], and be inclusive of all individuals who identify as being a member of a given community. This inclusiveness is important for understanding prevailing attitudes, beliefs, actions, and concerns that help to inform and improve our work.

For this section of the report, OHA evaluated qualitative data from several sources. In environmental public health, qualitative information helps public health practitioners understand the daily lives of people in the community in order to:

- learn about a community's history;
- focus on community priorities;
- understand how to best respond to community concerns;
- determine how people may be exposed to potential environmental contamination;
- identify the most effective ways to reduce potential exposures;
- communicate in relevant, inclusive, and equitable ways; and
- ensure the diversity of a community's perspective is represented [49].

Table 16 describes the sources of qualitative data we evaluated in this report. Because of the dynamic nature of social interactions and the lengthy history of both industrial chemical use and anti-pesticide activism in this area of the coastal mountains, we have included relevant information that may extend beyond the eight township-ranges that encompass the investigation area.

The community concerns section is not a sociological study, nor does it substitute for the report's conclusions. The purposes of this section are to:

- convey what we have learned is important to the community,
- understand the best ways to provide balanced and objective information, and

- assist with understanding the problems, alternatives, opportunities, and/or solutions.

OHA values, documents, and responds to community input as part of its public health assessment process. Listing or documenting a concern does not mean that we are verifying it as a fact, nor does it indicate our intent to address it with a specific recommendation. We also recognize that the information presented here is not an exhaustive list of concerns. Community members and the public will have an opportunity to review and comment on this section during the public comment period in order to ensure accurate representation.

Table 16: Qualitative data used in this Exposure Investigation.

Qualitative data sources	Types of data included	Usefulness
Participation	Meetings - internal & external, providing assistance, engaging in outreach, encouraging feedback, developing involvement approaches	Establishes relationships, builds rapport & promotes transparency with community; enhances ability to represent community's perspective in the investigation; uncovers assumptions
Observation	Visits and interactions with community, field notes, reflections, community meetings, filmed events, social media	Discovers the multiple communities within the investigation area & the complex set of community dynamics
Interviews, correspondences & conversations	Phone calls, visits to individual homes, conversations at community meetings, emails, correspondences and letters	Uncovers and describes community members' perspectives on events
Review of Documents	News stories, blogs, journal articles, agency documents, reports, community gathered qualitative data, editorials, speeches, pamphlets, newsletters, books, announcements	Documents experiences, values and beliefs of the community; useful in understanding and describing community dynamics; places EI into geographic and historical context
Videos, films & photographs	Community-submitted video, documentaries and photographs; YouTube videos documenting community meetings and gatherings; social media	Discovery; validation of community's experiences; provides information from non-replicable, unique events
Historical analysis	Oral testimonies, life histories, historical records, past events, contemporary records, legal records, statutes, public reports, advocacy group work, demonstrations, reports of eyewitnesses	Discovery; establishes a context for and enhances credibility of community concerns; re-examines questions & assumptions

Qualitative data sources	Types of data included	Usefulness
Questionnaires & surveys	Recruitment and pesticide use questionnaires, urine sample collection surveys	Provides direct answers to specific questions about community knowledge, actions, food sources, activities, time spent outdoors, occupation & hobbies

Analysis of qualitative data

OHA staff reviewed substantial amounts of information in the form of comments, questions, emails, phone calls, historical and legal documents, media articles, videotaped events, observations during public meetings, and other qualitative information sources. OHA grouped this information into four major categories, or themes, based on content analysis. These four themes are:

1. Past and current exposures to pesticides from local pesticide applications
2. Health concerns reported by community members that they attribute to local pesticide applications
3. Psychological, emotional, and social stress
4. Inadequate protection of public health

The following sections describe each of these themes in more detail.

1. Past and current exposures to pesticides from local pesticide applications

Community groups living in and around Oregon's coastal mountain range have raised concerns about the chemicals used in forestland management for several decades. While this EI is focused on chemicals used in both forest and agricultural practices, the predominant community concerns raised throughout the years by members of the community relate to the aerial spraying of pesticides. Historical and legal documents dating back to the 1960s have documented aerial applications of chemicals, including dioxin-contaminated 2,4,5-Trichlorophenoxyacetic acid (2,4,5-T) [50], on forestlands, pastures, and rights-of-way in the coastal mountains. In 1979, EPA issued an emergency order suspending the use of 2,4,5-T and Silvex after documenting high miscarriage rates among women living near Alsea in Oregon's coastal mountain range [51]. Some people who currently live in the investigation area were involved in these early efforts to stop aerial pesticide applications and continue to document their experiences. Some residents report being unaware of local pesticide application practices before moving into the area.

The investigation team heard many community members' concerns about their personal health, the health of their children, and the health of their animals and the environment. Some of these residents moved to the area intending to live and farm organically. They express frustration and anger about their inability to take action to protect their families and farms from alleged chemical drift. They also are angry that any amount of chemicals used in forestry practices were found in their urine. Some community members report moving to the area to retire, but have either left or are considering the option of moving away to avoid the seasonal sprays, which they find intolerable. Some parents are upset and angry that the pesticide imazapyr was detected in the local school's drinking well water after the land above the school was clear-cut and treated with pesticides, which included imazapyr. Families in the investigation area have reported postponing having children and others worry their children will suffer from future health effects.

There are residents who have spent a great deal of time and money in an effort to understand the area's unique geographic conditions and cool moist climate. These residents have surmised that pesticides applied to the steep slopes of the mountains are drifting down into the valleys where they live. They believe pesticide drift is threatening crops grown by farms and vineyards in the area. They assert that the area's climate, which is conducive to fog formation, causes pesticides to "re-volatilize" (or vaporize repeatedly from the soil to air). They contend that the re-volatilized chemicals travel down from the application sites to the valleys where most of the residents live.

While we have heard and documented these concerns, it is important to note that other community members report having no health concerns related to local pesticide application practices. These residents claim they have not experienced health effects from pesticide applications in spite of having lived and worked in the area for generations. Some residents report that they have never missed a day of work due to illness. Many of these community members are timber owners, farmers, and ranchers who use traditional methods of weed control, including the use of pesticides. One resident explained that if an aerial application were planned for an adjoining property, they would sometimes ask the applicator to fly over their property and spray a segment of their land.

This group of residents wants to continue having pesticides available as tools to control noxious, invasive, and unwanted vegetation. They see this controversy as a private-property rights issue. Many of these community members have stated they view anti-pesticide efforts as an invasion of their personal rights to manage their own land. Some of these residents have reported feeling harassed and intimidated by neighbors who are opposed to the use of chemicals. They are worried about possible legal action if they use chemicals on their own farms and timberlands, and have modified their land use decisions in response to these fears. These community members have said they hope the EI will lay the issue to rest, and are worried about ongoing conflicts with their neighbors and within their community.

The third and potentially largest segment of the community does not identify with either of the two positions taken by their fellow community members. Nonetheless, they are affected by the conflict generated by these opposing views. They have said they are interested in the findings of the EI and express support for efforts to learn if exposures may be occurring from local application practices. They also express concern about the ongoing conflict within their community.

2. Health concerns reported by community members that they attribute to local pesticide applications

Some area residents have reported and documented their own health issues and those of their friends, families, and neighbors. They assert that their illnesses and conditions correspond with the seasonal pesticide applications. In the absence of systematically collected health outcome data (i.e., from disease registries) these residents have reconstructed events on their own and have concluded that there are an unusual number of health problems in this area. The health issues reported by these residents include miscarriage, birth defects, congenital disorders in children, and rare cancers in teenagers and young adults.

Pesticide-related health conditions are difficult to diagnose because many of the known symptoms cannot be distinguished from other common illnesses. Most doctors are not trained to identify these conditions. It is very difficult to link environmental exposures of any kind to a specific health outcome in an individual, especially when there is a great deal of uncertainty about the nature of the exposure. In the Highway 36 community, there are uncertainties about whether and how people are being exposed to pesticides from local application practices, and the extent of any exposures. There also are uncertainties about the multiple chemicals used in pesticide applications and their singular and combined health effects, especially on developing babies, children, and the reproductive system.
Below is a list of human health effects attributed by community members to seasonal pesticide applications:

- miscarriages
- birth defects
- stillborn babies
- infertility
- endocrine disorders
- abnormal menstruation
- rare cancers in teenagers and young adults
- other more common types of cancer
- rashes, sores and other skin ailments
- cysts
- cardiovascular effects: tightness in the chest, difficulty breathing, heart arrhythmia, heart attacks, stroke
- weakness, muscle cramps and spasms, joint pain
- moodiness, depression, anxiety, fear, stress and aggression
- PTSD (Post-Traumatic Stress Disorder) and ongoing traumatic stress disorders
- Parkinson's Disease
- burning/itchy/sore/dry eyes, nose and throat
- inability to concentrate, loss of memory, headaches
- Attention Deficit Disorder
- asthma, coughs
- stomach and intestinal ailments, nausea
- porphyria
- chemical sensitivity
- auto immune disorders
- hair loss
- kidney Failure

There are other people living in the investigation area who have not had any health problems associated with forest pesticide applications. They express confusion and skepticism about why others in the community report being sick and unwell. While several of these people express concern about the reports of illness, they also express concern that these reports may be blown out of proportion.

3. Psychological, emotional & social stress

Psychological stress and its associated health effects are well-documented in communities living with real or perceived chemical contamination [52]. People who are unwillingly exposed to chemicals often experience anger, fear, irritability, uncertainty, and worry over the possible health effects of their exposures. People in these situations report feeling helpless and less secure within their homes and communities. Over time, this stress can lead to major depression, chronic anxiety, or post-traumatic stress disorder (PTSD), and physical changes such as increased blood pressure, increased heart rate, and changes in stress hormones [52].

It is not uncommon for conflict to arise within communities where reports of environmental exposures are under investigation. The divisions described above that are occurring within the Highway 36 community mirror conflicts identified in other such communities. These conflicts indicate a breakdown in social cohesion, which is an important protective factor and source of support for individual and community health.

Residents in the Highway 36 area have documented or reported many of the symptoms associated with psychological stress. Residents have stated in public meetings and to agency staff that they are experiencing hostility, fear, and a loss of community cohesion. Residents describe a pervasive climate of suspicion about the intentions of fellow community members, government agencies and industry. During the course of the EI, several themes related to stress have emerged, including:

- Fear and anxiety about:
    - their health and the health of their children
    - possible contamination of their property and the health of their animals and wildlife
    - their personal safety, including intimidating gestures, outbursts, and threats of violence
- Frustration and anger
- Feelings of mistrust
- Alienation from neighbors or former acquaintances and the erosion of social support

The following sections describe these themes in more detail.

Fear and anxiety:
Much of the fear and anxiety expressed by some community residents is related to the still-evolving scientific understanding of the effects from low-dose chronic exposures to pesticides and the uncertainties about the long-term health consequences. Some express deeply held beliefs that any amount of contamination is unacceptable. These community members are concerned that chemicals used in the investigation area are endocrine disruptors, for which there is a great deal of scientific uncertainty.

In the face of these uncertainties, some community members draw upon their own knowledge, beliefs, and values to develop a personal interpretation of their overall risk, and seek out others whose interpretations are similar to their own [53]. Several advocacy groups have emerged within the Highway 36 community that represent opposing viewpoints on the use of chemicals, in particular the aerial spraying of chemicals. This has become a polarizing issue. The differing beliefs and interpretations about risk and exposure reflect, and may contribute to, social conflict within the community.

There are also concerns that some of these groups receive assistance and resources from organizations outside of the investigation area. This perceived interference by outside interests has amplified community divisions. All of these dynamics contribute to the overall levels of stress within the community, and make it more difficult for people to cope with real or perceived chemical contamination [54].

The investigation team has heard repeated claims that it is a person's "right to know" where and when applications will occur near their homes, and what chemicals have been or will actually be used. Community members have reported more stress and anxiety during spray seasons because they cannot get this information prior to actual pesticide applications. They seek this information so they can leave the area when applications occur and avoid potential exposure. At the same time, they express frustration that they must take these actions to protect themselves.

Several community members pay a fee of $25 a year to receive ODF's application notifications as a way to anticipate where and when applications will occur.[18] Community members have voiced their frustration with this notification system, and have reported the following issues to the investigation team:

- The fee is a hardship.
- Notifications are not available electronically.
- The period within which applications may occur is not specific (applications can occur between 15 days to 12 months after the notification is submitted).
- The chemicals listed include what could potentially be used, not what will actually be used.
- Handwritten notifications are sometimes illegible.
- Notifications are difficult to understand.
- The forms are not standardized, and they do not collect the same information from every applicator.
- Many of the notification forms are not fully filled out.
- Several notifications are sent at one time in a packet through the mail for a five-section or square mile area.
- Notifications include a topographical map without context for the larger geographic area.
- Subscribers are not given notice when their subscription is up for renewal.
- Once a subscription has lapsed, there is no way to obtain notifications for the lapsed period of time.
- There is no way to notify subscribers of modifications or changes to a particular notification once it has been sent to the subscriber.
- If a landowner requests a waiver for any notification requirements, subscribers are not informed about why the waiver was requested or if one was granted.

Personal Safety:

There is a history of mistrust and community conflict in the coastal mountain range. This conflict stems from divergent views on forest practices, property and human rights, land use and the environment, and differences in personal beliefs and lifestyles. This history is relevant because some community members who oppose the use of pesticides have expressed fear of retribution based on historical events. Some of this ongoing fear for personal safety originates from events that occurred in the 1970's that they witnessed or heard about from others. Historical and legal documents have described harassment of anti-pesticide activists by government agencies and industry. These include allegations of "suspicious house fires, cars that were rigged to explode" [55], and in one case involving a noted activist, being "harassed by aircraft flying dangerously low and, in the case of the helicopters, hovering and circling for extended periods of time" [56].

[18] Under ORS 527.670(8), ODF provides copies of notifications and written plans for designated areas to interested persons who pay the required fee. In addition, under ORS 527.670(6), ODF provides such information on a non-fee basis to persons with downstream surface water rights, if such persons request that service in writing.

Other residents report feeling intimidated by the approaches used by activists who are opposed to pesticide use. Some people have expressed fear that they will be sued or harassed for using chemicals on their property. Helicopter pilots and activists alike have reported or documented threats to their personal safety. The EI team has observed aggressive and intimidating gestures and language from both sides during public meetings or on recorded tapes and videos.

Frustration and Anger:
Residents express anger at many things, including: Oregon's Right to Farm and Forest Law; the Forest Practices Act (FPA); the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); timber companies; pesticide makers; the chemical industry; trade lobbying organizations; environmental organizations; ODA; ODF; PARC; and the EI.

Community members have expressed frustration over having to navigate a complex system of governmental oversight in order to understand how to effect change. Some believe the law favors the economic interests of large industrial landowners more than it protects people's health. Other residents are frustrated and angry about letters they received from lawyers who were hired to prevent them from using chemicals on their own property. There are disputes and litigation between neighbors over allegations of chemical drift, economic and business losses, and property devaluation.

Mistrust and alienation:
Many community members have expressed some degree of mistrust and skepticism about industry's influence on the regulation of pesticides and on the EI. Some specific concerns related to the regulation of pesticides include:

- the chemical and timber industries' degree of influence over public policy relating to the regulation, application, and use of pesticides;
- the government's process for determining whether risks to human health are adequately understood and used to inform pesticide use laws; and
- the validity of research used to support claims of chemical safety and inform requirements for pesticide labeling and use.

Community members have also expressed skepticism about the EI, including concerns about the following:

- The EI lacks independence and scientific rigor. Community members are concerned that the EI will be unduly influenced by community activists who are intent on eliminating access to pesticides or by trade lobbying groups who are intent on ensuring continued access to the use of pesticides.
- The EI is an unwarranted expenditure of public funds.
- The resources needed to complete the investigation will be reduced or eliminated, or that industrial landowners have, and will continue, to thwart the investigation by using chemicals that cannot be tested for in urine.
- The EI is not inclusive enough of community input, does not allow community as an equal stakeholder, and is not doing enough to stop the spraying until the extent of human exposure is known.

4. Inadequate protection of public health

As pointed out, there is a wide range of viewpoints regarding aerial spraying and the use of pesticides within the Highway 36 community. Some people are confident that EPA's pesticide labeling and risk assessment process is protective of health. Others are skeptical and want the government to do more to protect their health. Some community members have proposed establishing aerial spray buffer zones around homes and schools, while others want a complete moratorium on all uses of pesticides.

Most community members express some degree of appreciation for the agencies' investment in their community and support for the investigation efforts. Some of these community members are comfortable with the initial, baseline EI conducted by ATSDR, are not concerned about exposures and question why the investigation continues. Others are frustrated with what they see as a delay in acting to prevent exposures they believe are occurring during each spray season.

Residents seeking a change in application practices express one or more of the following concerns or positions:

- Government agencies are not doing enough to protect private citizens' health.
- Existing environmental regulations are based on a risk assessment process that does not adequately protect human health and the environment.
- As science advances, pesticides will be found to be more harmful than previously thought.
- Government is not taking community concerns seriously, and they feel like "guinea pigs".
- The "Precautionary Principle"[19] should be invoked by placing a moratorium on some application practices (specifically aerial spraying) until these practices are proven safe.

In an effort to address their own health concerns, a few residents have taken steps to hire a forensic agronomist, test their own drinking water, collect and have their urine samples analyzed, and pay for air monitoring equipment and analysis. These residents want to know how pesticides move and act in the unique climate of the investigation area. In an effort to capture this information, they have educated themselves on the science of air and water monitoring and agronomics.

Summary

OHA believes that stress and community conflict in the investigation area negatively affects both individual and community health and well-being. This dynamic may impede future efforts to understand and respond to community concerns about pesticide exposures. The issue of pesticide use in general, and aerial applications in particular, has created conflict between neighbors and friends. One resident said that people who used to be friendly have stopped talking to her. Others have expressed their apologies to the investigation team for what they call embarrassing behavior - behavior they feel reflects poorly on their community. Many people have made it clear they do not know who to trust or what to believe. This type of polarization within rural communities is arguably more destructive and stressful than in more populated areas because people in rural areas or smaller communities may be more dependent on each other's relational resources and community capacity [57].

[19] The Science and Environmental Health Network describes the Precautionary Principle as follows: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."

OHA has identified several causes of stress and conflict within the Highway 36 community, including the following:

- fear and anxiety about personal health, safety, and children's health;
- differing views on pesticide use and human and private property rights;
- ongoing concerns about the lack of adequate notifications and records of pesticide applications;
- anger and distrust of government agencies; and
- divisions within the community and existing social networks.

These stressors negatively affect individual community members and the Highway 36 community as a whole. OHA believes that formal mediation services may help to reduce community stress and improve community cohesion in the longer term. Mediation may also be necessary for the successful completion of the EI.

Progress Toward Answering Investigation Questions

Table 17 describes the EI team's progress toward answering the original EI questions. The table also highlights outstanding gaps in available information and identifies the types of activities that would help fill these information gaps. OHA drew from information gaps identified in this table to guide recommendations and the public health action plan.

Table 17. Summary of the Exposure Investigation Questions and Progress Toward Answer

Exposure Investigation Question	Progress Toward Answer	Conclusions	What else is needed to answer the question?
Are residents in the Highway 36 Corridor being exposed to pesticides or herbicides from local application practices?	• Fall 2011 sampling was designed to capture baseline conditions when known pesticide applications were minimal. Overall results of fall 2011 sampling confirm that exposures to 2,4-D and atrazine were low among Highway 36 investigation area residents during the fall season. • Community-collected data from Spring 2011 indicate that exposures to 2,4-D and atrazine were occurring in Spring 2011.	1. This investigation did find evidence that residents of the investigation area were exposed to pesticides or herbicides in spring and fall 2011. While not possible to confirm that these observed exposures occurred as a result of local application practices or were from other sources, the evidence suggests that local applications that occurred near to and at the time the nine 24-hour subset samples were collected in spring 2011 may have contributed to the concentrations of pesticides detected in participants' urine.	Additional biologic testing, conducted to coincide with the timing and location of aerial application of pesticides that can be detected in urine would provide important evidence regarding the relationship between known applications of pesticide and detectable levels in local residents.
	If residents are being exposed:		
To what pesticides or herbicides are they being exposed?	• Spring and Fall 2011 urine data indicate that Highway 36 investigation area residents were exposed to 2,4-D, and Spring 2011 urine data indicate that residents were exposed to atrazine in the spring. • Fall environmental sampling indicates that exposure to	2. Residents in the Highway 36 investigation area had urinary biomarkers for exposure to 2,4-D in spring and fall 2011, and atrazine in spring 2011. We were unable to determine if tested residents in the investigation area had urinary biomarkers for exposure to	Additional laboratory methods that allow for measurement of other pesticides in urine would enhance OHA's ability to answer this question.

Exposure Investigation Question	Progress Toward Answer	Conclusions	What else is needed to answer the question?
	pesticides other than 2,4-D was minimal. • The inability to measure pesticides other than 2,4-D and atrazine in urine is a significant technical limitation.	pesticides other than 2,4-D and atrazine in spring or fall 2011. 3. Some Highway 36 investigation area residents may have been exposed to very low levels of DEET, fluoridone, or hexazinone in their drinking water during the fall of 2011 time-period. 4. Some Highway 36 investigation area residents may have been exposed to very low levels 2,4-D or glyphosate in their soil. 5. Some Highway 36 investigation area residents may have been exposed to very low levels of clopyralid in the air.	
To what levels are they being exposed?	• Fall 2011 urine data indicate that Highway 36 investigation area residents were exposed to low levels of 2,4-D at that time. • Spring 2011 urine data indicate that Highway 36 investigation area residents were exposed to levels of 2,4-D statistically higher than in the general U.S. population at that time and higher levels of both 2,4-D and atrazine in Spring than in	6. In the spring of 2011, Highway 36 investigation area residents had higher levels of 2,4-D exposure than the general U.S. population. 7. In the fall of 2011, Highway 36 investigation area residents had urinary 2,4-D levels that were not statistically higher than the general U.S. population.	

Exposure Investigation Question	Progress Toward Answer	Conclusions	What else is needed to answer the question?
	the Fall.	8. In the spring of 2011, urine samples from Highway 36 investigation area residents also had detectable levels of atrazine, but it is unknown how these levels compare to the general U.S. population.	
What are potential source(s) of the pesticides or herbicides to which they are exposed?	• Pre-application, spring 2011 urine results and pesticide application records data indicate that there are likely other sources of 2,4-D and atrazine exposure in Highway 36 investigation area residents that have not yet been identified with existing resources. • The nine 24-hour subset of urine samples collected in spring 2011, and four pesticide application records indicate that there may be an association between local pesticide applications and statistically significant increases in urinary atrazine metabolite levels.	9. There is insufficient information to confirm that local pesticide applications are the source of pesticides found in the urine of participating Highway 36 investigation area residents. However, there is evidence to suggest that some local aerial applications may be a contributing source of human exposure.	Additional information about non-regulated uses of 2,4-D and atrazine and environmental persistence would help to answer this question more fully. OHA will need continued access to pesticide application records data to accompany any future monitoring efforts.
What are potential routes (pathways) of residents' exposures?	• Fall 2011 environmental sampling ruled out drinking water, soil, and homegrown foods as routes of exposure for that specific time-period. • Community-collected environmental sampling from spring 2011 was insufficient to rule	10. We were unable to determine if air was a potential pathway of exposure to pesticides in the Highway 36 investigation area. 11. Drinking water can be eliminated as an exposure pathway for the 2,4-D and	Widespread passive air monitoring before and during a pesticide application season, coupled with analysis for the appropriate pesticides, would provide valuable

Exposure Investigation Question	Progress Toward Answer	Conclusions	What else is needed to answer the question?
	out any exposure routes for that time-period. • Lack of air monitoring data during the fall and spring pesticide application seasons represents a significant data gap. Without this air monitoring data, exposure via ambient air from either direct drift or volatilization cannot be ruled out.	atrazine detected in Highway 36 investigation area residents' urine. 12. Soil sampled in the fall of 2011 can be eliminated as an exposure pathway for the 2,4-D and atrazine detected in Highway 36 investigation area residents' urine. 13. Homegrown food sampled in the fall of 2011 can be eliminated as an exposure pathway.	information about whether or not ambient air is an important exposure pathway for Highway 36 investigation area residents.
What health risks are associated with these exposures?	• Urinary 2,4-D levels in Fall and Spring of 2011 were below toxicity-based BEs, indicating that measured 2,4-D levels are not associated with health risks. • OHA cannot conclude whether or not atrazine metabolite levels measured in Highway 36 investigation area residents' urine in Spring 2011 could harm people's health because there is no toxicity-based threshold value for atrazine in urine against which these measured levels can be compared.	14. The levels of 2,4-D measured in Highway 36 investigation area residents' urine in spring and fall 2011 were below levels expected to harm people's health. 15. We cannot determine whether the levels of atrazine metabolites measured in Highway 36 investigation area residents' urine in spring 2011 could harm people's health. 16. Drinking or contacting domestic water with pesticides at the concentrations detected in	BEs for additional pesticides, especially atrazine metabolites, would greatly enhance OHA's ability to make health determinations based on urinary pesticide concentrations. RfCs for pesticides in ambient air will be very helpful in evaluating air monitoring data collected in the future for health

Exposure Investigation Question	Progress Toward Answer	Conclusions	What else is needed to answer the question?
		some Highway 36 investigation area properties is not expected to harm people's health. 17. Contact with soil with pesticides at the concentrations detected in the fall of 2011 in some Highway 36 investigation area soil is not expected to harm people's health. 18. Handling or consuming garden vegetables, berries, eggs, milk or honey from the Highway 36 investigation area from fall 2011 will not harm people's health.	significance.

Conclusions

As a result of this EI, OHA reached *twenty-two* important conclusions addressing the questions about the presence, type and source of exposure to pesticides in the Highway 36 investigation area:

OHA reached *one* conclusion related to the question: **Are residents in the Highway 36 Corridor being exposed to pesticides from local application practices?**

> **Conclusion 1:** This investigation did find evidence that residents of the investigation area were exposed to pesticides or herbicides in spring and fall 2011. However, it was not possible to confirm if these observed exposures occurred as a result of local applications practices or were from other sources.

OHA reached *four* conclusions related to the question: **To what pesticides are they being exposed?**

> **Conclusion 2:** Residents in the Highway 36 investigation area had urinary biomarkers for exposure to 2,4-D in spring and fall 2011, and atrazine in spring 2011. We were unable to determine if participants in the investigation area had urinary biomarkers for exposure to pesticides other than 2,4-D and atrazine in spring or fall 2011.

> **Conclusion 3:** Some Highway 36 investigation area residents may have been exposed to very low levels of DEET, fluoridone, or hexazinone in their drinking water.

> **Conclusion 4:** Some Highway 36 investigation area residents may have been exposed to very low levels 2,4-D or glyphosate in their soil.

> **Conclusion 5:** Some Highway 36 investigation area residents may have been exposed to very low levels of clopyralid in the air.

OHA reached *three* conclusions related to the question: **To what levels are they being exposed?**

> **Conclusion 6:** In the spring of 2011, Highway 36 investigation area residents had higher levels of 2,4-D exposure than the general U.S. population.

> **Conclusion 7:** In the fall of 2011, Highway 36 investigation area residents had urinary 2,4-D levels that were not statistically higher than the general U.S. population.

> **Conclusion 8:** In the spring of 2011, urine samples from Highway 36 investigation area residents also had detectable levels of atrazine metabolites, but it is unknown how these levels compare to the general U.S. population.

OHA reached *two* conclusions related to the question: **What are potential source(s) of the pesticides to which they are exposed?**

Conclusion 9:
There are additional sources of 2,4-D and atrazine in the investigation area that are not accounted for in the pesticide application records available to the investigation team.

Conclusion 10:
Statistical associations suggest that four local aerial applications of atrazine and 2,4-D to forestland may have contributed to an increase in urinary atrazine metabolite levels in samples collected from nine participants within 24 hours of those applications.

OHA reached *five* conclusions related to the question: **What are potential routes (pathways) of residents' exposures?**

Conclusion 11: We were unable to determine whether air is a pathway of exposure to pesticides in the Highway 36 investigation area.

Conclusion 12: Drinking water was eliminated as an exposure pathway for 2,4-D and atrazine in the fall of 2011.

Conclusion 13: Soil sampled in the fall of 2011 was eliminated as an exposure pathway for the 2,4-D and atrazine detected in Highway 36 investigation area residents' urine.

Conclusion 14: Wild or homegrown food products sampled in the fall of 2011 were eliminated as an exposure pathway in fall of 2011.

Conclusion 15: Concentrations of pesticides in drinking water, soil and homegrown food in the spring of 2011 and other seasons and years are unknown.

OHA reached *five* conclusions related to the question: **What health risks are associated with these exposures?**

Conclusion 16: The levels of 2,4-D measured in Highway 36 investigation area residents' urine in spring and fall 2011 were below levels expected to harm people's health.

Conclusion 17: We cannot determine whether the levels of atrazine metabolites measured in Highway 36 investigation area residents' urine in spring 2011 could harm people's health.

Conclusion 18: Drinking or contacting domestic water with concentrations of pesticides detected in some Highway 36 investigation area properties in fall 2011 is not expected to harm people's health.

Conclusion 19: Contact with soil containing pesticides at the concentrations detected in the fall of 2011 in some Highway 36 investigation area soil is not expected to harm people's health.

Conclusion 20: Handling or consuming garden vegetables, berries, eggs, milk or honey collected from the Highway 36 EI participants' homes in fall 2011 will not lead to harmful health effects related to pesticide exposure.

OHA reached *two* additional conclusions related to the impacts to the EI and to the health of community members from community conflict.

Conclusion 21: Divisions and hostility within the community related to pesticide use, property rights and land use are creating significant stressors on many individual community members and on the community as a whole.

Conclusion 22: Leadership activity within the community has been oriented toward debating issues of land use, pesticide use, and property rights. No formal or informal leader has yet emerged who has a mediating influence on these differences. Formal mediation services for the Highway 36 community may be necessary for both the successful completion of the EI and for the important progress needed to reduce community stress and improve community cohesion in the longer term.

Recommendations

Pertaining to the results of this EI, OHA recommends that:

1. US EPA work with the EI team on developing a sampling and analysis plan designed to evaluate exposures to pesticides in air and to address gaps in the data needed to answer EI questions. At the time of publication of this report, passive air monitoring over several application seasons appears to be the best option to collect community-wide air data.
2. ODA and ODF continue to provide pesticide application data as needed to interpret air sampling (or other) data collected as part of this investigation.
3. State and federal agencies involved in the ongoing EI develop an implementation plan that includes identification of necessary resources to carry out activities appropriate for each agency's role in this effort.

Pertaining to broader and/or longer-term issues identified by the EI, OHA recommends that:

1. State agencies continue to collaborate on determining best practices that would protect human populations from pesticide exposures.
2. ODA and ODF work with pesticide applicators to develop consistent pesticide application record-keeping processes to ensure that application record data are accurately maintained and usable.
3. State agencies explore the feasibility of implementing a system that would allow people to be notified of imminent pesticide applications in such time and with such specificity that they could take action to avoid exposure to those applications. Such policies could include adoption of systems developed by other jurisdictions, or modification of existing regulatory systems designed to monitor pesticides applications.

4. State and federal agencies involved in the ongoing EI develop an implementation plan to address these recommendations, including the identification of resources to carry out activities appropriate for each agency's role in serving the communities of Oregon. That plan should include a recommendation on how the agencies should coordinate, collaborate and share resources.
5. Community members, including local elected officials and other community leaders, consider seeking the assistance of a professional mediation group to address immediate and long-term conflict within the community and identify actions to move this conflict toward resolution.

Public Health Action Plan

Public health actions completed:

- The EI team collected urine and environmental samples in fall 2011, and communicated individual results back to EI participants in winter 2011/2012.
- The EI team hosted two public meetings (July 2011 and April 2012) and one open house (November 2011) in Blachly, Oregon.
- ATSDR released a report on the fall 2011 urine sample results in March 2012.
- OHA led outreach activities for the EI, including recruiting participants, coordinating three community meetings and one open house, conducting surveys and questionnaires, determining chain of custody for the community-collected urine samples, and developing the Highway 36 EI web page and listserv, press releases, flyers, factsheets, and other communication materials.
- Since 2011, OHA has participated with ODF, ODA, and DEQ on the Water Quality Pesticide Management team, which serves as the scientific advisory committee for the Pesticide Stewardship Partnership Program aiming to reduce pesticide movement into waters of the state.
- OHA's role as co-chair of PARC, has been to provide a public health perspective on appropriate responses for human pesticide exposures in Oregon.
- OHA tracks acute pesticide exposures in Oregonians as part of its Pesticide Exposure, Safety and Tracking program (PEST). The EPA Office of Pesticide Programs reviews the findings from PEST (along with other states' surveillance programs), when determining updates to pesticide labels.

Public health actions planned:

OHA will:

- Work with state and federal partners, community members, and other stakeholders to implement the recommendations in this report.
- Provide updates through the Highway 36 web page and listserv about findings from:
    - Comparison of application records in any subsequent investigation to application records from 2009 to 2011 to determine if there are noticeable (substantial) changes in pesticide application practices after the EI was initiated.
    - Air sampling data once it is collected by the EPA.

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Report Preparation

This Public Health Assessment for the Highway 36 Corridor site was prepared by the Oregon Health Authority under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). This report was not reviewed or cleared by ATSDR.

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Appendix A: Response to public comments

This appendix describes how EHAP addressed and/or incorporated public comments into this final report of the Highway 36 Exposure Investigation Public Health Assessment. OHA received comments from 52 individuals, community groups, industry representatives and legal teams. Some comments were very extensive.

Since many comments contained multiple topics, we grouped statements together that were similar in nature. We have presented many comments verbatim, to minimize the chances of miscommunicating or misinterpreting the comment. In cases where two or more comments expressed the same question or concern, we paraphrased them for clarity.

OHA does not list names or affiliations with these comments, in order to protect the commenter's identity. In some cases, we have left names in a comment, when a group or company refers to itself within the comment. Each comment is numbered, and OHA's response follows in italics.
Visit www.healthoregon.org/ehap to access all (redacted) comments received by OHA.

Comment 1: "It is incomprehensible how the agency could avoid concluding that forestry aerial sprays were the source of the atrazine metabolites found in residents' urine. The only documented use of atrazine in the study area was in forestry aerial sprays, and urine levels tested shortly after aerial applications of atrazine showed significant increases above earlier levels, as documented in the draft report. Atrazine is a Restricted Use Pesticide, making it highly unlikely that residents in the study area use it on their property in any way."

Response: Many commenters made similar statements. In response - and based on additional analysis, OHA has revised conclusion 9 and added a new conclusion 10 to clarify the findings. Conclusion 9 is now focused on the evidence that there were additional sources of atrazine (and 2,4-D) not accounted for in the application records available to OHA. Based on what we now know, the 13 spring samples that were collected before any known pesticide application, contained levels of urinary atrazine metabolites (and 2,4-D) that were similar to the 26 samples collected at varying times after known applications (Table 10). In other words, all 39 spring 2011 samples had statistically higher levels than the fall 2011 samples, including those 13 spring samples that were collected before any known application.

In addition, OHA developed a new conclusion (#10) that identifies four aerial applications of 2,4-D and atrazine as likely contributors, in whole or in part, to the statistically higher atrazine metabolite levels in the nine 24-hour subset samples. The nine, 24-hour subset samples are those that were part of the original 39 spring samples, but were collected within 24 hours of a nearby spray. When compared to the other 30 spring samples, these nine subset samples contained statistically higher levels of atrazine metabolites.

However, in order to confirm that aerial sprays or ground applications are the actual sources of this statistical difference, OHA would need also to have simultaneous environmental sampling data to detail how atrazine persisted and traveled from the application sites to the nine participants' locations. This difference between the nine 24-hour subset urine samples and the other 30 spring 2011 urine samples could also be influenced, at least in part, by temporary changes in the amounts of pesticides released by *unknown source(s) of atrazine and 2,4-D that were taking place at the same time. These sources have not been identified in currently available application records.*

Comment 2: "Determination of 'Biological Equivalency (BE)'
The Interim PHA was unable to compare atrazine results with a bio-monitoring equivalent (BE) because there is not a BE for atrazine. However, information on derivation of the BE for atrazine and its metabolites was discussed and submitted by [redacted] (September 21, 2011) to the OHA, Oregon Department of Agriculture, Oregon Department of Environmental Quality, ATSDR and EPA Region 10. Information on derivation of an atrazine BE was based on the extensive atrazine database and by application of a Physiologically Based Pharmacokinetic (PBPK) model. An Excel spreadsheet-based Forward- and Back-Calculator tool was provided."

Response: OHA appreciates the provision of these resources. However, OHA is constrained to use publicly available, peer-reviewed resources to evaluate locally collected data.

*Comment 3: "*Based on the PBPK model, the urine detections in samples taken by some community members in spring 2011 are not plausible. Samples were taken to purportedly represent "pre- and post-spraying" and assumed passive exposure via air or water. As indicated in [redacted] September 21, 2011 submission, atrazine is rapidly metabolized, predominately to diamino-chloro-s-triazine (DACT), within hours of exposure. Furthermore, worker exposure studies have clearly characterized likely urine concentrations of DACT after known levels of exposure. This knowledge, together with atrazine's low vapor pressure and the application of the Calculator render the results from the 2011 "pre-spray" samples as unrealistic."

Response: OHA places confidence in measured data over modeled predictions. Regardless of how these data may appear, they represent actual measurements, and the investigation team is tasked with explaining those measurements to the best of our ability. In addition, DACT was the primary metabolite measured in spring 2011 urine samples, which is consistent with previous studies mentioned in the comment.

Comment 4: "The report does not document the use of adjuvants (various additives) that were applied concurrently with pesticides. These products, which are not subject to the same labeling requirements as active ingredients, are used for a variety of purposes, including making the product stick to vegetation, reducing foam, and reducing drift. Many of these products are considered toxic in their own right, yet OHA did not examine their use in the study area."

Response: This is a limitation of the investigation. Application records do not require that applicators include specific chemical identities for adjuvants. The ODF records do require that applicators list product names for adjuvants, but not the specific chemicals in the products. Typically they were described as "surfactants," "dyes," and "defoamers." This level of information is insufficient to determine what specific chemicals to test for in the environment or in urine in the Highway 36 Corridor. Without exposure data, it is impossible to evaluate the risk to human health.

ODA's record keeping requirements apply only to pesticides, not adjuvants. ODF explained that their requirements obligate applicators to record the brand name (product name) of all chemicals, including adjuvants in their application records. ODF explains:

"An ODF compliance assessment against Forest Practices Act (FPA) standards found compliance rates at or above 90% for recorded pesticide application locations, listed pesticides and operation start/end dates. The compliance rate for recording adjuvant information was 89%. While the audit indicates areas with lower compliance, the records do provide valid data on what products were applied, where and when. Education and outreach efforts have already begun to clarify expectations of pesticide application record contents, including an update to the pesticide application form (see http://www.oregon.gov/ODF/privateforests/pages/pesticides.aspx*), and will continue into 2014."*

Comment 5: "The OHA draft report contains total amounts for various pesticides, but using two different units, pounds and gallons, based on the pesticide formulation used. Then in Table 19, colors are used to indicate which pesticides were used the most. That table indicates that hexazinone was the pesticide used the most in the study area in 2011. It is possible to convert the liquid chemicals from gallons to pounds by using the density or other information contained on the product's label or MSDS (Material Safety Data Sheet)…. Thus, the application records provided by ODF show that forestry accounted for over 9 tons of pesticide products applied in the Triangle Lake Study Area during the year 2011. It is also clear, after converting the products to the same units, that hexazinone was not the most heavily used pesticide in the watershed. In fact, atrazine was the most-used pesticide in the watershed, followed by glyphosate, then 2,4-D, then imazapyr, and only then hexazinone. It should also be noted that while the amounts of metsulfuron methyl and sulfometuron methyl applied were relatively small, that the application rates for these two chemicals are far lower than the other chemicals used."

Response: OHA acknowledges that information about the amounts of pesticides applied is presented in mixed units, as they were received by ODA and ODF. The total and relative amounts of pesticide applied are pieces of information that are tangential to the exposure investigation. OHA's focus is human exposure relative to the toxicity of the active ingredients. Because some active ingredients are more toxic than others, absolute amount applied relative to other active ingredients is not a relevant measure of human health risk.

Comment 6: "In reviewing all of the pesticide application records provided by ODF, I found that of the 244 records provided, at least 65 (27%) lacked one or more of the items of information required by ODF rules for pesticide applicators on forest land. That is a dismal compliance rate, and has clearly affected the ability of investigators to accurately determine what products were applied, when, and where."

Response: ODF responded, "An Oregon Department of Forestry (ODF) compliance assessment comparing Forest Practices Act (FPA) standards found compliance rates at or above 90% for recorded pesticide application locations, listed pesticides and operation start/end dates. The lowest compliance rate was observed with the requirement to record the carrier type (69%). Most of the described applications were suitable for a water carrier and applicators probably did not consider that water needed to be listed as a carrier. As stated in a previous comment, the audit indicates there are areas with lower compliance. However, the records do provide valid data on what products were applied, where and when. Education and outreach efforts have already begun to clarify expectations of pesticide application record contents, including an update to the pesticide application form (see http://www.oregon.gov/ODF/privateforests/pages/pesticides.aspx*), and will continue into 2014."*

Comment 7: Multiple commenters independently obtained pesticide application records from ODF. Some of these commenters identified discrepancies between the numbers of records they obtained and the numbers obtained and reported by OHA.

Response: OHA has been in communication with these commenters and ODF. OHA has resolved these discrepancies and this final report accounts for all application records. The numbers of unique application records counted by independent commenters and OHA now match. This application record information is in Appendix B. None of the additional application records occurred during urine or environmental sample collection in the fall or spring of 2011 or contained either of the pesticides tested in urine samples.

Comment 8: "There are two errors in the chart on page 33 showing the Siuslaw Watershed Guardians' water quality testing results. Both are in the column showing the results for Hexazinone:
a. In the first row, showing the result for the original sample at Fish Creek near the Mouth, the amount of Hexazinone per POCIS should be 64 nanograms, not the 50.7 that is shown. The lab report shows 192 nanograms in the sample; therefore, the correct entry should be 192 divided by 3, or 64.
b. In the sixth row, showing the result for the original sample at Nelson Creek downstream of Almaisie Creek, the amount of Hexazinone per POCIS should be 13.6 nanograms, not the Not Detected that is shown. The lab report shows 40.8 nanograms in the sample; therefore the correct entry should be 40.8 divided by 3, or 13.6."

*Response: OHA made these corrections in this final version of the report. See page 36 [*Table 14*].*

Comment 9: "The OHA report indicates, at page 32, that the Oregon Department of Environmental Quality 'typically' finds atrazine and hexazinone in waters throughout the state. However, a review of sampling sites used by DEQ shows that these detections have typically been in larger streams draining much larger watersheds that typically contain many land uses, including agriculture. The sampling sites used by the Siuslaw Watershed Guardians were, with the exception of the Lake Creek sampler, sites on very small streams draining very small watersheds where forestry is typically the primary land use."

Response: OHA altered the text in the report to reflect that DEQ's typical atrazine detections by POCIS sampling are from larger streams draining multiple land use types including agriculture (See page 35).

Comment 10: "Other potential sources of pesticides in the watershed which have not been investigated include Triangle Lake itself (water, sediments), as well as air-borne contaminants released when treated lumber is burned."

Other comments stated that limited environmental sampling has led to uncertainties about pesticide exposures.

Response: It is true the investigation team has not sampled Triangle Lake or other surface waters aside from Little Lake. When treated lumber is burned, the pesticides are destroyed and so would not become a source of contamination. OHA acknowledges that environmental sampling data are limited and that conclusions of the report are limited to the available data. Given limited resources, environmental sampling was prioritized to characterize those pathways with the greatest potential for the largest exposures.

Comment 11: “The POCIS sampler that was located in Lake Creek above Fish Creek showed detections of Atrazine, Desethyl Atrazine and Hexazinone, but the pesticide application records show that there were no prior applications of those chemicals in the watershed above the sampling point. This is strong evidence that the contamination occurred through drift from pesticide applications in adjoining watersheds.”

Response: This is one line of evidence that pesticides can travel some distance from the application site. Other evidence is referenced in the report (Page 31). However, without quantitative information about ambient concentrations in the media (i.e. air, water, soil) that people are exposed to, it is difficult to know the potential impact of this movement on the health of people in the area.

Comment 12: “On page 4 of the draft report, OHA makes the following statement: ‘This investigation documented the presence of 2,4-D and atrazine in the urine of residents. There was a drop in those levels between the spring and fall 2011 for reasons that are currently unknown.’ This statement is very hard to understand, given that the application records examined by OHA show very clearly that atrazine and 2,4-D were applied aerially in the spring but were not applied at all in the fall. Table 19 on page 64 of the draft report shows no applications of either of these chemicals after May (although another section of these comments show that there was an application of 2,4-D in June which had been mislabeled by ODF and was therefore overlooked by the OHA). The reason for the drop in atrazine and 2,4-D in urine levels is obvious: the timber industry uses these chemicals only in the spring. It is extremely puzzling why OHA could not draw that very obvious conclusion. Maintaining a rigorous scientific study does not require abandoning logic and common sense.”

Response: The 13 pre-application samples from Spring 2011 make it difficult to simply conclude that the lower levels in fall 2011 are the result of no recent timberland applications. There were also no application records showing use of 2,4-D or atrazine in the several months leading up to these 13 samples, yet the 2,4-D and atrazine metabolite concentrations in these 13 samples were significantly higher than fall 2011 samples.

Comment 13: “The original investigation design, as described on page 16 of the draft report, was to include urine sampling before and after nearby ground or aerial spraying in the spring of 2012. However, as explained on page 23 of the draft report, the spring sampling was suspended on March 8, 2012, ‘because the areas that were slated for applications of 2,4-D and/or atrazine were in remote locations which have very few residents.’ On page 7 of the draft report, OHA states that ‘It is not known if the Exposure Investigation resulted in changes to pesticide application practices in the investigation area, and therefore if exposure conditions have changed for Highway 36 corridor residents.’ In fact, the pesticide application records provided by ODF for the years 2009 through 2011 document very clearly that for all three years, atrazine and 2,4-D were heavily applied in the study area during the spring. The records document that the following amounts of 2,4-D and atrazine were applied in the study area for the years 2009 through 2011: (see Table 2 in second tab). Application records from 2012 are not available; however, according to the OHA report, no sprays of 2,4-D or atrazine were planned for the spring for the study area. This is totally contrary to the pattern, which is clearly established by the records for 2009 through 2011, showing heavy use in the study area of atrazine and 2,4-D in the spring. Thus it seems fairly clear that the timber companies in the study area changed their practices by avoiding the use of

2,4-D and atrazine (the only two chemicals which OHA can test for in urine) and instead using other chemicals in their place."

Response: OHA did not have the resources to enter and analyze pesticide application records for 2009-2010. Analyzing trends of pesticide use over time is a task we have slated for a future report as the investigation continues as mentioned in the "Public Health Action Plan" in the summary section and on page 58. Your comments and work will give us a head start as we begin that process, and they are much appreciated.

Comment 14: "I urge those in charge of this investigation to expand the study area to include all of the state, and to redesign the study in such a way that the timber companies and pesticide applicators will not know when or where samples are being taken. I urge those in charge to invest appropriate resources so that adequate air, water and biological samples can be taken that will provide answers rather than simply raise more questions. I urge those in charge to pursue air testing for all chemicals used on forest and agricultural lands in Oregon, and to conduct such tests in adequate numbers that conclusions can be drawn."

Response: The investigation team does not have the resources to expand this investigation beyond the current area. However, if the EPA is successful in developing and deploying passive air samplers in the investigation area, they could be used in other areas of the state as well. EPA and DEQ will coordinate this work. EPA's efforts are focused on developing passive samplers that would capture the active ingredients currently used in forestry. Passive samplers would allow for monitoring over time without coordination with landowners.

A major difficulty in designing urine sampling without coordinating with landowners is that samples have to be collected within 24 hours of an application. Without knowing exactly when an application is to occur, it is logistically challenging to collect samples within that 24-hour window.

Comment 15: "OHA continues to use "pesticide" data when herbicide-specific data is available. The synergistic effects alluded to are generally with much more toxic insecticides. Available evidence on herbicides used in combination finds more antagonistic combinations than synergistic. And the worst-case scenario was only a multiple of two times toxicity (see Acute Toxicity of Commonly Used Forestry Herbicide Mixtures to *Ceriodaphnia dubia* and *Pimephales promeias*," Environmental Toxicology 27(12): 671-684). The claim of "potentially greater risk" overstates available information and appears to bias what is known about the health effects of herbicides."

Response: The field of toxicology is making advances in understanding the effects of complex mixtures. However, this area of study is still young and is associated with a lot of uncertainty. Where uncertainty exists, it is the role of public health agencies to err on the side of caution. The text of the report does not claim that there is greater risk, only that there is potential for greater risk. Another area of uncertainty is that the complex mixtures in question are not simply multiple herbicidal active ingredients, but also includes multiple adjuvants. Application records do not specify what chemicals are used as adjuvants. When confronted with these unknowns, OHA is constrained to assume that some additive or even synergistic mixture effects are possible.

Comment 16: "On page 21 and 23, the PHA concludes that only two commercial applications of pesticides occurred prior to the urine sampling on August 30 and 31, and that these were ground pesticide applications. However, according to the official spray records obtained by [redacted], one aerial spray took place on 8/18 and three aerial sprays took place 8/28-29. OHA did not do urine testing for the chemicals used in late August, 2011, nonetheless, it is important to include the full data set in the report."

Response: The section of the report mentioned here states that these were the only applications occurring <u>during</u> the sample collection – not <u>prior to</u> application. The 8/18 application was considered too early to have had a bearing on sampling results, and as indicated, it did not include either 2,4-D or atrazine. However, OHA agrees that the 8/28-29 aerial applications were close enough to the sample collections to warrant mentioning in the report, and they have been added to the section where this is discussed (Page 23). As noted, none of these four applications included 2,4-D or atrazine, so they would not have influenced urine results for these two pesticides.

Comment 17: "The OHA draft report mentions, but does not discuss, the possibility of volatilization of pesticides as a possible source in the study area. A recent study by the U.S.D.A.'s Agricultural Research Service indicates that under certain conditions, more pesticide product can be lost to volatilization than to surface runoff. (*Comparison of Field-scale Herbicide Runoff and Volatilization Losses: An Eight-Year Field Investigation*, Timothy J. Gish, John H. Prueger, Craig S.T. Daughtry, William P. Kustas, Lynn G. McKee, Andrew L. Russ and Jerry L. Hatfield, Journal of Environmental Quality 2011 40: 5: 1432-1442doi:10.2134/jeq2010.0092.) The study showed that revolatilization is significant when ground moisture is high and temperatures are increasing, the exact conditions in Oregon in the spring. A prepublication version of this study is included as Exhibit F."

Response: OHA agrees that volatilization is an exposure pathway that has not been adequately addressed to this point. It is mentioned in Table 1 (page 17) as a potential exposure pathway. Table 17 (page 50) mentions that volatilization cannot be ruled out as an exposure pathway and that air monitoring is needed in order to determine whether or not it is a significant pathway of exposure in the Hwy 36 area. OHA has recommended that EPA develop and deploy passive air monitoring devices that can be used to determine concentrations of herbicides in ambient air. Passive air sampling will not, in itself, allow us to differentiate volatilization from drift, but pesticide application records covering the period of monitor deployment can be used in combination with passive monitoring results to distinguish them.

Comment 18: "Parts of the Interim PHA mischaracterize the toxicological & human health data base for atrazine. Appendix E uses two short paragraphs to describe the extensive toxicological database for atrazine and does not adequately represent the current state of knowledge on atrazine. Several statements in Appendix E can be taken out of context if not taking into account environmental exposures. The Joint FAO/WHO Meeting on Pesticide Residues (JMPR) conducted a toxicological evaluation of atrazine in 2007 and published it in 2009. The JMPR states that 'The database on atrazine was extensive, consisting of a comprehensive set of GLP-compliant guideline studies with atrazine and its four key metabolites, as well as a large number of published studies' and 'investigations of other modes of action did not provide any evidence that atrazine had intrinsic estrogenic activity or that it increased aromatase activity in vivo' (WHO, 2009)."

Response: It was not OHA's intention for Appendix E (now appendix F on page 125) or any other portion of the PHA to serve as a comprehensive literature review for atrazine. Readers are referred to ATSDR's Toxicological Profile on atrazine for a more detailed and complete review. The PHA does not claim that atrazine causes cancer, though it does document some community members' concerns that it might. The PHA also does not claim that atrazine is intrinsically estrogenic. However, the extensive toxicological record on atrazine clearly demonstrates disruption of other endocrine pathways and interference with reproduction in animal models. These highly reproducible and consistent findings demonstrate that atrazine is an endocrine disruptor and that at sufficient doses can and does impair reproduction and cause developmental toxicity in animal models. As with all toxicological questions, actual risk depends on the dose.

Comment 19: "In 2010, the atrazine drinking-water guideline prepared for the Third Edition of the WHO Guidelines for Drinking-water Quality was revised following the 2008 publication of the 2007 Joint FAO/WHO Meeting on Pesticide Residues (JMPR) evaluation of atrazine and its environmental metabolites (WHO, 2008) http://www.fao.org/docrep/010/a1556e/a1556e00.HTM.

Based on the 2007 JMPR review, the Guideline Value of 100 ppb was derived for the sum of atrazine and its chloro-s-triazines in 2010 (WHO, 2010) http://www.who.int/water_sanitation_health/dwq/chemicals/dwq_background_20100701_en.pdf."

Response: As the agency regulating public drinking water safety in Oregon, OHA uses the current Maximum Contaminant Level (MCL) enforced by the EPA. This MCL is currently 3 ppb.

Comment 20: "Limited information provided in Appendix E fails to represent the comprehensive toxicological database on atrazine, and is solely "hazard" based, thereby ignoring potential exposures based on relevant environmental concentrations. PHA Question 2 (e) asks, "What health risks are associated with these exposures?" Scientifically valid data on both hazard and exposure are required to conduct an appropriate characterization of potential risk associated with atrazine. http://www.epa.gov/risk_assessment/basicinformation.htm#risk."

Response: See response to comment 18 regarding limited information in Appendix E (now Appendix F).

OHA has added a sentence to the end of the first paragraph on atrazine in Appendix E (now Appendix F) stating "As with all chemical exposures the severity and risk of health effects depends on a person's actual dose."

Toxicity values for atrazine are based on administered dose (e.g. EPA's oral reference dose or ATSDR's Minimal Risk Level). In the absence of a biomonitoring equivalent (BE), OHA was not able to quantitatively compare measured concentrations of atrazine metabolites in urine to an oral dose. Without this comparison, it was not possible for OHA to determine which of the potential health effects of atrazine may correlate to these measured exposures in the investigation area. For these reasons, OHA was unable to conclude whether or not measured atrazine exposures in Hwy 36 area residents could harm their health.

Comment 21: "On page 1 of the draft report, it is stated that community collected urine, water and air samples were analyzed by privately contracted analytical laboratories at Emory University in Atlanta, Georgia. That statement is correct only regarding the urine samples; the air and water samples were analyzed by Anatek Laboratories in Moscow, Idaho. On page 62 of the draft report, the paragraph between the figure and table summarizes Table 18, but fails to mention the 18 documented roadside applications of pesticides. It should also be noted that most of these roadside applications were done on private timberland by industrial timber companies."

Response: OHA corrected these errors in this final version of the PHA.

Comment 22: "The OHA report mentions only briefly the potential synergistic effects of combinations of pesticides such as the frequent combinations of 2,4-D and atrazine used aerially in the study area. So-called "tank mixes" are very common for both ground and aerial sprays, as the application records document clearly. Another combination of four pesticides (glyphosate, imazapyr, metsulfuron methyl and sulfometuron methyl) is frequently applied in the study area, sometimes in combination with additional adjuvants such as methylated seed oil."

Response: The investigation summarized in this report was subject to several limitations, chief of which was the available data on which to base conclusions. Concerns for the health effects of pesticides alone or in combination are understandable. However, in our work we are held to rigorous standards of scientific evidence so that conclusions drawn can be defended. We were only able to test for 2,4-D and atrazine individually and the possible human health effects of specific amounts of these two chemicals in combination is unknown. Gaps in the data are unsatisfactory to all parties, and a valid cause for concern. The Highway 36 / Triangle Lake Exposure Investigation should be seen as one step in a process of effective and appropriate scientific inquiry to protect the health of the community. The scope of OHA's involvement in future efforts is in the Public Health Action Plan section of the document. Recommendations of this report outline efforts led by other agencies.

Comment 23: Many commenters expressed concern about OHA's treatment of the statistical difference between the urinary 2,4-D levels of fall 2011 EI participants and the general U.S. population 75th percentile (p-value 0.06 in Table 3). Some commenters said it was inappropriate for a state agency to use phrases like "approaches statistical significance," claiming p-values are designed to be objective, binary pass/fail tests. Other commenters said that OHA should call a p-value of 0.06 close enough to be statistically significant, arguing that additional factors should be weighed considering significance of the result.

Response: In all fields of study, the numerical value at which statistical significance is declared is a threshold set by "alpha"; this corresponds to the probability that the results would occur 1-alpha percent of the time if the scenario were repeated many times. Most fields of study accept an alpha of 0.05 (95% confidence level that the results would repeat) as a conservative measure of statistical significance; however, some fields of study will consider and report alphas of 0.10 corresponding to a 90% confidence level. Many fields of study choose to report findings of alphas less than 0.05 as significant and alphas between 0.05 and 0.10 as marginally significant, as we have here.

The p-value in itself simply describes the probability that a given result could have occurred by random chance. In this case, there is a probability of 0.06 or 6% that the observed difference between EI participants and the general U.S. population could have happened by random chance and a 94% chance that the difference between the two groups is a true difference and not random. In other words, if we *repeated the sampling 100 times, we would expect true differences 94 of those times. Language in the report has been altered to reflect that the distribution of urinary 2,4-D in the two populations (EI participants and the general US population 75th percentile)is somewhat different.*

In summary, the difference between distributions of urinary 2,4-D concentrations in EI participants in fall 2011 and the general U.S. population appear to be slightly different in the upper quartile. There are more EI participants within the upper quartile of the expected range than would be expected. In other words, EI participants were still within the expected range as defined by 95th percentile of NHANES, just distributed at the higher end of the range.

OHA changed language in the report to clarify significance levels (see page 20). OHA also changed language to clarify that the range, as defined by comparing 95th percentiles of El participants and NHANES, is as expected and that the distribution within that range may be different (as measured by a marginally significant p-value=0.06) when comparing 75th percentiles.

Comment 24: "The Oregon Health Authority also opted to exclude a child, under six years of age because 'there are no NHANES values for comparison for children under six years old. We believe that OHA should include this child and reevaluate the statistical significance of the presence of 2,4-D in participants' urine. Had OHA included this child, then the p-value of the 75th percentile finding would likely have been statistically significant, i.e., <0.05. We request that OHA review its analysis and determine whether inclusion of this participant creates a statistically significant finding."

Response: OHA could not include the two children younger than six years in the analysis for the report itself for the reasons stated. However, OHA did test for significance with the two additional children included. Under these conditions, the p-value went below 0.05 indicating statistical significance for the comparison of Highway 36 residents to the NHANES 75th percentile. The p-value for the comparison of Highway 36 residents to the 95th percentile did not approach significance. Thus, the overall conclusions related to the comparison of fall 2011 urine samples to NHANES would not have changed even if the two children had been included. See response to Comment 23 for more discussion of statistical significance and meaning of p-values.

Comment 25: "On page 22 of the report under "Summary of Fall 2011 Sampling", the second bullet point states that: "[B]ecause statistical significance tests on urinary 2,4-D levels were equivocal, OHA cannot conclude whether EI participants were statistically different than the general U. S. population with respect to urinary 2,4-D levels at the time of sampling." This assertion is contradictory to the actual analysis of the data summarized on pages 17-18. Comparisons to the NHANES 90th percentile show that "this number was not higher than expected". Even when the results were compared to the arbitrary 75th percentile, the numbers were not statistically significant. The 2,4-D concentrations from the fall 2011 sampling show that the numbers are what should be expected for any like population in the United States. That is what the report should reflect."

Response: Statistical tests do not indicate EI participants' samples were higher than the general population at the time of sampling. Comparing NHANES 75th percentile with EI participants provided a p-value=0.06; this suggests, with 90% confidence, that the distribution of EI participants levels in the upper quartile may differ from the general population. Together these results suggest that individuals in *the EI population did not show statistically higher 2,4-D levels than the general population; however, individuals may be more likely to have levels in the high end of the expected range. Language in the report (page 20) has been changed to clarify the difference between statistically higher levels (or range) and statistically different distributions.*

Comment 26: "This report suggests that landowners deliberately changed application practices because of the investigation. This accusation should have some basis if it is to appear in the report. Contrary to the assertion made here, a review of application records show no major changes in application practices after the El began. The assessment implies that forestry landowners have not acted in good faith regarding the investigation, and that is simply not true. This statement should be backed up with data or removed from the report. This section of the report highlights the lack of understanding about forestry operations that has been a persistent issue throughout the Highway 36 Exposure Investigation. We encourage OHA to better engage with forestry landowners and the Oregon Department of Forestry to gain a better understanding of how our private forestlands are managed. After repeated attempts to explain our industry, OHA appears either unwilling or unable to accept that spray timing and constituents are not fixed."

Response: The statement referenced in the PHA is an acknowledgement that OHA understands pesticide application timing and constituents are not fixed and that last minute decisions are made based on needs on the ground at the time of application. The statement does not attribute motives to this fluctuation in practices, though it does assume that changes in practices are deliberate, in that they are not accidental.

OHA has not yet reviewed application records from years prior to 2011 or in 2012. OHA does plan to do this analysis as part of the ongoing exposure investigation as described in the Public Health Action Plan section. If the commenter is willing to share their analysis of application records with OHA, this will help expedite the process. ODF is a partner in the exposure investigation and as such, has had multiple opportunities to clarify forest practices and provide input on this report.

Comment 27: "This report fails to address the many potential pathways of exposure and makes the assumption that it is likely caused by spray drift from aerial applications. This conclusion [Conclusion 10 on pages 5 and 55] is not justified by the sample results. The 2011 fall urine samples determined that 92% of the participants had detectable levels of 2, 4-D (of which all were below levels expected to harm people's health) However, the report does not address the fact that 2, 4-D was not aerially applied in this same time period. How can one conclude that the source of exposure is spray drift when 2, 4-D was not even aerially sprayed in the preceding months? Conclusion 9 of the report states there is "insufficient information to confirm that local pesticide applications are the source…. However, available evidence suggests it is possible". Where is this evidence?"

Response: See response to Comment 1 for updates on revisions to Conclusion 9 and the new Conclusion 10. The information referenced in this comment is now addressed in Conclusion 10 of the final report. Conclusion 10 cites the statistically significant increase in spring 2011 urinary atrazine metabolite levels in the nine samples collected within 24 hours of known aerial applications of 2,4-D and atrazine. Given that atrazine is a controlled substance whose use must be reported, these four aerial applications were the most likely sources contributing to the observable increase in urinary atrazine metabolite levels for those nine 24-hour subset samples.

The spring 2011 urine samples had overall generally elevated concentrations of 2,4-D and atrazine metabolites and many of them (13) were collected prior to any known applications for the year. This indicates that additional sources of these pesticides in the community exist that cannot be explained by the application records data available to OHA.

Comment 28: "I think that the PHA should recognize that any rural farming or forestry populations are going to have greater exposure levels than US urban populations to these compounds. If the comparison base was stratified for this bias, I did not see it in the PHA."

Response: The NHANES data used as a representation of the general U.S. population may have an urban bias, however, it is the only dataset available for use as a reference point for the U.S. overall. It is not possible to stratify these data by parameters that would separate urban from rural subpopulations.

Comment 29: "By treating the Highway 36 Investigation as an isolated incident, the PHA fails to assess the overall risk of pesticide exposure and how the increase of that risk is related to Oregon's forestry chemical policy."

Response: OHA understands that many of the climate, topography, and land use patterns at play in the investigation area are not unique in Oregon. However, the State does not have the resources to expand the investigation beyond its current geographical scope.

Comment 30: "We encourage PARC to continue to study the effects of pesticide/ herbicide applications in the forested rural Oregon, making an effort to:

a. include larger sample sizes to gain statistical significance
b. establish adequate scientific measures to test the air
c. obtain accurate chemical applicator records including private applicators
d. investigate research into the impact of pesticide/herbicide impact on human health including research in addition to EPA data, and evidence of the synergistic effect of multiple and chronic chemical exposure for both adults and children
e. study long term health data for residents in rural forested areas"

Responses:

a. OHA currently does not have the resources or capacity to test larger numbers of affected community members
b. EPA is developing methods and equipment for testing air quality relative to ambient pesticide concentrations
c. The records that ODF, ODA, and OHA have requested and reviewed include private chemical applicators. Private applicators are also required to keep application records and supply them when requested.
d. See response to comment 22 and 32
e. A long-term health study is beyond the scope of this exposure investigation. An academic institution would be best suited to seek special funding for and implement a long-term health study.

Comment 31: "On page 23, the PHA states that 'eight of the thirteen known ….pesticide applications that occurred during fall 2011 … used Glyphosate.' However, according to the official spray records obtained by [redacted], there were thirteen instances of Glyphosate use. (See table)"

Response: The referenced statement in the PHA only applies to applications from both forestry and agricultural sources that occurred on the days EPA and DEQ were collecting environmental samples (Sept. 19-22). The referenced table provided by this commenter listed seven forestry applications that occurred outside of the Sept. 19-22 period and did not include two agricultural applications that did occur during that period.

Comment 32: Many commenters attached or provided links to peer-reviewed studies that supported evidence showing low-dose chronic exposure to atrazine can cause harmful health effects. The comments claim these studies and materials indicate that current toxicity thresholds are not protective of public health, especially for children. Based on conclusions of submitted materials, commenters urged OHA to conclude more definitively that the level of exposure documented in Highway 36 Corridor residents has harmed, is harming or will harm their health or the health of their children.

Other comments state that the PHA understated the margins of safety built in to the toxicity threshold values used to evaluate exposures in terms of public health risks.

Response: OHA reviewed the materials submitted by commenters. There is a wide variety in findings, quality, and relevance of materials provided. Some of the materials submitted to OHA consisted of research papers describing effects on wildlife (e.g. frogs), and it is difficult to know how relevant those effects are to human health. Other submitted materials described effects observed in vitro (looking at cells in isolation in a petri dish), and it is difficult to predict how changes seen in vitro will translate into a complex, living human being. Toxicologists use in vitro studies to determine which outcomes to look for in animals or humans. Sometimes those outcomes are found in animals or humans, and often times they are not. Because predictions based on in vitro studies often do not translate into observed changes in animals or people, they cannot be used on their own to support toxicity thresholds. Other submitted articles described epidemiological studies in humans where atrazine exposure was statistically associated with specific health outcomes in humans. This report already references some of those epidemiological studies. EPA and ATSDR have regular review schedules for atrazine. Epidemiological studies published before the last review would have already been considered in existing toxicity threshold values. Epidemiological studies published after the last review will be considered in the next round of review for atrazine.

OHA cannot develop its own threshold values, as the time and cost is prohibitive. OHA relies on the EPA and ATSDR to determine appropriate toxicity threshold values.

Toxicity threshold values represent doses, including large safety margins, of a given chemical below which no human health effects are expected over designated lengths of exposure. EPA has an oral reference dose (RfD) for atrazine (35 µg/kg-day) which applies to chronic exposure over a lifetime and was designed to be protective of sensitive populations including children. ATSDR also has an oral minimal risk level (MRL) for atrazine that applies to acute or short-term exposures lasting less than 2 weeks. This acute MRL is 10 µg/kg-day. ATSDR also has an MRL for oral exposure to atrazine lasting longer than 2 weeks but less than 1 year. This intermediate MRL is 3 µg/kg-day.

One common thread for all of these toxicity thresholds is that they are expressed in terms of an oral dose delivered per kilogram body weight per day. Given that none of the environmental sampling (drinking water, food, soil) for this EI found atrazine at detectable levels, it is impossible to estimate an oral exposure that could be compared against these toxicity thresholds. Community sampling found atrazine metabolites in urine. However, there are no currently available methods (public or peer-reviewed) to estimate an oral exposure that could be compared to these toxicity thresholds based on a concentration in urine. Therefore, OHA is not able to compare measured concentrations of atrazine metabolites in urine against any toxicity thresholds, which would support conclusions about health effects related to the measured atrazine concentrations in urine.

Comment 33: Several comments expressed concern that the toxicity information on 2,4-D and atrazine that the government uses relies too heavily on industry-funded studies. These comments suggest that industry-funded studies could be influenced by a conflict of interest. The argument presented by commenters is that the companies selling these products have a vested financial interest in obtaining study results that indicate that their products are safe so that they can continue to sell them.

Response: While OHA understands and acknowledges this concern, it is beyond the scope of OHA's ability to address it. In addition to industry-funded studies, EPA also considers information provided from other sources such as the findings of researchers at academic and scientific institutions who study the toxicology of pesticides, as long as those studies meet appropriate data quality requirements. ATSDR establishes its MRLs using the same or similar information. To assure impartiality and data quality, the conduct of these studies is subject to strict controls, and there are steep penalties for conduct not in-line with these controls. It is the EPA and not OHA that audits these studies and enforces those controls.

Comment 34: "The PHA fails to address the fact that 2,4-D was detected in urine samples of 92% of the residents tested in fall 2011, despite that fact no 2,4-D was used in forestry or agricultural applications during the fall, with the last reported 2,4-D spray occurring in May 2011. It is unlikely that 92% of the residents used any 2,4-D products in the fall months, particularly since many of the residents do not use any pesticides on their residential property. The PHA should add a discussion as to whether 2,4-D may be more persistent in the environment than previously reported, might have a longer urinary half-life than previously reported, or that 2,4-D exposures might be from residual environmental exposures. The report should make recommendations about future investigations to better understand the fate of 2,4-D in a forestry ecosystem and to understand how the (latent) exposure is occurring."

Response: The fall 2011 urine samples indicate that 2,4-D exposure during that time period were within the expected range for anywhere in the United States. In the most recently released NHANES report, at least 50% of the sampled population had detectable levels of 2,4-D, and the sampled population was skewed towards urban environments where 2,4-D exposure is expected to be lower than in rural environments. OHA expects that the frequency of 2,4-D detection will continue to increase across the country, not so much as a function of increased 2,4-D exposure but rather as a function of chemists' abilities to detect smaller and smaller amounts of 2,4-D. None of the environmental samples collected for the EI (soil, water, food) explain where the urinary 2,4-D in fall 2011 samples came from. Because 2,4-D passes through the body within 24 hours and only lasts a few weeks in soil, 2,4-D would have been expected in soil, water, or food if those were the sources of the 2,4-D in urine.

Comment 35: Several commenters expressed concerns about the validity of community-collected urine samples based on gaps in the chain of custody. The predominant concern is that the gap in the chain of custody could have provided community members opportunity to tamper with their samples by either adding atrazine-containing pesticides to their urine samples after they had been produced or intentionally exposing themselves to atrazine.

Response: The portion of the chain of custody that was missing for some samples did not occur until after samples had been delivered to the loading docks at Emory University. All samples had complete chains of custody from the time the samples were collected at the health clinic until they were shipped from the clinic to Emory University (as explained on page 27 of the report). In order for a community member to have used the existing gap in the chain of custody to tamper with their sample, they would have to have been physically present at Emory University in Atlanta, Georgia when the samples arrived at the loading dock, intercepted them between the time university mail services picked them up from the dock and dropped them off at the researcher's laboratory, resealed the packages, and delivered them to the researcher's laboratory. This scenario is so unlikely that it cannot be viewed as a credible possibility.

Alternatively, participants could have brought pesticides containing atrazine with them into the clinic restroom where they produced their sample and added the pesticides before handing them to clinic staff. This is very unlikely because adding an atrazine-containing pesticide to a urine sample would have resulted in high concentrations of parent atrazine detected in the samples. In fact, no parent atrazine was detected in any of the urine samples. Only DACT and other metabolites of atrazine were detected. This indicates that the parent atrazine had passed through a living body and into the urine samples.

It is possible to purchase the detected atrazine metabolites online, but to add them to the urine samples in the expected ratios, as they were detected, would have required considerable skills in chemistry and sophisticated methods of measurement and the ability to distribute this knowledge to all of the participants. This scenario is extremely unlikely, and it cannot be viewed as a credible possibility.

The participants could have intentionally exposed themselves to atrazine before producing their samples, but no chain of custody or method of sample collection or delivery could have prevented this, including OHA's fall 2011 sampling procedure. Concerns about this method of tampering are separate and distinct from concerns about the chain of custody.

Comment 36: Several comments noted conflicting language in the summary portion of the PHA. The introduction to conclusions related to the question "What health risks are associated with these exposures?" stated "…no levels (of pesticides) expected to cause health effects were documented in this investigation." This statement is inconsistent with conclusion 14 (now 16) which states that "We cannot determine whether the levels of atrazine metabolites measured in Highway 36 investigation area residents' urine in spring 2011 could harm people's health."

Response: OHA updated the introductory language to that section of the summary (see page 7)to be consistent with all of the conclusions in that section.

Comment 37: "The basis of the decision for Conclusion 11 [now Conclusion 12] is misleading. Atrazine or 2,4-D were not detected in drinking water samples taken in fall 2011, most likely because neither chemical was used by the commercial pesticide operators since spring 2011. It is possible that spring sampling would find pesticide detections. Thus, drinking water cannot be eliminated as a potential exposure pathway for future exposures."

Response: The objective of our investigation included the determination of exposure pathways for the 2,4-D and atrazine that was found in the residents' urine. When the sampling protocol was developed, the EI team considered the potential for exposure from drinking water and agreed that it was very important to test the drinking water pathway. There was also agreement among the hydrogeologists on the team that if there were no detections in groundwater, this would likely rule out drinking water as an exposure pathway. The key reason for this is that groundwater chemistry tends to be stable and persistent over time. If the chemicals were infiltrating to groundwater in this area, and were transported to the drinking water sources, there would be detections in at least some of the wells. The drinking water sources tested in the fall of 2011 had no detections of 2,4-D or atrazine. Our conclusion with respect to the drinking water pathway was that it is unlikely that atrazine or 2,4-D could have been present at concentrations high enough to cause the observed urine concentrations in the spring of 2011 and then be low enough to be undetectable by fall of the same year. We apologize for not explaining this in our basis of decision in Conclusion 11 (now Conclusion 12).

OHA modified Conclusion 11 (now Conclusion 12) to specify that the elimination of this exposure pathway applies only to fall 2011 when water sampling was done. OHA also added a new conclusion (Conclusion 13) stating that the concentrations of pesticides in drinking water at other times of year and in other years are unknown. Available pesticide application records do not indicate any applications of 2,4-D or atrazine for several months prior to the first thirteen spring 2011 community-collected urine samples that contained 2,4-D and atrazine metabolites. In the unlikely event that 2,4-D or atrazine were in drinking water at that time, the source is unknown.

Comment 38: "Buried in conclusion number 14 is the following statement, 'The levels of 2,4-D measured in Highway 36 investigation area residents urine in spring and fall of 2011 were 'below levels expected to harm people's health.' Rigorous systems are established to register herbicides for use in the United States. Voluminous data are collected and analyzed prior to setting standards for exposure; in this case biomonitoring equivalents for 2,4-D. This conclusion is the definitive finding of the report. It should be presented as a dominant finding and could be more affirmatively stated, for example, '…below levels determined by the EPA to pose any health risks.'"

Response: OHA and partner agencies approached the EI with a set of guiding questions (page 1). OHA expressed conclusions in the same sequence as the questions they answer. The relative importance of the report's conclusions may vary depending on the audience.

Comment 39: A few commenters suggested that some of the exposure pathways in Table 1 should be listed as "completed" exposure pathways rather than "potential" exposure pathways.

Response: For a pathway to be listed as "complete," all five elements of the pathway (source/release, transport in environment, point of exposure, route of exposure, exposed population) have to be known to exist. In all of the potential pathways listed, there was at least one element of the pathway where there *was no data to confirm or rule-out the pathway. Most often, the missing piece of data was in the "transport in environment (media)" element of the pathway. This means there was a critical data element on pesticides in air, water, or soil missing from the pathway. It is also important to note that a pathway exists for individual pesticides. This means that imazapyr in water and 2,4-D in urine, for example, does not constitute a completed exposure pathway because they are different chemicals. Because there was no environmental (air, water, soil, food) data collected in conjunction with spring 2011 urine samples, it is not possible to determine whether any specific exposure pathway is complete for those samples. Again, this is because, for that time period, there are no data for the "transport in environment (media)" element in the exposure pathway (column 3 in Table 1 page 17).*

Comment 40: "If valid air sampling results are obtained, there should be other exposure information for use in any analysis. [Redacted] suggests that issues with the Interim Report must be resolved to ensure the best available data is used and that sample design problems are identified to substantiate data reported are of maximum quality."

Response: EPA will be the lead agency on method development, study design, and sampling plans for any future air monitoring. OHA will provide input, but will primarily rely on EPA's expertise.

Comment 41: "Because there is evidence of pesticide/herbicide exposure despite a paucity of data, and because the OHA has expressed a sincere interest in the health of the local residents, we feel one conclusion of this investigation should recommend a moratorium on aerial helicopter applications in the area as a precautionary principle to protect the dozens of residents in the area whose subjective reports, alongside PARC's investigation, point to likely airborne pathways of exposure in the process of elimination. The implicit conclusion that aerial pesticide/herbicide applications are benign until a proven pathway if found, given the extensive first-hand experience, initial urine data, and visual evidence of local residents, is biased towards the status quo, and against common sense and a basic human ethic of care."

Response: To recommend a moratorium on aerial applications, we would need to determine that aerial applications were the actual source of exposure. The evidence collected so far indicates that in spring 2011 some residents were exposed to 2,4-D and atrazine at levels that were higher than normal for the general U.S. population. However, the timing of many of the spring 2011 samples collected was before any known aerial applications (see responses to comments 1 and 12). These samples had elevated levels of 2,4-D and atrazine even though they were collected before any known aerial applications. This indicates that aerial applications may not be the major source of atrazine or 2,4-D found in urine samples. With this uncertainty, we must conclude that the data do not support a moratorium on aerial applications.

Comment 42: OHA received several comments with specific suggestions and input about the study design and sampling plans for future air monitoring and other kinds of environmental monitoring in the EI area. Some of the suggestions include numbers of monitors that should be deployed, where they should be deployed, how long they should be deployed for, and who should know when and where monitors are deployed. Some comments provided detailed plans for water and other environmental sampling.

Response: See response to comment 40. OHA has already provided EPA these comments for them to consider as they design future environmental monitoring methods, studies, and sampling plans.

Comment 43: Some comments requested that OHA work directly with legislative counsel to develop a bill that would establish a notification system that would allow residents necessary information about timing and location of pesticide applications to be able to leave the area if desired.

Response: OHA has already recommended that partner agencies that are more directly involved with the regulation of pesticides develop or modify a notification system. OHA intentionally kept the language in the recommendation broad, with the ultimate goal of a functional notification system in mind. It may be that the goal can be achieved more quickly without engaging the legislative process. OHA wanted to avoid designating a specific process by which this goal must be achieved, allowing room for innovation and efficiency. OHA does not have enough experience in pesticide use regulation to confidently recommend a specific process or notification system. OHA is available to partner agencies to consult and inform the process as needed.

Comment 44: Several comments expressed that no amount of exposure to pesticides is acceptable, no matter how small.

Response: Every individual chooses whether a level of exposure is acceptable to them or not. As a public agency, OHA is constrained to make determinations about thresholds of toxicity based on science. The weight of scientific evidence clearly demonstrates that toxicity depends on the dose of a chemical received. Even in the case of endocrine disruptors and other types of chemicals with low-dose effects, evidence still suggests that the dose is important. There is a great deal of public debate occurring about whether current testing programs are adequate to capture potential low-dose effects, but most scientists still agree that there is some dose below which no harmful health effects are likely to occur. The reality of life in the developed world is that exposure to chemicals at some level is unavoidable, and as chemists improve their ability to detect lower and lower concentrations of chemicals in the environment we expect to find chemicals where previously we could not.

Comment 45: Several comments expressed concern about the cost of the EI in light of the lack of clear findings of harm to public health. These comments request that the EI be discontinued.

Response: One critical exposure pathway, air, has not yet been fully characterized. It is important to continue the EI until we have a clear picture of the potential for people to be exposed to pesticides via air, from either drift or re-volatilization. The EPA is in the lead of future work on the EI related to air monitoring. OHA will be available to consult and inform EPA's process, but this involvement is not likely to be extensive or costly to the state. OHA has also committed to analyze pesticide application record data from 2009 and 2010 to document trends in application practices over time and to determine whether conditions in 2011 were representative of typical years. OHA will present the results of this analysis along with (i.e. at the same time as) results from EPA's air monitoring.

Comment 46: Several comments expressed concern that additional sampling is needed and that the EI would be discontinued too soon.

Response: See response to 45.

Comment 47: Several comments requested buffer zones around residences and schools where no aerial pesticide applications would be allowed. Suggested buffer zones varied in distance from schools and residences and in the permanence or duration of the use of buffer zones. Some wanted permanent buffer zones, while some wanted temporary buffer zones until air movement from application sites is better understood.

Response: OHA created a new recommendation (page 10) to partner agencies to continue to collaborate to develop best practices to reduce exposures to people in the community. Buffer zones may be one of multiple options to address this recommendation.

Comment 48: Several comments suggested that OHA, "Complete a thorough analysis of the pesticide data using spray records data from 2009 through 2013. Look for trends and examine the forestry pesticide practices and human health and environmental data to determine the source of pesticides exposures."

Response: As stated in the response to comment 13, OHA did not have the resources to enter and analyze records from 2009-2010 for this report, but it is on the Public Health Action Plan for additional work on the EI. That additional analysis will be done and released in coordination with additional air monitoring work the EPA is planning. Also, see response to comment 26.

Comment 49: There were several comments that were similar to this one asking OHA to "Perform air sampling and monitoring, and test for biomarkers in accordance with the seasonal cycles of forestry pesticide spray. [Redacted] has analyzed the seasonal trends and found that Atrazine, 2,4-D, Clopyralid and Hexazinone are typically used in the spring. Glyphosate, Imazapyr, Triclopyr, Metsulfuron methyl and Sulfometuron methyl are typically used in the summer and fall. Fall urine samples should be analyzed for Glyphosate."

Response: Additional air monitoring is in the methods development and planning phases (see response to comment 45 and 26). The second paragraph of the "Suspension of Spring 2012 Sampling" section on page 26 of the report highlights the logistical challenges of additional urine sampling timed to pesticide applications. These challenges make additional urine sampling unfeasible for OHA. While many environmental laboratories have the technical capacity to test for additional pesticides in liquid media, they often lack the necessary accreditation to handle human biological samples. Conversely, public health laboratories that have the accreditation to handle human biological samples often lack the equipment to test for pesticides. The laboratory at the National Center for Environmental Health (NCEH) in Atlanta, GA is one laboratory with the capacity to do both. However, they do not have methods in place to test for glyphosate or any of the other pesticides mentioned in the comment. California and Washington States both have some capacity to test for pesticides in biological samples, but for the most part they house the same methods used at the lab in the NCEH to ensure that their results can be compared against NCEH's reference populations (NHANES). Another challenge to testing for additional pesticides in urine highlighted on page 26 of the report is that having results with nothing to compare them with would have little meaning. Without some reference population or toxicity value, it would be impossible to determine whether measured results (if detected) were high or low compared to other people in the United States or compared against toxicity thresholds. Also, see responses to comment 13 and 45 regarding additional analysis of pesticide application records.

Comment 50: "Detection of pesticides in residents' urine samples indicates the probability that pesticide applications violate registered product labels and present a heightened drift risk. [Redacted] recommends that the Investigation Team undertake a thorough investigation of aerial forestry spray practices, including height of aerial craft at time of spray, weather, wind, temperature, droplet size, pesticide product, tank mixing and the use of adjuvants."

Response: Detection of pesticides in resident's urine does not necessarily indicate that a registered label violation has occurred. Numerous studies of applicators and their families have routinely found detectable concentrations of pesticides in their urine even when applicators carefully follow label instructions. OHA relies on ODA and ODF to ensure that pesticides in Oregon are applied according to the labels.

Comment 51: One commenter recommended that OHA:
"1. Obtain spray records for 2009-2013.
2. Ascertain why there have been increases in
    a. Number of spray applications
    b. Pounds of pesticide applied
    c. Increase in the pesticide products sprayed
    d. Increase in the pounds applied per acre
3. Fill in the data gaps to evaluate how repeated applications, tank mixes, adjuvants and aerial spray may increase risk to public health.
4. Use different ways to evaluate the spray data for environmental toxicity and impacts to public health. RfDs and BEs are narrow ways to view the data; we recommend a systems approach.
5. Evaluate individual practices of the timber operators and make recommendations to develop policies that ensure the safest practices that will protect nearby communities from aerial drift and exposure to 2,4-D and Atrazine."

Response:
1. See responses to comments 13 and 45
2. Items under recommendation 2 are beyond the scope of the current report
3. These questions are beyond the scope of the current EI and require research budgets not available to the EI team.
4. Environmental toxicity is beyond the scope of OHA's expertise and involvement in the EI. Developing a new method to evaluate human toxicity of pesticides beyond RfDs and BEs is an extremely time and resource intensive process that is beyond the capability of the EI team.
5. Continued work on the EI may help to reach some of the goals in this recommendation. Recommendations in the report itself are designed to protect nearby communities and obtain additional information needed to assess the health risk of area pesticide application practices.

Comment 52: Several commenters stated that they have used various pesticides including 2,4-D and atrazine for many years and have never seen any ill health effects as a result in themselves, their families, or their friends as a result.

Response: Individual experiences or anecdotal information can be helpful in identifying areas for further study. However, without systematic measurement, such information is not usually sufficient to draw conclusions about the burden of disease in a community.

Comment 53: A few comments stated that the report is fatally biased and flawed and should be rewritten or not published

Response: OHA acknowledges that no report can please all readers. All comments are valued and recorded.

Comment 54: A few comments asked for a spray drift study in the Highway 36 Corridor.

Response: EPA is developing plans for future air monitoring to determine concentrations of pesticides in air over a few weeks at a time that span one or more aerial applications. This is not a drift study per se, but will be useful information to help answer questions about human exposure.

Comment 55: Several comments accused state and federal regulators and state and local elected officials of allowing pro-pesticide lobby and trade associations to unduly influence their decisions in regulating how pesticides are used in Oregon and in thwarting efforts to complete originally planned sampling in the spring of 2012.

Response: This comment has been noted.

Comment 56: Some comments accused individual staff on the EI team of demonstrating bias in interactions with community members and in the report.

Response: This comment has been noted.

Comment 57: Some comments stated that atrazine should be banned in the United States as it is in the European Union.

Response: Banning any particular pesticide is beyond the scope of this EI and national policy is beyond the scope of OHA's authority.

Comment 58: "The Oregon Forest Practices Act is a 40 year old policy and is ineffective in protecting rural communities from the impacts of forestry operations for their homes, schools, gardens, drinking water and other activities; the OFPA fails to monitor pesticide applications and the environmental fate of these chemicals, fails to ensure that any aerial practice does not exceed the product label recommended maximum height of ten feet which is used by the EPA to assess drift risk off-site drift; does not address weather, slope, wind direction and swath adjustment for moving wind and fog; and does not address deposition, run-off and chemical-laden sediment in streams."

Response: The Forest Practices Act is the result of state legislation, and as such, it would require legislative action to change it. OHA encourages citizens to work with their elected officials to address concerns about this or any other state law.

Comment 59: "Legal Responsibilities and Rights – Though it may be outside of the scope of your study, I feel that it would strengthen the assessment of a section was added that clearly outlined both the specific responsibilities that state agencies and leaders have for monitoring, analyzing, and regulating use of chemicals in Oregon forests, and the rights of Oregonian related to use of chemicals in Oregon forests. I would assume that this would include such things as my right, as a forest owner, to use chemicals, and the right of my neighbor not to be poisoned by the chemicals that I use. One role of government is to sort out how best to balance these two rights. Your assessment would be more helpful if it both highlighted these types of tensions and explained how we currently resolve the tensions between these two rights."

Response: A summary of legal authorities regulating pesticide use in forest practice and the agencies responsible for administering those laws is outside the scope of this report but has been posted to OHA's website at: http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/EnvironmentalHealthAssessment/Hwy36/Documents/Oregon%20Regulations%20on%20Pesticide%20Applications_final.pdf

Comment 60: "[Redacted] suggests that the final report reference the Washington Forest Practices Act as a viable model for policy changes that would:
1. Align forest practices in neighboring states;
2. Create consistency for timber operators who have operations in both Washington and Oregon, and have a history of compliance with the Washington Forest Practices Act;
3. Promote monitoring and metrics, two aspects of developing good science and reliable data;
4. Provide a blueprint to update the 40-year-old Oregon Forest Practices Act to reflect new information about health and environmental harms associated with pesticide use.
5. Provide the suggested notification of upcoming pesticide sprays that are necessary for rural communities who seek to protect their families, their home grown food and their property."

Response: See response to comment 59. For a comparison of aerial pesticide application practices in the Pacific Northwest see the analysis written by EPA's Region 10 office here: http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/EnvironmentalHealthAssessment/Hwy36/Documents/Oregon%20Regulations%20on%20Pesticide%20Applications_final.pdf

Comment 61: "The basis of the decision for Conclusions 19 and 20 (now Conclusions 21 and 22) are misleading. We observe that a great deal of frustration and friction arises from the lack of credible and meaningful response from state agencies and the Board of Forestry. The community needs a response from the government that respects citizens' rights not to be poisoned and eliminates pesticide exposure from chemical trespass."

Response: OHA received and responded to several similar comments (see below) and revised Conclusion 19 (now Conclusion 21) to broaden the language to include frustrations other than those existing among and between community members.

Comment 62: "While understanding that divisiveness is not healthy for any local community, and many expressions of local distress have been disrespectful and counterproductive, we'd like the PARC team to recognize that their actions also serve a role in the system, and being "neutral scientists" does not exempt the group from impacting the conflict and potentially further polarizing the community. In particular, we would like PARC to:

- respond with more concern to those most vulnerable and expressing distress – this includes validating subjective experience rather than invalidating this experience as untrue until proven by research to be otherwise
- holding an appropriate empathetic presence to those whose lives have been seriously impacted by events described to the PARC team
- allow residents to speak directly to the PARC team in any future meetings rather than have the community "speak to one another," an action which appears self-protective rather than productive. It is also obfuscating to communicate details of the investigation and government agency intricacies beyond the interest and understanding of most participants, rather than distill this information in an appropriate manner in order to open the discussion in a more constructive manner.
- avoid advice that can sound patronizing, and assessment that local conflict can be reduced to "property rights issues" or "different values." All people value health – this is not up for question. When encountering hostility, anger or lack of trust, it may be useful to look into the ways in which they are also a response to the way in which the public agencies have failed to protect public health in the past despite the good intentions of this current PARC team. While not conducive mindsets to positive change, we feel it is inappropriate to blame local residents for poor behavior on top of their original and long standing complaint and to reduce this very serious environmental issues to lifestyle preferences."

Response: Thank you for your comments and suggestions; we will consider them in our future efforts with the investigation. The community concerns section of the report (pp. 40) is where we describe people's subjective experiences more fully, and hopefully, more meaningfully.

Comment 63: "In regard to the section of your preliminary report that addressed internal community relations and, in your opinion, the value of a mediator, we hereby agree but with one key difference: The mediation process would be valuable but the participants in the mediation should be between industry reps and those community members that feel have been harmed by their practices. I – the lead petitioner to the EPA – have never once had any problem with a local farmer or any other community member."

Response: OHA recognizes that formal mediation is one approach among many that could help reduce community stress and improve well-being. If all parties are receptive to the idea stated in the comment, then community leaders, formal leaders (i.e. elected officials), or others in a leadership role can take an active role in initiating that process.

Identifying leadership to spearhead the effort is a critical first step. In the event the community would like to look into professional mediators, here are a few resources to consider. OHA does not have experience with any of these resources and cannot recommend one over the other:

- *The Center for Dialogue & Resolution (formerly Community Mediation Services): www.communitymediationservices.com Phone: (541) 344-5366*
- *The Oregon Mediation Association: www.omediate.org Phone: 503-872-9775*
- *Linn-Benton Mediation Services: 541-928-5323*
- *Your Community Mediators of Yamhill County: http://www.ycmediators.org/ Phone: 503-435-2835*

- *Six Rivers Community Mediation (has an agriculture disputes program): http://www.6rivers.org/community-mediation.html Phone: 541-386-1283*
- *Oregon Solutions: www.oregonsolutions.org/about/contact-us phone: 503-725-9092*

Comment 64: Several commenters felt that the agencies involved in the investigation should increase their knowledge of environmental justice (EJ) issues and establish EJ-related goals for the remainder of the investigation. One commenter felt that the community was denied meaningful public input and instead was blamed for the conflicts and dysfunction. From their viewpoint, this constituted "a violation of EJ principles". This commenter also recommended that the federal agencies on the Investigation Team set a goal of complying with the 1994 Presidential Executive Order 12898 on Environmental Justice.

Response: EPA defines environmental justice (EJ) as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."

OHA is dedicated to the principles of environmental justice. OHA has worked throughout the EI process to incorporate input from Highway 36 Corridor community members who have provided a broad range of viewpoints. OHA's efforts to solicit and incorporate meaningful input from the community have included:

- *Engaging in multiple phone conversations, in-person conversations, emails and listserv updates to and from community members;*
- *Coordinating and hosting three large community meetings that included significant portions dedicated to listening to the community, with input from the community on how that was accomplished;*
- *Coordinating an open house with all involved agencies, as an opportunity for community members to ask questions of and give feedback to the investigation team;*
- *Coordinating a data-sharing open house with community members to share community-collected environmental data and give permission for OHA to include the community-collected urine samples for consideration to be included in the report;*
- *Participating in a community-led conference call with a professor of biochemistry & molecular biology about endocrine disruptors (at the request of community members);*
- *Incorporating and analyzing community-collected air, water and urine data into the report;*
- *Sending out mass mailings, distributing surveys and seeking input on community engagement approaches;*
- *Responding to requests for information, reading literature submitted by community members;*
- *Securing and documenting the chain of custody for the community collected urine samples in order for them to be included in the report;*
- *Soliciting, describing and documenting community concerns; and*
- *Continuing to be a source of information, updates, outreach, and resources*

It is OHA's intention to engage with community members in a meaningful way and support partner agencies to do the same in any future activities related to this investigation.

Comment 65: "The draft report contains two conclusions regarding community conflict over the issue of pesticide use in the study area. In my opinion, this is what is popularly called a "red herring" designed to distract attention from the fact that stress in the study area has resulted from the abject failure of Oregon's state agencies to responsibly address the concerns of study area residents for up to seven years before this investigation began. While I believe that the OHA staff who are participating in this investigation are approaching their work professionally and responsibly, there is no doubt that the residents of the study area have been ignored, insulted, and treated badly for many years by the Oregon Departments of Forestry and Agriculture, as well as the multi-agency Pesticide Analytical and Response Center (PARC)… I saw first-hand how individuals who complained about pesticides to state agencies were ignored, vilified, and demonized by staff from ODA and ODF in particular. It is the nature of regulatory agencies in this country to develop strong ties with the regulated community, and in this case, those ties have interfered with the ability of ODA and ODF in particular to appropriately respond to community concerns regarding potential ill effects from pesticides."

Response: We understand that concerns have been ongoing for many years. Identifying safety concerns is one of public health's roles when working with communities, and OHA is concerned that underlying animosities could result in property damage, personal injuries or worse. We have identified personal safety, mistrust of government and inadequate protection of public health as explicit community concerns that were reported directly to us. Conclusions 19 & 20 (now 21 and 22) were not intended to distract attention from public agencies' responsibilities, but rather to highlight a significant finding of concern.

Comment 66: "The following statement is taken from page iii of the draft report:
"The Highway 36 Corridor EI is a multi-agency effort to respond to several community members' requests to investigate possible exposures to pesticides and herbicides used in applications in the Highway 36 corridor." In fact, the impetus for this investigation was not the requests of community members to investigate possible exposure to pesticides and herbicides; it was the testimony of a national expert in pesticide exposure that residents' urine tested positive for 2,4-D and atrazine, at levels higher than found in the general population. Requests by residents for investigation were routinely ignored by state agencies for years, and it was only when exposure was already documented by urine testing that the state took notice. With all due respect, I suggest that starting out this report with such an obviously self-serving statement that stretches the truth will do little to add to the report's credibility. It would be refreshing, indeed, if the authors would acknowledge the truth—that it was only after pesticide exposure had been documented by urine tests from an acknowledged national expert that state officials took any action at all."

Response: This comment has been noted. OHA added language in the report's forward that more explicitly describes how the EI was initiated.

Comment 67: Some comments expressed concern that the recommendation to improve notification of neighbors about impending forestry pesticide applications places the burden on citizens to protect their health and their children's health (e.g. by leaving their homes for a time) rather than controlling the source of the pesticides.

Comments expressed that state and federal agencies should not allow aerial pesticide applications at all, claiming that it is a human right to not be exposed to hazardous chemicals that have trespassed onto their own private property or public property where they may be exposed.

Response: While OHA recognizes that many people are dissatisfied with pesticide application practices and regulation of pesticide use in Oregon, the Oregon Forest Practices Act (FPA) regulates pesticide use in Oregon's state and private forests. ODF is the state agency responsible for administering the FPA. ODF responded to this comment, "The FPA directs the Oregon Board of Forestry to adopt administrative rules to encourage economically efficient forest practices consistent with natural resource protection. Under the authority of the FPA, the Board has adopted the Chemical and Other Petroleum Product Rules regulating pesticide use on private and non-federal public forestland. The Oregon Department of Forestry administers the FPA and associated administrative rules, but neither the Board nor the Department has the authority to ban pesticide use to protect human health, as long as federal and other state laws allow the uses. If there are monitoring or research findings indicating that current forest practices for pesticide applications result in quantities in soil, air or waters of the state that are injurious to water quality or the overall maintenance of terrestrial wildlife or aquatic life, the board may consider the need for forest practice rule changes. The Board intends that that the FPA and administrative rules work together with federal regulations (U.S. EPA's product registration and labeling requirements) and other state regulations (Oregon Department of Agriculture's Pesticide Control Law) in an integrated pesticide regulatory framework that protects human life, health and property, and the environment. Citizens who believe changes are needed in the FPA may contact their state elected officials to talk about their concerns."

For more information about how pesticide use is regulated in Oregon, see the summary on OHA's website here:
http://public.health.oregon.gov/HealthyEnvironments/TrackingAssessment/EnvironmentalHealthAssessment/Hwy36/Documents/Oregon%20Regulations%20on%20Pesticide%20Applications_final.pdf

Comment 68: "My over-all observation is that if one detects a few parts per trillion in urine, and that this detection differs slightly or not at all from the general population, *there is no possibility of identifying the source, and that the exposures are trivial and low priorities for investigations* (italicized emphasis part of original comment as received). This should have been a guiding principle in this investigation as soon as the first evidence of urine samples had been evaluated."

Response: This comment has been noted. Urine concentrations in the investigation area have been measured in the parts per billion range, not parts per trillion. The EI was initiated not only in response to measured urine concentrations but also in in response to community requests.

Comment 69: "Holistic vs. Reductionistic [sic] Assessments - Though I understand that the nature of the division of responsibilities between state agencies presents challenges in doing this, I feel strongly that future research into the impacts of chemical use in Oregon forests should use a holistic and integrated approach by investigating the impacts on all of the major living communities in the study are – human and more than human. Continuing to do research in isolated silos compromises our collective success in fulfilling our responsibilities to accurately understand the impacts of chemical use across the landscape."

Response: This comment has been noted. While OHA's focus in the EI and on this report is human health, OHA has collaborated with agency partners such as DEQ, ODA, ODF, EPA, and ATSDR throughout the process. OHA is keenly aware that the natural environment and human health are linked, and OHA collaborates with other agencies to ensure that this connection is understood.

Comment 70: One commenter pointed out that the investigation has not analyzed the urine of individuals living within a few hundred feet of aerial sprays, and that participants in the Exposure Investigation lived miles from known applications. The commenter stated that no samples were collected on the same day of exposure, and that those participating in the community-collected urine sampling lived an average of 1.5 miles away from spraying activity and that OHA has not and cannot comment on the level of harm to those living within a few hundred feet of aerial sprays.

Response: All scientific studies are limited in their conclusions by the data collected. One of the areas in which this EI is limited is that data only exists for the individuals that participated in the investigation. There may have been residents living closer to pesticide applications than those participating in the EI, but without data, OHA is unable to support conclusions on how those individuals may have been affected by pesticide applications.

Appendix B: Application Records

OHA requested 2009-2011 application records from ODA and ODF in October 2011 and received most of the application records in June 2012. This section describes OHA's analysis of 2011 application records.

2011 Application Records: Descriptive Statistics

There were 161 reported pesticide applications in the Highway 36 investigation area during 2011. Forty-one (25%) of these 161 reported applications were only reported to ODA, and 120(75%) applications were reported to ODF. Based on OHA's interpretation of the data, 10 (6%) of the 161 applications were for agricultural purposes (e.g., applications on Christmas tree farms and pastureland), 133 (82%) were for forestry operations, and 18 (11%) were roadside applications. Table B1 shows a breakdown of the 2011 application data by these three major "sectors".

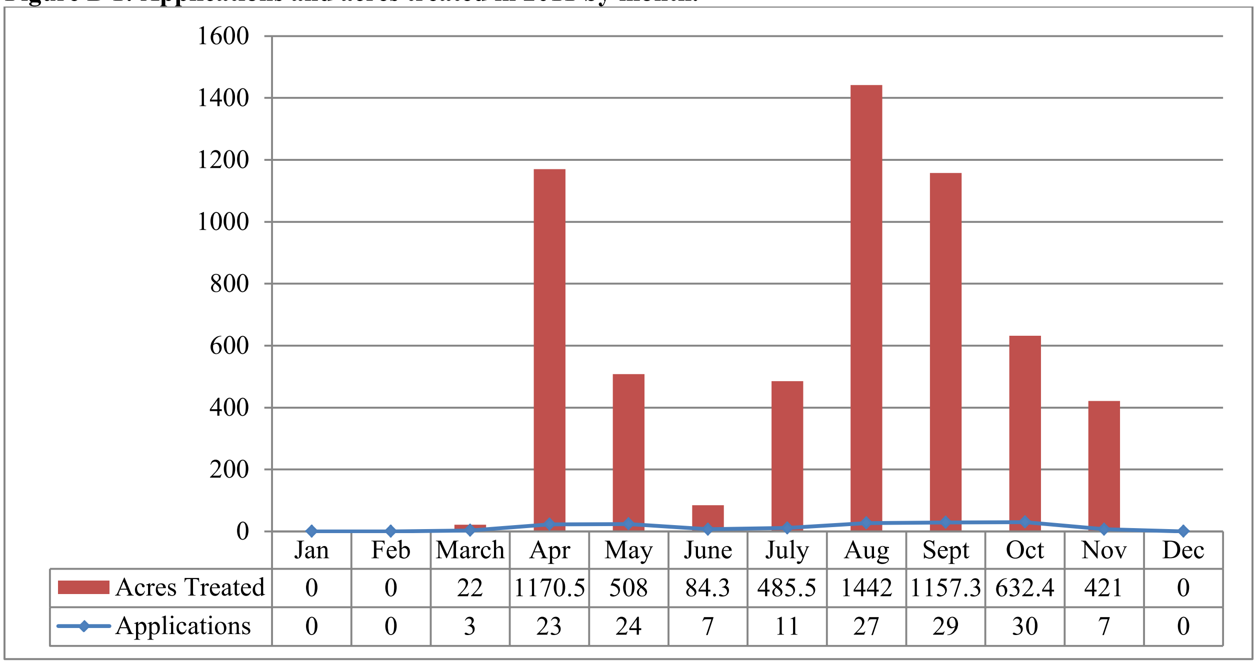
Table B 1: 2011 application data by sector

	Agricultural	Forestry	Roadside	Total
Applications	10 (6%)	133 (82%)	18 (11%)	161 (100%)
Acres Treated	90 (2%)	5,750 (97%)	83 (1%)	5,923 (100%)
Amount pesticides applied (gallons)	128.6 (6%)	2043.5 (92%)	53.5 (2%)	2225.6 (100%)
Amount pesticides applied (pounds)	60.0 (4%)	1345.9 (96%)	0.0 (0%)	1405.9 (100%)

% = percent
Percentages do not add up to 100% because of rounding

There were no applications in January and February, and three applications on 22 acres of land at the end of March (Figure B1). There were 23 applications on 1,171 acres in April, and 24 applications on 508 acres in May. There were few applications in June, 11 applications on 486 acres in July, and 27 applications on 1,442 acres in August. There were 29 applications on 1,157 acres in September, 30 applications in October on 632 acres, and seven applications in November on 414 acres. There were no applications in December 2011. See Figure B1 below.

Figure B 1: Applications and acres treated in 2011 by month.*



* Note: Two applications in March, one application in June and one application in July were missing data on acres treated.

Aerial applications accounted for 23% of 2011 applications, and roughly 37% of acres in the investigation area were treated with this method (Table B2). Approximately 22% of applications were hack and squirt treatments (34% of acres), 11% of applications were roadside applications, and approximately 27% of applications were ground-based treatments (18% of acres).

Table B 2: Application methods for 2011 pesticide applications in investigation area.*

Application Method	Number of Applications	Acres Treated
Aerial	37 (23%)	2198.5 (37%)
Ground	44 (27%)	1045.2 (18%)
Roadside	18 (11%)	82.8 (1%)
Hack and Squirt	35 (22%)	2022.0 (34%)
Unknown	27 (17%)	574.5 (10%)
Total	161 (100%)	5923.0 (100%)

*Note: We inferred application method for six aerial applications, three ground applications and two roadside applications. % = Percent. Percentages do not add up to 100% because of rounding.

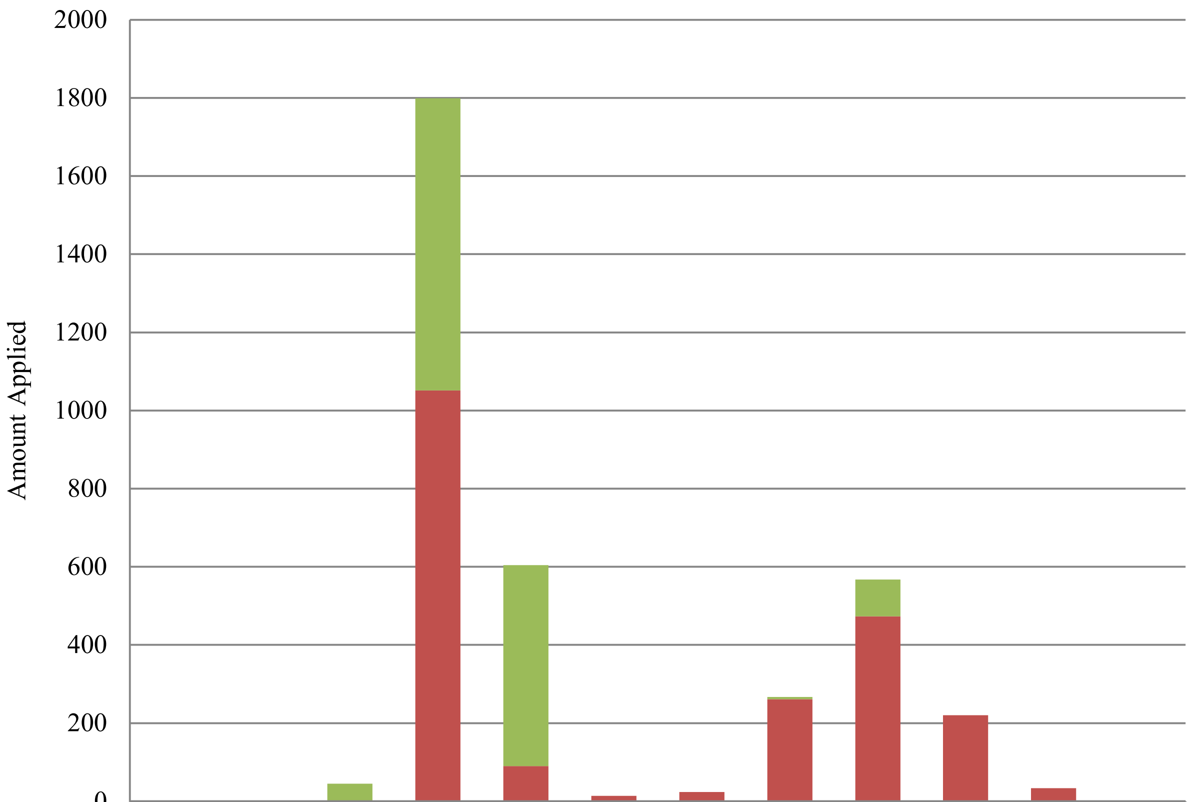
During 2011, an estimated 2,168 gallons of liquid pesticides and 1,406 pounds of dry pesticides[20] were applied in the investigation area (Figure B2). There were ten pesticides (not including adjuvants)

[20] These are estimates of pesticides in liquid and dry form before they were mixed with water, surfactants and other additives.

applied in the same area in 2011: 2,4-D, aminopyralid, atrazine, clopyralid, glyphosate, hexazinone, imazapyr, metsulfuron methyl, sulfometuron methyl, and triclopyr. Pesticide amounts were reported as a mixture of pounds and gallons. It is possible to convert gallons to pounds, but OHA did not have the time resources to make those conversions for this report. Without making this conversion, it is not possible to rank pesticides by overall amount applied. The pesticides used were: hexazinone (1,304 lbs/50 gallons), glyphosate (710 gallons), atrazine (702 gallons), 2,4-D (345 gallons) and imazapyr (252 gallons). 2,4-D, atrazine, clopyralid, and hexazinone were used exclusively during during the early part of the year (April and May), while imazapyr, metsulfuron methyl, and sulfometuron methyl were used predominantly in late summer and fall applications (Table B3).

In the investigation area, the township ranges with the most pesticide applications and largest number of acres treated were 16S 06W and 16S 07W (Figure B3). The township ranges with fewest applications (and fewer acres treated) were 16S 08W and 17S 07W.

Figure B 2: Amounts of pesticide products applied in 2011 by month.*



	Jan	Feb	March	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Pounds	0.0	0.0	44.0	747.8	514.5	0.0	0.0	5.8	93.9	0.0	0.0	0.0
Gallons	0.0	0.0	1.1	1051.5	90.0	14.1	23.4	261.0	473.4	220.5	33.0	0.0

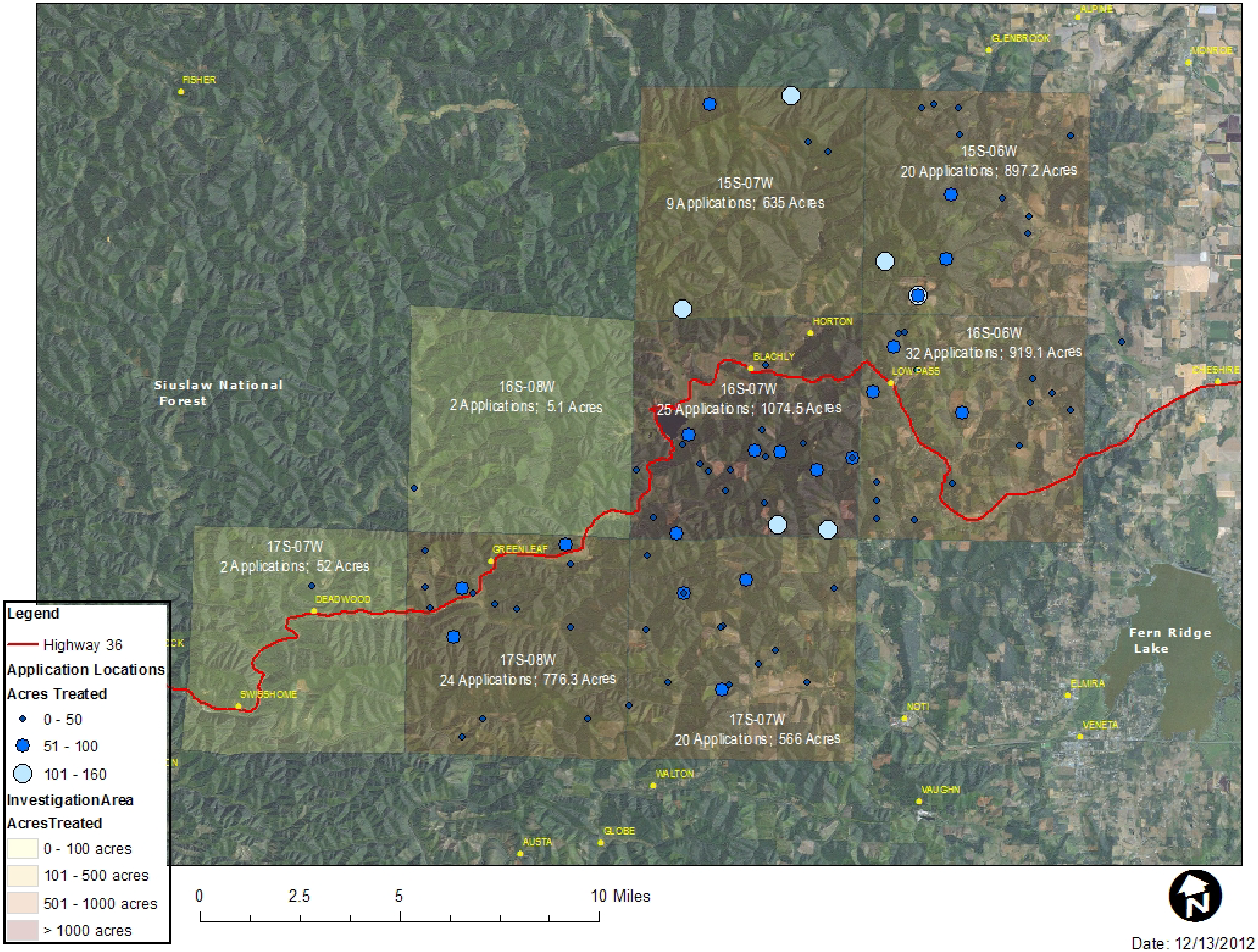
* Note: The amount applied does not include adjuvants or carriers (e.g., water, surfactants, and dyes). Two applications (one in March, one in August) were missing data indicating the amount applied.

Table B 3: Amount of pesticides applied in 2011 by month (darker shading indicates larger amounts).

Active Ingredient	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Total
2,4-D (gal)		325.4	20.0							345.4
Aminopyralid (gal)		1.5			0.6	2.7	0.5			5.3
Aminopyralid, Triclopyr (gal)			5.1	1.2	1.5					7.8
Atrazine (gal)		672.6	29.0							701.6
Clopyralid (gal)		10.8	2.1							12.9
Glyphosate (gal)	1.0	2.5	22.0	12.8	16.5	202.4	330.9	167.5	2.6	709.5
Hexazinone (gal)		38.6	11.2							49.8
Hexazinone (lbs)	44.0	745.8	514.2							1304.0
Imazapyr (gal)			0.3		3.8	48.6	140.4	44.9	30.4	251.5
Metsulfuron methyl (gal)						0.1	0.9	0.2		1.3
Metsulfuron methyl (lbs)						5.8	22.6			28.3
Sulfometuron Methyl (gal)	0.1					3.8	0.6	4.0		8.6
Sulfometuron Methyl (lbs)		2.0	0.4							2.3
Sulfometuron methyl, Metsulfuron methyl (gal)						3.3		3.8	0.2	3.3
Sulfometuron methyl, Metsulfuron methyl(lbs)							71.3			71.3
Triclopyr (gal)			0.8	1.3	21.8	24.6	8.6	0.8		57.5
Total (gal)	1.1	1051.5	90.5	15.3	45.2	285.5	482.0	221.2	33.2	2225.6
Total (lbs)	44.0	747.8	514.5	0.0	0.0	5.8	93.9	0.0	0.0	1405.9

*Notes: Excludes carriers and adjuvants. One application of glyphosate and sulfometuron methyl in March, and one application of glyphosate and triclopyr in August were missing data on the amount applied. Gal = gallons; lbs = pounds.

Figure B 3: Pesticide application locations in Highway 36 investigation area, 2011.



Data Processing and Analysis

The ODA and ODF application data were processed in Excel and SAS to obtain a single dataset of 2011 pesticide applications in the Highway 36 investigation area. The final merged dataset had data on 161 applications (Table B4). SAS was used to obtain basic descriptive statistics (e.g., number of applications per month, acres treated) for the pesticide application data.

Table B 4: Number of records and applications in 2011 dataset.

	ODA Records	ODF Records
Files	-	88
Total Observations (Rows)	165	324
Number applications	100	120
ODA applications not in ODF dataset	41	
Total applications	161	
ODF – Oregon Department of Forestry; ODA = Oregon Department of Agriculture		

ODF Records Data Entry

OHA staff abstracted all available ODF records for 2011. Data were abstracted into an Excel spreadsheet. Table B5 shows the fields abstracted from the records. One OHA staff member abstracted records from January – July 2011, and another OHA staff member abstracted records from August – December 2011.

Table B 5: Data fields abstracted from ODF records.

Data Field	Notes
Notification and Unit Number	-Indicates the corresponding ODF notification number
Application Date	-Date of application. Some records had more than one date on the record. If the record indicated the amount of chemicals applied on each date, we entered each date as a unique application. If the record provided the total amount of chemicals applied over several dates, we treated the record as a single application, and entered multiple dates/times in the appropriate cells.
Project Name	Name of treated unit
Landowner, Operator, Contractor	The Landowner and Contractor fields were abstracted from records; the operator field was populated based on information on ODF's SharePoint site.
Township, Range and Section	Township-Range-Section location of treated unit. If the area spanned multiple sections, we entered all sections separated by commas (e.g., 10, 12, 14).
Longitude, Latitude	Many records did not have latitude/longitude indicated. For these records, we estimated coordinates using the following process: 1) If the record (or corresponding notification) included a map of the unit, we visually identified the unit using ArcGIS, and used the rough center point of the unit for longitude/latitude coordinates. 2) If no map was available, we used the coordinates of the center point of

Data Field	Notes
	T/R-Section in which the unit was located. Note: Used GCS_NA_1983 coordinate system
Other location	Not standard across records; may drop this field. Some records indicated elevation (entered as E:XXXX). A few applications occurred in Benton County, but within our investigation area.
Acres	Most records indicated the number of acres treated, though a few records of roadside treatments indicated miles instead of acres.
Chemical Supplier	Entered company indicated on record; left blank if not indicated.
Product Name and Registration Number	Chemical name and EPA registration number. In some cases, the product name and registration number did not match up. In these cases, we crosschecked the information with ODA application records, or used our professional judgment to enter the correct product name and corresponding registration number. In addition to registered products, we entered data on adjuvants (e.g., surfactants, dyes).
Active Ingredient	Identified from EPA product labels
Product Application Rate	In most cases, we entered the product application rate as indicated on the record. If the rate was not provided on the ODF record, but provided in a corresponding ODA record, we entered the ODA application rate. In some cases, we back calculated the rate by dividing the total amount applied by acres.
Product Total	Total product applied during the application. If the total was not provided on the record, we calculated the total amount by multiplying the application rate by number of acres.
Carrier	Product carrier used during application
Carrier Rate	Product carrier rate. In some cases, we back calculated the rate by dividing the total amount applied by acres, or estimated the rate based on the percentages provided on the record.
Carrier Total	If the total was not provided on the record, we calculated the total amount by multiplying the application rate by number of acres, or estimated the total based on the percentages provided on the record.
Start Time and End Time	The start and end time indicated on the application record.
Total Rate and Total Applied	The total amount of product(s) and carrier applied during an application. If not indicated on the record, we calculated this field based on product and carrier rates/totals.
Application Type	This information was not indicated on some records. In some cases, we inferred application type based on other information on the record (e.g., equipment used, meteorological data).
Meteorological Information	We entered the time of measurement, temperature, humidity, wind speed, and wind direction for up to 4 meteorological readings. A few records (with multiple application dates) had more than 4 readings; for these, we entered the first four readings.
Planting Date	Date/Year unit was planted; rarely indicated on record, may drop this field.
Target Species	Species targeted during application.
Equipment Used	Equipment used for application; sometimes method was indicated (e.g., hack and squirt)

Data Field	Notes
ODF – Oregon Department of Forestry; T = Township; R = Range; EPA = Environmental Protection Agency; ODA = Oregon Department of Agriculture	

Data Quality Check
To ensure the data were abstracted correctly, all data entries were checked against the actual application record by OHA staff. In addition, ODF conducted a 10% check of abstracted records.

ODA Records Acquisition and Data Quality Control
The following pages are an ODA document describing the records acquisition and data quality control process that ODA used in support of this EI.

Oregon
John A. Kitzhaber, MD, Governor

Department of Agriculture
635 Capitol St NE
Salem, OR 97301-2532

Oregon Department of Agriculture, Pesticides Program
HWY 36, Health Exposure Investigation (EI), Western Lane County
Pesticide Application Record Data Review Project, Verification and Validation
November 21, 2012

Background

Residents living in western Lane County, near Triangle Lake and Highway 36, have expressed concern for several years over possible exposures to pesticides from application activities on forestland, right-of-way, and agricultural sites. Several residents have reported potential health effects associated with pesticide use in the surrounding area. Based on concerns of adverse health expressed by some residents, the multi-agency Oregon Pesticide Analytical Response Center (PARC), in cooperation with Oregon Health Authority (OHA), Department of Agriculture (ODA), Department of Environmental Quality (DEQ), the Agency for Toxic Substances and Disease Registry (ATSDR) and the U.S. Environmental Protection Agency USEPA), initiated an Exposure Investigation (EI) to assess whether, and to what extent, these residents are being exposed to pesticides. The Oregon Health Authority (OHA) had been identified as the state lead agency to initiate the Exposure Investigation. OHA requested ODA, Pesticides Program, to collect and provide specific pesticide application data for 2009, 2010, and 2011, in support of the Exposure Investigation. The investigation was initiated in the fall of 2011 and is anticipated to continue into the fall of 2012.

Objectives:

#1 – Obtain Commercial Pesticide Operator and Public Pesticide Applicator pesticide application record data for 2009, 2010, and 2011, within subject area. Request Private Pesticide Applicators to submit pesticide application data within the subject area for 2009, 2010, and 2011, in support of the Exposure Investigation.

#2 - Verify and validate pesticide use application data submitted to the Oregon Department of Agriculture, Pesticides Program, by Commercial Pesticide Operators and Public Pesticide Applicators in support of the Highway 36 Exposure Investigation (EI). Collect and compile Commercial Pesticide Operators, Public Pesticide Applicator and Private Pesticide Applicator application data submitted to ODA within the subject area for 2009, 2010, and 2011, in support of the Exposure Investigation.

Oregon Pesticide Applicator License Definitions/Recordkeeping Requirements

A Commercial Pesticide Operator is defined as: "a person who owns or operates a business engaged in the application of pesticides upon the land or property of another." Oregon Revised Statute (ORS) Chapter 634.146 requires Commercial Pesticide Operators to prepare, maintain and make available for inspection during business hours pesticide application information. Records shall be maintained for a period of at least three years from the date of application. Specific record elements to be maintained are identified in ORS 634.146.

A Public Pesticide Applicator is defined as: "a person who is an employee of the State of Oregon or its agencies, counties, cities, municipal corporations, other governmental bodies or sub divisions thereof, irrigation districts, drainage districts and public utilities and telecommunications utilities who performs or carries out the work, duties or responsibilities of a pesticide applicator utilizing power equipment or a restricted use pesticides. Pursuant to Oregon Administrative Rule 603-057-0130, Public Pesticide Applicators shall prepare and maintain the records required of pesticide operators as identified by ORS 634.146 for applications utilizing power equipment or a restricted use pesticide. Specific record elements to be maintained are identified in ORS 634.146.

A Private Pesticide Applicator is defined as; "a person who uses or supervises the use of any pesticide, classified by the department as a restricted-use or highly toxic pesticide, for the purpose of producing agricultural commodities or forest crop on land owned or leased by the person". Oregon Revised Statutes, Chapter 634 (ORS 634) – Pesticide Control, and corresponding Oregon Administrative Rules, OAR 603 Division 57, do not require private pesticide applicators to prepare or maintain pesticide application records.

As required by the 1990 Farm Bill, and administered by the U.S. Department of Agriculture (USDA), Agricultural Marketing Service (AMS), Recordkeeping Branch, private pesticide applicators are required to maintain records of all restricted use pesticides applied to agricultural commodities or forest crop on land owned or leased by the person. USDA authorized representatives may perform compliance and inspection of the USDA recordkeeping requirements. Record information shall be maintained for a period of two years following the application.

Note: As specified by Oregon Laws 1999, Chapter 1059, Sections 2 to 11,15,20,21 and 22, each pesticide user must report to the Department of Agriculture the use of any pesticide product, as defined by ORS 634.006(8). This requirement is referred to as the Pesticide Use Reporting System (PURS). The term "pesticide user" is defined as any person who uses or applies a pesticide in the course of business or any other non-profit enterprise, or for a governmental entity, or location that is intended for public use or access. Private Applicators would be included in the definition of "pesticide user". Due to state budget constraints, the Pesticide Use Reporting System (PURS) is not available to provide pesticide use data to support the Exposure Investigation. In 2009 the Oregon Legislature amended the PURS statutes. Among those amendments was that no pesticide user is required to report pesticide use information into PURS when PURS is not funded or available. In addition, Oregon Administration Rules (OAR) states that no enforcement action shall be taken for failure to report pesticide use "... for any calendar year in which the Department does not provide a fully effective means for pesticide users to report pesticide use. The Pesticide Use Reporting System has not been available for reporting pesticide use information from 2009 to present due to funding constraints.

Project/Task Description

The exposure investigation subject area was defined as T15S R06W, T15S R07W, T16S R06W, T16S R07W, T16S R08W, T17S R07W, T17S R08W, T17S R09W (Attachment #1). The pesticide active ingredients of interest were identified as atrazine, aminopyralid, 2,4-D, clopyralid, glyphosate, hexazinone, imazapyr, metsulfuron-methyl, picloram, sulfometuron-methyl, triclopyr. The specific data elements requested by ODA and agreed upon by OHA include: date of application, location of application and acres applied, trade name/ EPA Registration Number, amount applied/Acre, crop or property treated. ODA will utilize the Pesticides Program licensing database to identify licensed pesticide businesses and applicators that may have performed pesticide application activities within the subject area during 2009, 2010, and 2011. To meet the data needs of the EI, ODA identified licensed businesses or individuals with specific pesticide license types to request pesticide application data. The license types were identified as Commercial Pesticide Operators, Public Pesticide Applicators and Private Pesticide Applicators. Within these license types, ODA identified specific pesticide use categories as well as county designations to further focus the data request to site-specific pesticide application activities within the study area. Site-specific categories utilized or for Commercial Pesticide Operator licenses include Forest (Statewide), Agriculture Herbicide (Lane, Linn, Benton, Douglas, Lincoln, Marion) as well as any license designation for Aerial-Helicopter. Site-specific categories utilized or for Public Pesticide Applicators included Right-of-Way (Lane County), Agriculture Herbicide (Lane County), and Forest (Lane County). Site-specific categories are not utilized or for Private Pesticide Applicator licensing.

Data Acquisition, Verification/Validation

Utilizing the Pesticides Program Licensing Database, ODA identified (421) licensed pesticide businesses or applicators that met the license criteria identified above: one hundred fifty six (156) Commercial Pesticide Operators, eighty-eight (88) Public Pesticide Applicators, and one hundred seventy seven (177) Private Pesticide Applicators.

On or about March 2, 2012, ODA mailed letters (Attachment #2-4) to (421) licensed pesticide businesses or applicators requesting submission of pesticide use data in support of the EI. The letters identified the specific pesticide application timeframe (2009,2010,and 2011), EI subject area map, pesticide active ingredients under review and ODA data request form (Attachment #5). ODA requested businesses and licensees to respond by submitting the pesticide application information by March 23, 2012. Pesticides Division staff will follow up with Commercial Pesticide Operators and Public Pesticide Applicators who fail to respond.

ODA Information Services (IS) utilized computer software programming to provide a ten percent (10%) random selection from the (421) licensed Commercial Pesticide operators and Public Applicators that met the license criteria. ODA Compliance/Enforcement staff will conduct routine follow-up Applicator Record Inspections (ARI) on 10 percent (10%) of the Commercial Pesticide Operators (16) and 10 % of the Public Pesticide Applicators (9) based on the IS random selection. If during ARI compliance inspections, reported pesticide application data discrepancies (Incorrect data reported, failure to provide requested data, failure to maintain required data) are documented in excess of 10 percent (10%) of the businesses or individuals inspected, ODA will increase the ARI follow up inspections by 5 percent until a confidence level of 90 percent has been confirmed. Follow up compliance inspections will be conducted utilizing established ARI procedures.

ODA Pesticides Division will not be conducting verification/validation of pesticide use data submitted to ODA by Private Pesticide Applicators. Oregon Private Pesticide Applicators are not required under Oregon Revised Statutes, Chapter 634 (ORS 634) to prepare, maintain or make available for inspection pesticide use records. Response from Private Pesticide Applicators to ODA's letter of request for pesticide use data is strictly voluntary. Pesticide use data provided to ODA in response to the request does become public record and will be provided to OHA in support of the EI.

Pesticide Application Data Management

Pesticide application record data was received by ODA and logged into an Excel spreadsheet for tracking of reporting party and comparison to the list of letters mailed by ODA. The record data from the reports was then entered into the spreadsheet containing the following data points: Company Name, Submitted by, Did not apply, Date, Location of application, Acres, Product Name, Amount applied, and Specific Crop. Each active ingredient was recorded on a separate line within the spreadsheet. The final spreadsheet was printed and provided to OHA along with the actual reports and a disk containing the spreadsheet file.

Findings:

Response To ODA Data Request Letters:

Commercial Pesticide Operators – ODA sent one hundred fifty six (156) letters to Commercial Pesticide Operators. As of May 1, 2012, ODA received one hundred fifty three (153) responses (98%). Of the three businesses that did not respond, two (2) were confirmed by ODA as being out of business and one (1) business provided verbal response that no pesticide applications had been performed within the subject area. Of the one hundred fifty three (153) written responses received, seventeen (17) reported pesticide applications within the EI subject area. One hundred thirty six (136) reported no pesticide applications within the EI subject area.

Public Pesticide Applicators – ODA sent eighty- eight (88) letters to Public Pesticide Operators. As of May 1, 2012, ODA received eighty-six (86) responses (98%). Of the eighty-six (86) written responses received, three (3) public applicators reported pesticide applications within the EI subject area. Eighty-three (83) public applicators reported no pesticide applications within the EI subject area.

Private Pesticide Applicators - ODA sent one hundred seventy seven (177) letters to Private Pesticide Applicators. As of May 1, 2012, ODA received sixty- six (66) responses (37%). Of the responses received, one (1) Private Pesticide Applicator reported pesticide applications within the EI subject area, (65) Private Pesticide Applicators reported no pesticide applications within the EI subject area.

Follow-up Applicator Record Inspections (ARI)- Data Validation and Verification:

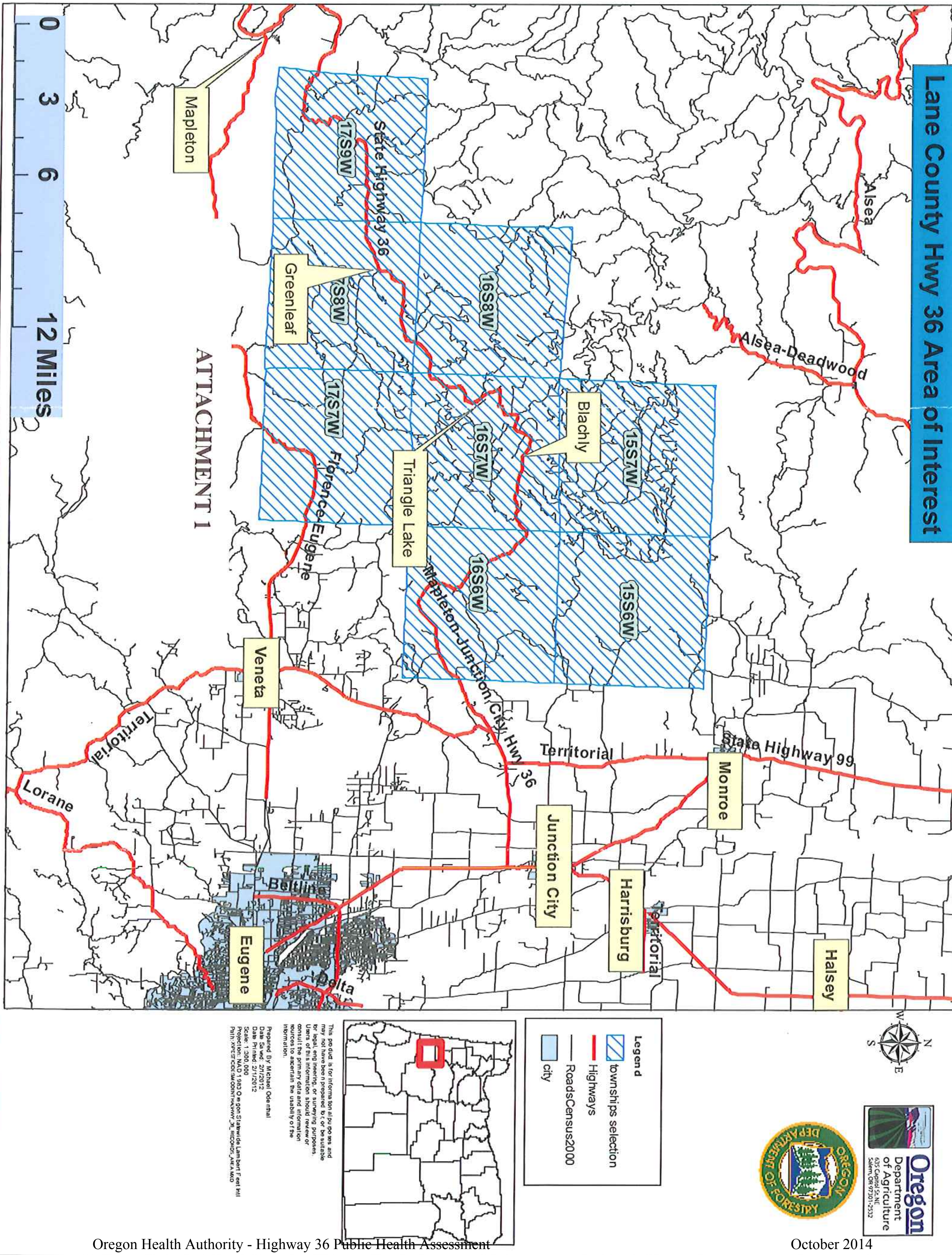
Commercial Pesticide Operators –As of November 1, 2012, ODA has completed fifteen (15) of the sixteen (16) Commercial Pesticide Operator follow-up record inspections to validate and verify response to data request and data provided to ODA. Follow up compliance inspections were conducted utilizing established ARI procedures. Thirteen (13) of the fifteen Commercial Operators reported no pesticide applications conducted in the subject area. ODA's inspection did not identify records or data subject to the EI. Two (2) of the fifteen Commercial Operators reported pesticide applications conducted within the subject area. One of the Commercial Operators records and data had been verified and confirmed. However, one of the Commercial Operators had failed to provide record data for two applications conducted within the subject area. This information was obtained by ODA and will be provided to OHA in support of the EI.

Due to scheduling conflicts with the one remaining Commercial Operator, ODA will continue to pursue scheduling of the follow-up record inspection.

Public Pesticide Applicators – As of November 1, 2012, ODA had completed all nine (9) of the Public Pesticide Applicator follow-up record inspections to validate and verify response to data request and data provided to ODA. Follow up compliance inspections were conducted utilizing established ARI procedures. Eight (8) of the Public Applicators reported no pesticide applications conducted in the subject area. ODA's inspection did not identify records or data subject to the EI. One (1) of the Public Applicators reported pesticide applications conducted within the subject area. ODA's inspection and review of record information verified and confirmed records and data submitted subject to the data request.

Private Pesticide Applicators – ODA Pesticides Division did not conduct verification/validation of pesticide use data submitted to ODA by Private Pesticide Applicators. Oregon Private Pesticide Applicators are not required under Oregon Revised Statutes, Chapter 634 (ORS 634) to prepare, maintain or make available for inspection pesticide use records. Response from Private Pesticide Applicators to ODA's letter of request for pesticide use data is voluntary. Pesticide use data provided to ODA by Private Applicators in response to the request has been provided to OHA in support of the EI.

With the exception of the one remaining Commercial Pesticide Operator follow-up inspection, ODA has completed it's verification and validation of the pesticide application record data submitted to ODA in support of the EI. Based on the follow-up inspection of record data submitted and reviewed, ODA does not anticipate additional follow-up inspections at this time.



Lane County Hwy 36 Area of Interest
ATTACHMENT 1
0
3
6
12 Miles
Mapleton
Alsea
Alsea-Deadwood
State Highway 36
17S9W
16S8W
17S8W
Greenleaf
17S7W
16S7W
15S7W
Blachly
Triangle Lake
Florence-Eugene
16S6W
15S6W
Mapleton-Junction City Hwy 36
Veneta
Territorial
State Highway 99
Monroe
Junction City
Harrisburg
Halsey
Lorane
Beltline
Eugene
Delta
N
S
E
W
Legend
townships selection
Highways
RoadsCensus2000
city
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Prepared By Michael Odenthal
Date Saved: 2/1/2012
Date Printed: 2/1/2012
Scale: 1:300,000
Projection: NAD 1983 Oregon Statewide Lambert Feet Intl
Oregon Department of Agriculture
Department of Forestry Oregon

Oregon

John A. Kitzhaber, MD, Governor

Department of Agriculture
635 Capitol St NE
Salem, OR 97301-2532

PESTICIDES DIVISION

March 2, 2012

ATTACHMENT 2

«Name»
«Address»
«City», «State» «Zip_Code»

RE: Pesticide Application Record Information, Western Lane County, Oregon

Residents living in western Lane County, near Triangle Lake and Highway 36, have expressed concern for several years over possible exposures to pesticides from application activities on forestland, right-of-way, and agricultural sites. Several residents have reported potential health effects associated with pesticide use in the surrounding area. Based on information provided by some residents, the multi-agency Oregon Pesticide Analytical Response Center (PARC), in cooperation with Oregon Health Authority, Department of Environmental Quality, the Agency for Toxic Substances and Disease Registry (ATSDR) and the U.S. Environmental Protection Agency, initiated an Exposure Investigation to assess whether, and to what extent, these residents are being exposed. The investigation was initiated in the fall of 2011 and is anticipated to continue into the spring of 2012.

To support the ongoing efforts of the exposure investigation, the Oregon Department of Agriculture (ODA) requests Commercial Pesticide Operators provide specific pesticide application record information. The information may be used by any of the agencies participating in the exposure investigation. Accompanying this letter is detailed information identifying the subject area and active ingredients under review, along with the required record elements to be submitted. The required information must meet each of the following three criteria (see reverse):

- Applications were made in calendar years 2009, 2010, and 2011
- Applications were made in the investigation subject area.
- Applications were made with pesticide products containing the active ingredients under review

This information shall be submitted on the attached ODA form provided. If you need additional forms, please reproduce as necessary.

ODA requires this information pursuant to the authority established in Oregon Revised Statutes (ORS) Chapter 634. The specific record information required of Commercial Operators is listed in ORS 634.146. Failure to provide the information would be considered a violation of law and may be subject to an enforcement response.

If you did not apply pesticides meeting the above criteria, check the box on the form and return it to ODA. Negative responses are required.

Return the record information on the form provided no later than **March 23, 2012.** Record information may be provided by mail, fax to (503) 986-4735, or sent via e-mail pestreg@oda.state.or.us to the attention of Mike Odenthal. If you have any questions regarding this request, please contact me. Thank you for your cooperation.

Sincerely,

Michael L Odenthal

Michael Odenthal
Investigator
Oregon Department of Agriculture Pesticides Division
635 Capitol ST NE
Salem, OR 97301
PH: (503) 986-4655, FAX: (503) 986-4735
E-MAIL: modenthal@oda.state.or.us

<u>Provide the following information for each pesticide application on the form provided:</u>

- **The location of the land or property where application was made:** The address of the site, or a geographic description of the application site (such as circle number, map number, or township/section/range), and the size of the area treated (acres, square feet, linear feet, etc.)
- **The month/day/year of the application**
- **The trade name and the strength of such pesticides applied:** The EPA registration number of each pesticide product applied or the manufacturer, product name, and formulation type of each product applied
- **The amount or concentration (pounds or gallons per acre of active ingredient or concentration per approximately 100 gallons):**
  - The amount of each pesticide product applied per unit of measure (ounces, pounds, pints, quarts, etc.)
  - The type and amount of carrier applied per unit of measure (acre, square feet, etc.) or, where a specific unit of measure is not applicable, the total amount applied to the site
  - The amount and type of other material applied (such as spreader/sticker, wetting agent or drift retardant)
- **The specific site (property, crop or crops to which the pesticide was applied)**

<u>Investigation Subject Area (within Lane County, defined by the following townships)</u>

T15S R06W, T15S R07W, T16S R06W, T16S R07W, T16S R08W, T17S R07W, T17S R08W, T17S R09W

(See included map)

<u>Active Ingredients Under Review</u>

atrazine, aminopyralid, 2,4-D, clopyralid, glyphosate, hexazinone, imazapyr, metsulfuron-methyl, picloram, sulfometuron-methyl, triclopyr

Oregon

John A. Kitzhaber, MD, Governor

Department of Agriculture
635 Capitol St NE
Salem, OR 97301-2532

PESTICIDES DIVISION

March 2, 2012

ATTACHMENT 3

«Name»
«Address»
«City», «State» «Zip_Code»

RE: Pesticide Application Record Information, Western Lane County, Oregon

Residents living in western Lane County, near Triangle Lake and Highway 36, have expressed concern for several years over possible exposures to pesticides from application activities on forestland, right-of-way, and agricultural sites. Several residents have reported potential health effects associated with pesticide use in the surrounding area. Based on information provided by some residents, the multi-agency Oregon Pesticide Analytical Response Center (PARC), in cooperation with Oregon Health Authority, Department of Environmental Quality, the Agency for Toxic Substances and Disease Registry (ATSDR) and the U.S. Environmental Protection Agency, initiated an Exposure Investigation (EI) to assess whether, and to what extent, these residents are being exposed. The investigation was initiated in the fall of 2011 and is anticipated to continue into the spring of 2012.

To support the ongoing efforts of the Exposure Investigation the Oregon Department of Agriculture (ODA) requests your cooperation and assistance as a Private Pesticides Applicator, by voluntarily providing specific pesticide use information. Information provided will be used in the assessment of possible health exposures as part of the investigation. The Department acknowledges that you are not statutorily required to maintain records or make them available, however, your cooperation is appreciated. Accompanying this letter is detailed information identifying the subject area and active ingredients under review, along with the requested record elements to be submitted. The requested information must meet each of the following three criteria (see reverse):

- Applications were made in calendar years 2009, 2010, and 2011
- Applications were made in the investigation subject area
- Applications were made with active ingredients under review

A form for the information and a map of the subject area are included with this letter for your use. If you need additional forms, please reproduce as necessary.

If you did not apply pesticides meeting the above criteria, check the box on the form and return it to ODA. Negative responses are helpful and appreciated.

Send the record information (**on the form provided**) to the attention of Mike Odenthal by fax, by e-mail, or by mail (information below), no later than **March 23, 2012.** If you have any questions regarding this request, please contact me. Thank you for your cooperation.

Sincerely,

Michael L Odenthal

Michael Odenthal
Investigator, Pesticides Division
Oregon Department of Agriculture
635 Capitol ST NE
Salem, OR 97301
PH: (503) 986-4655, FAX: (503) 986-4735
E-MAIL: modenthal@oda.state.or.us

Provide only the following information for each pesticide application on the form provided:

- **The location of the land or property where application was made:** The address of the site, or a geographic description of the application site (such as circle number, map number, or township/section/range), and the size of the area treated (acres, square feet, linear feet, etc.)
- **The month/day/year of the application**
- **The trade name and the strength of such pesticides applied:** The EPA registration number of each pesticide product applied or the manufacturer, product name, and formulation type of each product applied
- **The amount or concentration (pounds or gallons per acre of active ingredient or concentration per approximately 100 gallons):**
  - The amount of each pesticide product applied per unit of measure (ounces, pounds, pints, quarts, etc.)
  - The type and amount of carrier applied per unit of measure (acre, square feet, etc.) or, where a specific unit of measure is not applicable, the total amount applied to the site
  - The amount and type of other material applied (such as spreader/sticker, wetting agent or drift retardant)
- **The specific site (property, crop or crops to which the pesticide was applied)**

Investigation Subject Area (within Lane County, defined by the following townships)

T15S R06W, T15S R07W, T16S R06W, T16S R07W, T16S R08W, T17S R07W, T17S R08W, T17S R09W

(See included map)

Investigation Active Ingredients

atrazine, aminopyralid, 2,4-D, clopyralid, glyphosate, hexazinone, imazapyr, metsulfuron-methyl, picloram, sulfometuron-methyl, triclopyr

Oregon

John A. Kitzhaber, MD, Governor

Department of Agriculture
635 Capitol St NE
Salem, OR 97301-2532

PESTICIDES DIVISION

March 2, 2012

ATTACHMENT 4

«Name»
«Address_»
«City», «State» «Zip_Code»

RE: Pesticide Application Record Information, Western Lane County, Oregon

Residents living in western Lane County, near Triangle Lake and Highway 36, have expressed concern for several years over possible exposures to pesticides from application activities on forestland, right-of-way, and agricultural sites. Several residents have reported potential health effects associated with pesticide use in the surrounding area. Based on information provided by some residents, the multi-agency Oregon Pesticide Analytical Response Center (PARC), in cooperation with Oregon Health Authority, Department of Environmental Quality, the Agency for Toxic Substances and Disease Registry (ATSDR) and the U.S. Environmental Protection Agency, initiated an Exposure Investigation to assess whether, and to what extent, these residents are being exposed. The investigation was initiated in the fall of 2011 and is anticipated to continue into the spring of 2012.

To support the ongoing efforts of the exposure investigation, the Oregon Department of Agriculture (ODA) requests Public Pesticide Applicators provide specific pesticide application record information. The information may be used by any of the agencies participating in the exposure investigation. Accompanying this letter is detailed information identifying the subject area and active ingredients under review, along with the required record elements to be submitted. The required information must meet each of the following three criteria (see reverse):

- Applications were made in calendar years 2009, 2010, and 2011
- Applications were made in the investigation subject area.
- Applications were made with pesticide products containing the active ingredients under review

This information shall be submitted on the attached ODA form provided. If you need additional forms, please reproduce as necessary.

ODA requires this information pursuant to the authority established in Oregon Revised Statutes (ORS) Chapter 634. The specific record information required of Commercial Operators is listed in ORS 634.146. Failure to provide the information would be considered a violation of law and may be subject to an enforcement response.

If you did not apply pesticides meeting the above criteria, check the box on the form and return it to ODA. Negative responses are required.

Return the record information on the form provided no later than **March 23, 2012.** Record information may be provided by mail, fax to (503) 986-4735, or sent via e-mail pestreg@oda.state.or.us to the attention of Mike Odenthal. If you have any questions regarding this request, please contact me. Thank you for your cooperation.

Sincerely,

Michael L Odenthal

Michael Odenthal
Investigator, Pesticides Division
Oregon Department of Agriculture
635 Capitol ST NE
Salem, OR 97301
PH: (503) 986-4655, FAX: (503) 986-4735
E-MAIL: modenthal@oda.state.or.us

Provide the following information for each pesticide application on the form provided:

- **The location of the land or property where application was made:** The address of the site, or a geographic description of the application site (such as circle number, map number, or township/section/range), and the size of the area treated (acres, square feet, linear feet, etc.)
- **The month/day/year of the application**
- **The trade name and the strength of such pesticides applied:** The EPA registration number of each pesticide product applied or the manufacturer, product name, and formulation type of each product applied
- **The amount or concentration (pounds or gallons per acre of active ingredient or concentration per approximately 100 gallons):**
    - The amount of each pesticide product applied per unit of measure (ounces, pounds, pints, quarts, etc.)
    - The type and amount of carrier applied per unit of measure (acre, square feet, etc.) or, where a specific unit of measure is not applicable, the total amount applied to the site
    - The amount and type of other material applied (such as spreader/sticker, wetting agent or drift retardant)
- **The specific site (property, crop or crops to which the pesticide was applied)**

Investigation Subject Area (within Lane County, defined by the following townships)
T15S R06W, T15S R07W, T16S R06W, T16S R07W, T16S R08W, T17S R07W, T17S R08W, T17S R09W
(See included map)

Active Ingredients Under Review
atrazine, aminopyralid, 2,4-D, clopyralid, glyphosate, hexazinone, imazapyr, metsulfuron-methyl, picloram, sulfometuron-methyl, triclopyr

Oregon Department of Agriculture

PARC Health Exposure Investigation - Western Lane County Oregon.

Requested Pesticide Application Data for HWY 36 Area of Interest from years 2009, 2010, 2011.

☐ **Did not apply pesticide products within subject area**

ATTACHMENT 5

Date	Location of application & acres applied	Trade Name/ EPA Reg number of product applied	Amount applied/acre; type and amount of carrier	Specific crop or property, ie: forest site prep, pasture, roadside

Mail to: Oregon Dept. of Agriculture
635 Capitol ST NE
Salem, OR 97301

Company Name: ____________________ Submitted by: ____________________

Appendix C: Comparison Values Used to Evaluate Biological and Environmental Samples

Many State and Federal agencies develop comparison concentrations for chemicals in various media (urine, water, food, soil, etc.). The purpose of this Appendix is to explain how OHA selected and derived the comparison values (CVs) used in this report.

Urine

Urine is a unique medium for evaluating pesticide exposures because no clear associations have been drawn between specific urine concentrations and health outcomes in humans. OHA compared the urine results from this EI to those measured in the general population through the National Health and Nutrition Examination Survey (NHANES) and reported in the Fourth National Report on Human Exposure to Environmental Chemicals [20]. For 2,4-D, OHA compared the EI results to the NHANES 75th and 95th percentiles. OHA also compared the 2,4-D results to the biomonitoring equivalent (BE) for 2,4-D. A BE represents the estimated concentration of 2,4-D that would be present in the urine of a person who was chronically exposed to 2,4-D at a dose equal to EPA's reference dose (RfD) for 2,4-D. The BE for chronic exposures (lasting more than 7 years) to 2,4-D is 200 µg/L; for acute exposures (lasting one day), the BE is 400 µg/L for women of reproductive age and 1,000 µg/L for the rest of the population [23], [24]. There are no national reference values for atrazine in urine. Therefore, OHA searched peer-reviewed literature for smaller studies where the same atrazine metabolites were measured in human urine (see Table 12).

Water and Soil

OHA used ATSDR's hierarchy for choosing CVs for water and soil (Figure C1). If a hierarchy 1, 2 or 3 CV was not available, EHAP chose the lowest of EPA's Regional Screening Levels (RSL), U.S. Geological Survey's Health-based Screening Levels (HBSL), or EPA's Human Health Benchmark for Pesticides (HHBP). Tables C1 and C2 show the CVs used for water and soil respectively.

Figure C 1: ATSDR's hierarchy for selecting comparison values in water, soil, and air [6].

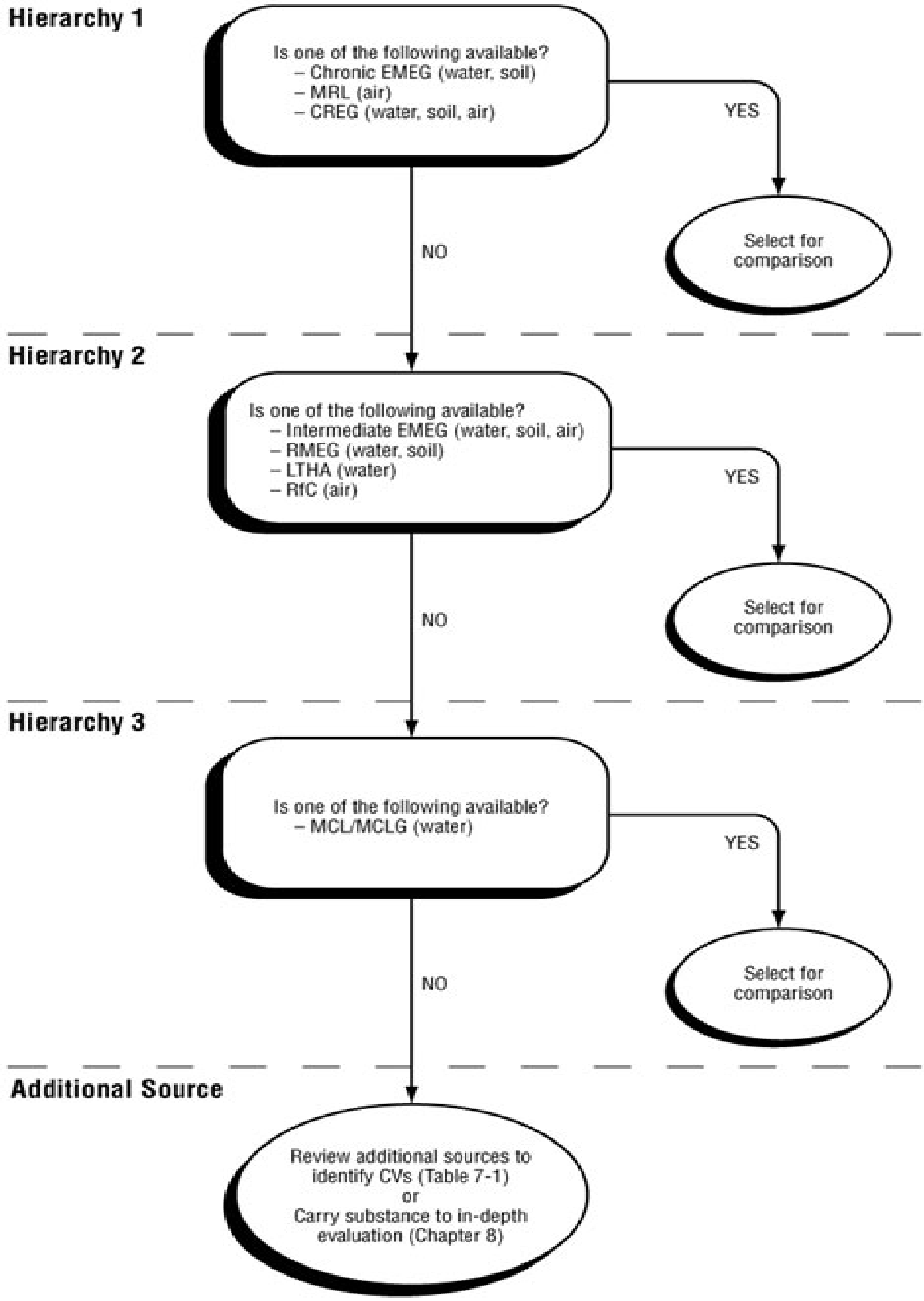

Table C 1: Analytes, detections, and comparison values for water samples.

Analyte	Detections (N = 37)**	Maximum Detected (ppm)	Comparison Value (ppm)	CV Source
2 (2,4,5-Trichlorophenoxy) propionic acid (2,4,5-TP/Silvex)	0	<0.00011	0.05	LTHA
2,4,5-Trichlorophenoxyacetic Acid 2,4,5 (2,4,5-T)	0	<0.00033	0.07	LTHA
2,4-Dichlorophenoxyacetic Acid (2,4-D)	0	<0.00011	0.1	RMEG
3,5-Dichlorobenzoic acid	0	<0.00033	NA	-
4-(2,4-dichlorophenoxy) butyric acid (2,4-DB)	0	<0.00066	0.08	RMEG
4-chloro-2-methylphenoxyacetic Acid (MCPA)	0	<0.022	0.005	RMEG
Acetamiprid	0	<0.0000041	0.5	HHBP
Acetochlor	0	<0.00001	0.2	RMEG
Acifluorfen	0	<0.00022	0.09	HBSL
Alachlor	0	<0.000031	0.1	RMEG
Aldrin	0	<0.000026	0.0000021	CREG
alpha-Chlordane (cis-Chlordane)	0	<0.000026	0.0001	CREG
alpha-Hexachlorocyclohexane (alpha-BHC)	0	<0.000026	0.000006	CREG
Ametryn	0	<0.0000041	0.06	LTHA
Aminocarb	0	<0.0000041	NA	-
Atrazine	0	<0.000051	0.03	Intermediate EMEG
Baygon	0	<0.0000041	0.003	LTHA
beta-Hexachlorocyclohexane (beta-BHC)	0	<0.000026	0.000019	CREG
Bifenthrin	0	<0.000082	0.091	HHBP
Bromacil	0	<0.000026	0.07	LTHA
Butachlor	0	<0.000026	NA	-
Butylate	0	<0.000026	0.4	LTHA
Carbaryl	0	<0.0000051	1	RMEG
Carbofuran	0	<0.0000041	0.05	RMEG
Chlorneb	0	<0.000026	0.09	HHBP
Chlorobenzilate	0	<0.000026	0.2	RMEG
Chlorothalonil	0	<0.000026	0.15	RMEG
Chlorpropham	0	<0.000026	2	RMEG
Cyanazine	0	<0.000026	0.001	LTHA
Cycloate	0	<0.000026	0.035	HHBP
Dacthal (DCPA - Dimethyl tetrachloroterephthalate)	0	<0.000026	0.07	LTHA
DCPA (Dimethyl tetrachloroterephthalate) acid metabolites	0	<0.00066	0.07	LTHA* (Parent: DCPA)
delta-Hexachlorocyclohexane (delta-BHC)	0	<0.000026	0.000006	CREG* (Parent: alpha-BHC)

Analyte	Detections (N = 37)**	Maximum Detected (ppm)	Comparison Value (ppm)	CV Source
Desethyl Atrazine	0	<0.0000041	0.03	Intermediate EMEG* (Parent: Atrazine)
Desisopropyl Atrazine	0	<0.0000041	0.03	Intermediate EMEG* (Parent: Atrazine)
Diazinon	0	<0.000026	0.007	Chronic EMEG
Dicamba	0	<0.00033	0.3	RMEG
Dichlorodiphenyldichloroethane (4,4'-DDD)	0	<0.000026	0.00015	CREG
Dichlorodiphenyldichloroethylene (4,4'-DDE)	0	<0.000026	0.0001	CREG
Dichlorodiphenyltrichloroethane (4,4'-DDT)	0	<0.000026	0.0001	CREG
Dichloroprop	0	<0.00033	0.3	HBSL
Dichlorvos	0	<0.000026	0.00012	CREG
Dieldrin	0	<0.000026	0.0000022	CREG
Dimethoate	0	<0.000026	0.002	RMEG
Dinoseb	0	<0.00033	0.007	LTHA
Diuron	0	<0.0000041	0.02	RMEG
Chlorpyrifos	0	<0.000026	0.01	Chronic EMEG
Endosulfan I	0	<0.000026	0.02	Chronic EMEG
Endosulfan II	0	<0.000026	0.02	Chronic EMEG* (Parent: Endosulfan I)
Endosulfan sulfate	0	<0.000026	0.02	Chronic EMEG* (Parent: Endosulfan I)
Endrin	0	<0.000026	0.003	Chronic EMEG
Endrin aldehyde	0	<0.000026	0.003	Chronic EMEG* (Parent: Endrin)
Ethoprophos	0	<0.000026	0.001	HBSL
Etridiazole (Terrazole)	0	<0.000026	0.112	HHBP
Fenamiphos	0	<0.000031	0.0007	LTHA
Fenarimol	0	<0.000026	0.042	HHBP
Fenvalerate/Esfenvalerate	0	<0.000512	0.25	RMEG
Fluometuron	0	<0.0000041	0.09	LTHA
Fluridone	1	0.000031	1.05	HHBP
gama-Hexachlorocyclohexane (Lindane)	0	<0.000026	0.0001	Intermediate EMEG
gamma-Chlordane (trans-Chlordane)	0	<0.000026	0.0001	CREG
Heptachlor	0	<0.000026	0.0000078	CREG
Heptachlor epoxide	0	<0.000026	0.0000038	CREG
Hexazinone	1	0.000183	0.4	HBSL
Imazapyr	0	<0.000041	17.5	HHBP
Imidacloprid	0	<0.00002	0.4	HHBP

Analyte	Detections (N = 37)**	Maximum Detected (ppm)	Comparison Value (ppm)	CV Source
Linuron (Lorox)	0	<0.0000041	0.005	HBSL
Malathion	0	<0.000026	0.2	Chronic EMEG
Methiocarb	0	<0.0000041	0.04	HBSL
Methomyl	0	<0.0000041	0.2	LTHA
Methoxychlor	0	<0.000026	0.04	LTHA
Methyl paraoxon	0	<0.000026	0.003	Chronic EMEG* (Parent: Methyl Parathion)
Methyl parathion (Parathion methyl)	0	<0.000026	0.003	Chronic EMEG
Azinphos-Methyl (Guthion)	0	<0.000041	0.03	Chronic EMEG
Methylchlorophenoxypropionic acid (MCPP)	0	<0.066	0.28	HHBP
Metolachlor	0	<0.000026	0.7	LTHA
Metribuzin	0	<0.000026	0.07	LTHA
Mevinphos	0	<0.000026	0.002	HHBP
Mexacarbate	0	<0.0000041	NA	-
Molinate	0	<0.000026	0.02	RMEG
N,N-Diethyl-3-methylbenzamide (DEET)	2	0.0000058	0.2	Minnesota Department of Health [21]
Napropamide	0	<0.000026	0.8	HBSL
Neburon	0	<0.0000051	NA	-
N-Octyl bicycloheptene dicarboximide (MGK 264)	0	<0.000051	0.427	HHBP
Norflurazon	0	<0.000026	0.01	HBSL
Oxamyl	0	<0.0000041	0.25	RMEG
Pebulate	0	<0.000026	0.05	HBSL
Penoxalin (Penoxsulam)	0	<0.000026	1.029	HHBP
Pentachlorophenol	0	<0.00011	0.000088	CREG
Permethrin	0	<0.000051	0.5	RMEG
Phosmet	0	<0.000026	0.004	HBSL
Picloram	0	<0.00066	0.5	MCL
Prometon	0	<0.0000041	0.15	RMEG
Prometryn	0	<0.0000041	0.04	RMEG
Pronamide	0	<0.000026	0.75	RMEG
Propachlor	0	<0.000026	0.13	RMEG
Propazine	0	<0.000026	0.01	LTHA
Propiconazole	0	<0.00002	0.07	HBSL
Pyraclostrobin	0	<0.0000041	0.24	HHBP
Pyriproxyfen	0	<0.000256	2.5	HHBP
S-ethyl dipropylcarbamothioate (EPTC)	0	<0.000026	0.25	RMEG
Siduron	0	<0.0000041	1	HBSL

Analyte	Detections (N = 37)**	Maximum Detected (ppm)	Comparison Value (ppm)	CV Source
Simazine	0	<0.000026	0.05	RMEG
Simetryn	0	<0.0000041	NA	-
Sulfometuron-Methyl	0	<0.0000041	1.9	HHBP
Tebuthiuron	0	<0.000026	0.5	LTHA
Terbacil	0	<0.000026	0.09	LTHA
Terbufos	0	<0.000041	0.0004	LTHA
Terbutryn	0	<0.0000041	0.01	RMEG
Terbutylazine	0	<0.0000041	0.002	HBSL
Tetrachlorvinphos (Stirophos)	0	<0.000026	0.3	HHBP
trans-Nonachlor	0	<0.000026	NA	-
Triadimefon	0	<0.000026	0.238	HHBP
Triclopyr	0	<0.00033	0.35	HHBP
Tricyclazole	0	<0.000026	NA	-
Trifluralin	0	<0.000026	0.0045	CREG
Vernolate	0	<0.000026	0.01	RMEG

N = Total number of samples; ppm = parts per million; CV = comparison value; < = Less than; NA = Not Available; - = Not Available; LTHA = Life-time Health Advisory; RMEG = Reference dose Media Evaluation Guide; HHBP = U.S. Environmental Protection Agency Human Health Benchmark for Pesticides [58]; HBSL = U.S. Geological Survey Health-Based Screening Level [59]; CREG = Cancer Risk Evaluation Guideline; EMEG = Environmental Media Evaluation Guide; MCL = Maximum Contaminant Level

* Comparison value for parent compound as surrogate for environmental degradates.
**37 samples include 36 drinking water samples and one surface water samples not used for drinking water.

Table C 2: Analytes, detections, and comparison values for soil samples.

Analyte	Detections (N = 29)	Maximum Detected (ppm)	Comparison Value (ppm)	CV Source
2,4-D	2	0.046	500	RMEG
Aminopyralid	0	<0.010	25,000	RMEG – provisional*
Atrazine	0	<0.010	150	Intermediate EMEG
Clopyralid	0	<0.010	25,000	RMEG – provisional*
Glyphosate	2	3.3	5,000	RMEG
Hexazinone	0	<0.010	2,000	RSL
Imazapyr	0	<0.010	125,000	RMEG – provisional*
Metsulfuron Methyl	0	<0.010	12,500	RMEG – provisional*
Picloram	0	<0.010	4,300	RSL
Sulfometuron Methyl	0	<0.010	13,750	RMEG – provisional*
Triclopyr	0	<0.010	2,500	RMEG – provisional*

N = Total number of samples; ppm = parts per million; CV = Comparison Value; < = less than; 2,4-D = 2,4-dichlorophenoxyacetic acid; RMEG = Reference dose Media Evaluation Guide; EMEG = Environmental Media Evaluation Guide; RSL = U.S. Environmental Protection Agency Regional Screening Level

*Provisional RMEG = Derived using the analyte's Reference Dose (RfD and the Agency for Toxic Substances and Disease Registry's drinking water RMEG equation for children. This was a fourth tier option because there were no other comparison values for these analytes.

Food

ATSDR does not have CVs for chemicals in food. Therefore, OHA used the hierarchy shown in Table C3 to select CVs for pesticides in food samples. Table C4 shows results for egg, milk and honey samples. Table C5 shows results for berry, leafy vegetable, and tomato samples.

Table C 3: Hierarchy used to select Comparison Values for food.

Hierarchy Level	Source of Comparison Value	Rationale
1	US EPA Pesticide Tolerance for foods [60]	Chemical and medium specific
2	Tolerance or equivalent from World Health Organization [61] or Health Canada [62] *	Chemical and medium specific
3	European Union Default Maximum Residue Limit [63] (0.01 ppm)	Not chemical or medium specific

US EPA = US Environmental Protection Agency; ppm = parts per million
*If both the World Health Organization and Health Canada had a tolerance for a particular food, chose the lower of the two tolerances.

Table C 4: Analytes, detections, and comparison values for egg, milk, and honey samples.

	Eggs				Milk				Honey			
Analyte	Detections (N = 4)	Max Detected (ppm)	CV (ppm)	Source	Detections (N = 2)	Max Detected (ppm)	CV (ppm)	Source	Detections (N = 2)	Max Detected (ppm)	CV (ppm)	Source
2,4-D	0	<0.01	0.01	WHO	0	<0.01	0.05	EPA	0	<0.01	0.01	EU
Aminopyralid	0	<0.01	0.01	WHO	0	<0.01	0.03	EPA	0	NR	0.01	EU
Atrazine	0	<0.01	0.04	HC	0	<0.01	0.02	EPA	0	<0.01	0.01	EU
Clopyralid	0	<0.01	0.1	EPA	0	<0.01	0.2	EPA	0	<0.01	0.01	EU
Glyphosate	0	<0.01	0.05	EPA	0	<0.01	0.05	WHO	0	<0.01	0.01	EU
Hexazinone	0	<0.01	0.01	EU	0	<0.01	11	EPA	0	<0.01	0.01	EU
Imazapyr	0	<0.01	0.05	HC	0	<0.01	0.01	EPA	0	<0.01	0.01	EU
Metsulfuron Methyl	0	<0.01	0.01	EU	0	<0.01	0.05	EPA	0	<0.01	0.01	EU
Picloram	0	<0.01	0.05	EPA	0	<0.01	0.25	EPA	0	<0.01	0.01	EU
Sulfometuron-Methyl	0	<0.01	0.01	EU	0	<0.01	0.01	EU	0	<0.01	0.01	EU
Triclopyr	0	<0.01	0.05	EPA	0	<0.01	0.01	EPA	0	<0.01	0.01	EU

N = Total number of samples; Max = maximum; ppm = parts per million; CV = Comparison Value; < = less than; 2,4-D = 2,4-dichlorophenoxyacetic acid; NR = No Result; EPA= US Environmental Protection Agency; HC = Health Canada; EU = European Union; WHO = World Health Organization

Table C 5: Analytes, detections, and comparison values for berry and vegetation samples.

	Berries				Vegetation (Leafy Greens/Tomatoes)			
Analyte	Detections (N = 4)	Max Detected (ppm)	CV (ppm)	Source	Detections (N = 14)	Max Detected (ppm)	CV (ppm)	Source
2,4-D	0	<0.01	0.2	EPA	0	<0.01	0.05	EPA
Aminopyralid	0	<0.01	0.01	EU	0	<0.01	0.01	EU
Atrazine	0	<0.01	0.01	EU	0	<0.01	0.25	EPA
Clopyralid	0	<0.01	0.5	EPA	0	<0.025	5	EPA
Glyphosate	0	<0.01	0.2	EPA	0	<0.04	0.1	EPA
Hexazinone	0	<0.01	0.6*	EPA	0	<0.01	0.01	EU
Imazapyr	0	<0.01	0.01	EU	0	<0.01	0.01	EU
Metsulfuron Methyl	0	<0.01	0.01	EU	0	<0.01	0.01	EU
Picloram	0	<0.01	0.01	EU	0	<0.05	0.01	EU
Sulfometuron-Methyl	0	<0.01	0.01	EU	0	<0.01	0.01	EU
Triclopyr	0	<0.01	0.01	EU	0	<0.01	0.01	EU

N = Total number of samples; Max = maximum; ppm = parts per million; CV = Comparison Value; < = less than; 2,4-D = 2,4-dichlorophenoxyacetic acid; EPA= US Environmental Protection Agency; HC = Health Canada; EU = European Union; WHO = World Health Organization

*For blueberries

Appendix D: Fall 2011 Survey Questions on Home/Work Pesticide Use

Hi ________
Thank you for participating in the Highway 36 pesticide Exposure Investigation. We have a few questions for you to answer, that will help us learn more about any potential exposure to pesticides or herbicides you may have had in the last several days. Please reply to this e-mail, with your responses to the questions below. Please call me at 971-XXX-XXXX if you have any questions. Thank you.

We were at your house on ____________________.
....

1. Approximately how much time per day did you spend outdoors around your home, in the week (7 days) before providing your urine sample? Is that typical for you?

2. Do you work at home?

3. Do you use any pesticides or herbicides on your land or in your garden?

4. Do you have a job where you handle or are around pesticides or herbicides?
 If Yes:
 What do you use?

 What application method(s) do you use?

 How much do you use on a weekly basis?

5. Did you use pesticides or herbicides in the week (7 days) before providing your urine sample?
 If Yes:
 When did you apply them?

 What did you use?

 Where did you apply it?

6. Do you know of any herbicide applications that occurred near your home (within a mile or so) in the week before you provided a urine sample?
 If Yes:
 Where did that application occur?

 When did that application occur?

 Do you know what method was used to apply them (backpack, aerial spray)?

Thank you for your time!

Appendix E: Chain of Custody for Community-Collected Urine Samples

Description of urine collection and shipment process

1. Community organizers assigned each participant a unique alphanumerical Personal Identification Number (PIN).
2. A medical doctor in Eugene, OR provided prescriptions for urine collection.
3. Participants had urine samples collected at a PeaceHealth laboratory facility per PeaceHealth's Urine Collection Process and protocols PHL.ALL.271.114, PHL.ALL.69.05, PHL.OR.394.57 and PHL.ALL.69.7
    a. Each participant had their identification verified using two sources of identification confirming their full name and birthdate.
    b. Participants verified their unique PIN.
    c. Each sample was labeled with the unique PIN and a unique PeaceHealth Laboratory accession number (PHLAN). No personally identifiable information (e.g., name, birthdate) were included on the sample label.
4. A PeaceHealth courier transported the urine samples from the collection site to the PeaceHealth Send Out Department. Each sample was accompanied by a packing slip that included the specimen label (with PIN and PHLAN) and a copy of the original prescription.
5. The PeaceHealth Send Out Department packed and shipped the samples via United Parcel Service or Federal Express to the lab at Emory University in Atlanta, GA.
6. Packaged samples were received by Central Shipping and Receiving (CS&R) at Emory University, and were delivered to the laboratory by an Emory University courier.

Laboratory Analysis

The urine samples were analyzed for 2,4-D and atrazine using CDC's laboratory methods for these chemicals [38], [39].

Reconstruction Process

In June 2012, after obtaining consent from 31 community urine collection participants, OHA began reconstructing and verifying the chain of custody from sample collection at PeaceHealth to delivery at Emory University. Forty-six of the 50 samples from consenting participants were collected at the PeaceHealth collection site in Eugene, OR. The other four samples were collected at a community hospital in Grants Pass, OR. These four samples were from two individuals who live outside the Exposure Investigation area and were excluded from further analyses in this PHA. A chain of custody was not established for those four samples.

To reconstruct and verify the chain of custody, OHA took the following steps:

1. Obtained and generated a list of PINs and PHLANs from:
    a. Copies of packing slips from packages received by the laboratory (provided by laboratory researcher on 6/12/2012);
    b. List of all consented participants with corresponding PINs and birthdates (provided by community organizers on 6/20/2012).
2. Sent PeaceHealth Client Services a list of PINs and corresponding PHLANs and birthdates

3. Obtained internal reports from PeaceHealth Client Services, Send Out Department, and Quality and Compliance to confirm the following for all 46 samples:
    a. Date and time the samples were picked up by the PeaceHealth Laboratory courier at the collection site;
    b. Date and time the samples were received at PeaceHealth's Send Out Department; and
    c. Date, time, ship-to address and method of shipment from PeaceHealth's Send Out Department to Emory University
4. Contacted Senior Operations Manager at the Rollins School of Public Health at Emory University, who confirmed the receipt of 26 samples by the CS&R at Emory University and the delivery of those 26 samples to laboratory.
5. Confirmed receipt of seven unanalyzed samples by CS&R at Emory University through the Federal Express tracking system.

Appendix F: Herbicides and Human Health

Herbicides are pesticides that are designed to be toxic to plants or specific types of plants. However, some herbicides have the potential to cause health problems in humans. In concentrated mixtures, herbicides can cause irritation to the skin and eyes if there is direct contact with these tissues. In general, the strongest scientific evidence on the health effects from herbicide exposures is from studies that examined relatively high levels of herbicide exposure. There is less certainty about the health effects of long-term exposure to lower doses, which characterizes the types of exposures the general public is most likely to experience. Some herbicides have been proven so harmful to human health that they have been banned. Others have been shown to be less toxic to humans.

Health Effects of 2,4-D and atrazine

Both 2,4-D and atrazine have the potential to harm human health. The types and severity of harm depend on the dose or how much of these pesticides get into the body. Pesticides are typically assessed for potential human health hazards based on laboratory studies in animals exposed to the pesticides via the diet and other routes of exposure. The lowest dose at which test animals show adverse effects is used as an endpoint for estimating potential risks to humans. Measurements of adverse effects are typically taken from studies of one-time or short-term exposures ("acute studies") and longer-term exposures ("chronic studies") to the pesticide.

2,4-D

In acute studies in rodents and rabbits, 2,4-D generally has demonstrated low acute toxicity via the oral, dermal, and inhalation routes of exposure. In people inadvertently exposed to 2,4-D in the short-term, the most common symptoms were dermal irritation and ocular problems. In chronic testing that serves as the basis for EPA's current human health risk assessment of 2,4-D, adverse effects observed in laboratory rats exposed to 2,4-D included gait abnormalities in a neurotoxicity study, skeletal abnormalities in pups in a developmental study, and decreased weight gain in a chronic toxicity study [64]. Some studies of pesticide exposures in humans ("epidemiology studies") have found links between 2,4-D and a specific type of blood cancer called non-Hodgkin's lymphoma, but other studies have not found evidence of this link. Because 2,4-D is often mixed with other herbicides, it is difficult for scientists to tell whether 2,4-D or other herbicides in the mix might be linked to cancer. Currently, scientists don't know whether 2,4-D can cause cancer in humans [64], [65]. EPA is currently updating its toxicology database and risk assessments for 2,4-D through an ongoing process referred to as registration review. As part of this process, EPA is reviewing studies specifically designed to address the potential for endocrine disrupting effects from 2,4-D.

The urinary half-life of 2,4-D is 18 hours in humans [36]. This is a relatively short half-life meaning that the human body rapidly eliminates 2,4-D.

Additional resources on the health effects of 2,4-D are available at the National Pesticide Information Center (NPIC): http://npic.orst.edu/factsheets/24Dgen.html

Atrazine

Adverse effects associated with laboratory animal testing with atrazine include delayed ossification of certain bones in fetuses, decreased weight gain in adults, disruption of hypothalamic function, and kidney lesions [31]. Based on epidemiologic evidence, EPA has concluded that atrazine is "not likely to be carcinogenic to humans." Atrazine is an endocrine disruptor meaning that it interferes with the body's hormone system. Atrazine seems to interfere with some of the hormones that control reproduction and development of the reproductive system. At higher doses, atrazine can cause liver, kidney, and heart damage in animals. It is possible that atrazine could cause these same effects in people, although no scientific studies have examined these outcomes in humans exposed to atrazine [31], [66]. EPA's registration review of atrazine is scheduled to commence during 2013. As with all chemical exposures the severity and risk of health effects depends on the dose a person actually gets.

The urinary half-life of atrazine is 24-28 hours in humans [37]. This is a relatively short half-life meaning that the human body rapidly eliminates atrazine. Atrazine is also rapidly metabolized into other compounds [31].

Additional resources about the health effects of atrazine can be found at the Agency for Toxic Substances and Disease registry. http://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=59

Appendix G: ATSDR Glossary

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 serves the public by using the best science available to take 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 EPA, which is the federal agency that develops and enforces environmental laws to protect the environment and human health.

This glossary defines words used in this PHA when communicating with the public. It is not a complete dictionary of environmental health terms. If you have questions or comments, call CDC/ATSDR's toll-free telephone number, 1-800-CDC-INFO (1-800-232-4636).

Absorption:	How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.
Acute Exposure:	Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.
ATSDR:	The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.
Background Level:	An average or expected amount of a chemical in a specific environment or amounts of chemicals that occur naturally in a specific environment.
Cancer:	A group of diseases that occur when cells in the body become abnormal and grow, or multiply out of control.
Carcinogen:	Any substance shown to cause tumors or cancer in experimental studies.
Chronic Exposure:	A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.
Completed Exposure Pathway:	See **Exposure Pathway**.
Comparison Value: (CVs)	Concentrations of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.
Concern:	A belief or worry that chemicals in the environment might cause harm to people.

Concentration:	How much or the amount of a substance present in a certain amount of soil, water, air, or food.
Contaminant:	See **Environmental Contaminant**.
Dermal Contact:	A chemical getting onto your skin. (See **Route of Exposure**).
Dose:	The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as "amount of substance(s) per body weight per day".
Environmental Contaminant:	A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than the **Background Level**, or what would be expected.
Environmental Media:	Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals that are eaten by humans. Environmental Media is the second part of an **Exposure Pathway**.
U.S. Environmental Protection Agency (EPA):	The federal agency that develops and enforces environmental regulations to protect human health and the environment.
Exposure:	Coming into contact with a chemical substance. (For the three ways people can come in contact with substances, see **Route of Exposure**.)
Exposure Pathway:	A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical. ATSDR defines an exposure pathway as having 5 parts: 1. Source of Contamination, 2. Environmental Media and Transport Mechanism, 3. Point of Exposure, 4. Route of Exposure, and 5. Population (Receptor). When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. When additional information is needed on one or more of the five parts, it is called a **Potential Exposure Pathway**. Each of these 5 terms is defined in this Glossary.
Frequency:	How often a person is exposed to a chemical over time; for example, every day, once a week, or twice a month.

Ingestion:	Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).
Inhalation:	Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).
kg	Kilogram or 1000 grams. Usually used here as part of the dose unit mg/kg/day meaning mg (contaminant)/kg (body weight)/day.
µg	Microgram or 1 millionth of 1 gram. Usually used here as part of the concentration of contaminants in water (µg/Liter).
mg	Milligram or 1 thousandth of 1 gram. Usually used here as in a concentration of contaminant in soil mg contaminant/kg soil or as in the dose unit mg/kg/day meaning mg (contaminant)/kg (body weight)/day.
MRL:	**M**inimal **R**isk **L**evel. An estimate of daily human exposure – by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used to predict adverse health effects.
PHA:	**P**ublic **H**ealth **A**ssessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.
Point of Exposure:	The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). Some examples include the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, or the backyard area where someone might breathe contaminated air.
Population:	A group of people living in a certain area or the number of people in a certain area.
Potential Exposure Pathway:	See **Exposure Pathway**.
Public Health Assessment(s):	See **PHA**.
Reference Dose (RfD):	An estimate, with safety factors (see **safety factor**) built in, of the daily, lifetime exposure of human populations to a possible hazard that is not likely to cause harm to the person.

Route of Exposure:	The way a chemical can get into a person's body. There are three exposure routes: – breathing (also called inhalation), – eating or drinking (also called ingestion), and – getting something on the skin (also called dermal contact).
Source (of Contamination):	The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.
Special Populations:	People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.
Toxic:	Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.
Toxicology:	The study of the harmful effects of chemicals on humans or animals.
Safety Factor	Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. Safety factors are used to account for variations in people's sensitivity, for differences between animals and humans, and for differences between effect levels. Scientists use safety factors when they have some, but not all, the information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called an uncertainty factor].

Oregon
John Kitzhaber, Governor

Department of Agriculture
635 Capitol Street NE
Salem, OR 97301-2532

Case Number: 150406
Case Name: Applebee Aviation Inc. / Ivy

Case Closed ☐

Overview

Investigator	Case Reviewer	Manager
Michael Odenthal	Michael Babbitt	

Date Started	04/29/2015	Date Completed	09/23/2015
ROL Sent?	○ Yes ◉ No	Date ROL Sent	
Referral to Another Agency?		Date of Referral	
Number of Samples Taken		List Test(s) Requested	
Number of Samples Analyzed			
Complaint?	◉ Yes ○ No	Sample Type	☐ Air ☐ Veg ☐ Animal ☐ Other ☐ Soil ☐ Swab ☐ Water
Refer to PARC?	◉ Yes ○ No		
Cease & Desist	○ Yes ◉ No		
LOA	○ Yes ◉ No	Type of Investigation	AUF
Verified Compliance?	○ Yes ○ No	Suspected Violation?	◉ Yes ○ No
Date Reviewed	09/23/2015	Related Cases	ROL 150452
Date Case Completed			
Sixty Days	06/28/2015		
One Hundred Twenty Days	08/27/2015		

Tracking Devices

- Aerial
- AIs of interest
- Liquid spray application
- RUP
- Forestry
- OERS

Nature

Sunny Jones 9/29/15

Parties Involved

Parties Involved	Last / Business Name Address City	First State	 Zip	License # Phone	License Type Expiration Date County	 Category
Operator	APPLEBEE AVIATION INC PO BOX 309 22330 NW Fisher Rd BANKS	 OR	 97106	AG-L1005130CPO 503-647-7656	CPO 12/31/2015 Washington	AgH, AgIF, AQ, FOR, PUB, ROW
Complainant	Ivy Sprayed2015@gmail.com	Darryl		 907-717-6977		
Owner	APPLEBEE PO BOX 309 BANKS	MICHAEL OR	 97106	AG-L1005041CPA 503-349-6678	CPA 12/31/2015 Washington	AgH, AgIF, AQ, FOR, PUB
Applicator	MCDANIEL 55999 WOOD DUCK DR BEND	DAVID OR	 97707	AG-L0066182CPA 541-593-7201	CPA 12/31/2015 Deschutes	AgH, AgIF, AgSF, AQ, D&R, FOR, PUB, ROW
Employee	TAYLOR 11811 OLD STAGE RD GOLD HILL	ROBERT OR	 97525	AG-L1035310IST 541-301-8953	IST 12/31/2015 Jackson	

Application Information

Date of Application | Start Time | End Time | Time of Day

Application Note: April 9-26, 2015

Category

Forest

Location of Application

See application records- multiple sites

Specific Site/Crop

Forestry

Rate of Application (mixing rate, diluent, rate per area, etc)

See application records

Purpose

Forestry Release

Method of Application

Aerial - helicopter

Pesticides Involved

Type	**Manufacturer**	**Trade Name**	**EPA Reg. No.**	**Active Ingredients**

Pesticides Involved

Type	Manufacturer	Trade Name	EPA Reg. No.	Active Ingredients
Herbicide	Helena	Velossa	5905-579	Hexazinone
Herbicide	NuFarm	Clean Slate	228-491	Clopyralid
Herbicide	Drexel	Atrazine 4L	66222-36	Atrazine
Herbicide	Albaugh	Agristar 2,4-d LV6	42750-20	2,4-d ester
Herbicide	Dupont	Velpar DF	352-581	Hexazinone
Herbicide	Dow AgroSciences	Element 4	62719-40	Triclopyr

Narrative

April 27, 2015: The **Pesticide Analytical and Response Center** (PARC) received an **Oregon Emergency Response System** (OERS) incident report stating that: "Hazmat 1 reported a male subject was contaminated by a low-toxicity herbicide. Occurred somewhere on BLM land and has been ongoing for 2 weeks due to inadequate workplace safety. Herbicide is identified as Atrazine. It is reported at the workers are not provided proper safety gear while working with this herbicide and that the helicopter releases the herbicide overhead while they're working. The subject is Darryl Ivy 907-717-6977. Subject quit his job today and some of the information provided may be escalated due to subject being disgruntled. Subject complained of blisters in his mouth and a swollen airway. After quitting his job today the subject went to a restaurant before seeking medical treatment. Subject arrived at Mercy Medical Center in Douglas County at approximately 1745. The ER doctor is looking into toxicology reports and will have those available for Hazmat tomorrow. Meanwhile the subject was decontaminated and his clothing secured at the recommendation of Hazmat 1. The d-con shower is being left in place for the night and Hazmat will examine this in the morning. DEQ is requested for confirmation of clean-up method and OSHA will be advised due to incident information." This was forwarded to the Pesticides Program within Oregon Department of Agriculture.

Based on the report, I, **Michael Odenthal** Lead investigator Pesticides Program ODA, initiated an investigation and asked PARC to refer the incident to OR-OSHA and ODF and OHA. I consulted with **Garnet Cooke** at OR-OSHA and determined that OSHA would be the lead agency.

I received an e-mail from **Eric Martenson**, EPA Criminal Investigation, stating he would follow up with BLM Land/Douglas. I let him know that I was coordinating with OR-OSHA to conduct and investigation.

April 28, 2015: Cooke contacted me by phone and established that she would conduct an opening interview with **Applebee Aviation** on April 29, 2015. I would accompany her and listen to the conference to determine if there was additional follow up by ODA needed.

April 29, 2015: Cooke and I met with Applebee Aviation owner **Michael Applebee** at their hangar at 22330 NW Fisher Road, Banks, OR. Both Cooke and I presented our state identification and provided business cards. Cooke explained the nature of the visit and began the opening conference required by OR-OSHA. After the conference with Applebee, Cooke talked with Ivy via phone and established a meeting for Friday May 1 at the ODA offices.

May 1, 2015: Cooke contacted Ivy via e-mail to confirm the meeting during the afternoon. Ivy refused to meet until he had the proper representation.

Narrative

May 8, 2015: I contacted Ivy and explained that Cooke and I needed to meet with him so we could continue our investigations. He said he was looking for an attorney to represent him because he didn't trust ODA. He said he hadn't filed a complaint and wouldn't talk to ODA or OSHA until he was represented. He asked for sometime to get an attorney or if that didn't work out could he record the meeting. I responded he could record the meeting and I could provide a recorder for him if he would like. We agreed to talk on the next Friday.

May 14, 2015: Cooke set up meetings to interview the Applebee employees and the **Seneca Jones** foresters who were on the site.

May 15, 2015: I attempted to contact Ivy. His voicemail was full and would not allow for leaving a message and he didn't answer after several attempts.

May 20, 2015: Cooke, and I met with Oregon Department of Forestry foresters **Keith Waldron** and **Scott Swearingen** in the Roseburg Forestry Office. We conducted interviews of **Robert Taylor** (Applebee Aviation), **Adam Stinett** (Seneca Jones), **Shara Dippel** (Seneca Jones) and **Larry Saxton** (Seneca Jones).

Cooke conducted OSHA interviews of the above mentioned individuals to determine work practices on site.

Robert Taylor stated: On April 26 Daryl told him that he had dropped an empty atrazine barrel on the ground and some splashed up onto his face. He said he cleaned it up. At the end of the day when Robert was cleaning the truck using water at the Seneca site Robert was sure that Daryl probably got splashed with water. The next thing he knew Daryl had his backpack and was walking off.

Adam Stinett stated: He did not know of any incidents of exposure while he was working on site with Applebee. He said there was always a Seneca forester on site when applications were made and for the batching process. The forester did product calculations separate from Applebee, compared the results and observed the mixing and stowing of empty containers prior to operation. The forester may move off the landing during the application to better observe the helicopter at work. He said one time while on the landing he did get a little spray mist on the windshield of his truck and another time when he was parked at the edge of the unit unknown to the pilot.

He worked with this crew for four days.

Shara Dippel stated: She worked with the crew to spray 20 units this year. She had a radio that communicated with Applebee's crew. She said she did get mist on her person once and on her truck once. Both times she was were she wasn't supposed to be.

Larry Saxton stated: He worked with the crew to spray 15 units this year. He had a radio that communicated with Applebee's crew. He said that Dave (McDaniel) always left the last load for the landing after all the vehicles had left. He did not make any direct applications over them. He said he calculated mix rates and then watched the mixing process. He said Daryl started about a week into the job. He did not observe any splashing during the operation and never saw the pilot intentionally fly right over people.

Narrative

May 21, 2015: Ivy contacted Cooke for my e-mail address. Then he e-mailed me, stating that he was now represented and I could set up a meeting any time after Thursday the 28th. I proposed several dates and established a meeting date and time May 29, 2015 at 1000 hours with Ivy and his attorney **David Paul**.

May 27, 2015: Cooke and I interviewed **David McDaniel** (Applebee Aviation pilot) at the OR-OSHA field office in Salem. McDaniel explained that he didn't spray within 150 to 200 feet of the landing while people were there. He does have the crew shelter inside the vehicles when he got as close as 150 feet just in case of some product moved farther than he expected. He sprayed the landings after everyone had left the landing.

McDaniel stated on Ivy's first day they attended the Beyond Toxics meeting in Roseburg. Ivy expressed concerns and wanted to see the labels of the products they were using. McDaniel provided Ivy the labels. McDaniel said Ivy told him he studied the labels and was getting it and those products were used everywhere.

McDaniel also noted that a second Applebee Aviation crew was at the Beyond Toxics meeting as well.

May 29, 2015: Cooke, Eric Martensen (EPA Criminal), **Lori Bensel** (DOJ Attorney) and I met with Daryl Ivy and his attorney David Paul at the Law Offices of David Paul in Portland. Cooke started the interview with questions relating to workplace practices and safety training. I followed with several questions: Did he get directly sprayed or misted on? Ivy stated that he did get directly sprayed and misted on. He said the trucks were directly sprayed and that sometimes Dave (McDaniel) sprayed the landing before the rest of the unit and sometimes at the end. If he sprayed the landing at the start they sprayed the vehicles.

Martensen asked about other people involved with the crew and who they worked for.

Dave McDaniel and Robert Taylor - Applebee Aviation; Adam Stinett, Larry Saxton, and Shara Dippel - Seneca Jones. Martensen asked why he quit April 26? Ivy said two days prior they were loading a lot of atrazine. Robert disconnected a hose and he was splashed with chemical and water across his face. On the 26th he had blisters and welts on his face. The 26th was a hard day; they sprayed a bunch of units and the wind was constantly blowing to them. Then Dave sprayed the landing. Ivy said he saw the Seneca representative recording wind readings and thought that wasn't right. Ivy was also concerned about rinsing empty containers with very little water. He said sometimes they dumped the rinsate on the ground and sometimes into a 5-gallon bucket then pumped into a batch tank. At the end of the day, they returned the empties to the Seneca warehouse and picked up full ones.

At the end of the interview, Cooke and I asked that Ivy provide us with copies of his videos and the photographs he claimed documented his claims. Ivy agreed to provide those to us.

Narrative

June 16, 2015: I received a call from **Kelly Soule**, **Federal Aviation Association** (FAA) Safety Inspector. She asked if someone involved in the investigation related to Mr. Darryl Ivy could talk with them about the investigation. I explained to her that I was the investigator on that case. We set up a meeting for June 18, 2015 at the FAA office in Hillsboro.

June 18, 2015: I met with **David Long** and Kelly Soule at the FAA office.

Darryl Ivy was also there. Long and Soule interviewed me first privately. They asked questions related to terminology used in forestry spray applications and discussed some FAA rules and how they may apply in this situation.

After that discussion Mr. Ivy was brought in. He answered some questions. Long asked me if there was anything that I needed from Mr. Ivy to conduct my investigation. I stated that Ivy had promised to provide all the videos and photos he had taken as evidence. Long asked Ivy to provide that evidence to me. Ivy provided a flash drive that he stated held all the photos and videos. I thanked him and asked if I could share that information to OR-OSHA's Cooke and EPA's Martensen. Ivy stated yes I could. Then meeting ended. As we left the building Ivy asked if he could talk to me in private. He stated he would turn his recorder off.

We talked in the FAA parking lot and discussed the next steps of the investigation. Mr. Ivy stated he was not a complainer and had not filed a complaint so why was the State picking on him. I explained that we knew he had not complained but the emergency room he visited was obligated to report a pesticide exposure and since his exposure was on the job both OR-OSHA and ODA were obligated to investigate. He asked how he could get us off his back. I suggested that if he cooperated with the investigations we could finish and not bothering him anymore. Ivy told me he had other videos that showed the most egregious violations so he could drop them to the media to blow the lid off this. I reminded him that we needed all the evidence possible to prove any violations. He didn't offer the remaining evidence. He asked me to provide him information on how to get out of this mess and provided me his e-mail address.

August 13, 2015: I e-mailed **Warren Howe** with Applebee Aviation and requested application records for the David McDaniel applications from April 9 through April 26, 2015 related to Daryl Ivy's incident. Howe replied that he would be out of the office for a few days and had forwarded the request to **Brenda**.

August 18 , 2015: I sent another e-mail to Howe and to Brenda asking the status of my request because I had not had any response.

September 8, 2015: I received a package of records from Applebee.

Narrative

Record Review: Applebee Aviation provided 50 application records covering the period April 9 through April 27, 2015. The records provided were not complete records. Applebee Aviation did not include the unit maps, the pesticide product supplier, the specific crop applied, and the application equipment used with the record information sent. I sent an e-mail asking about the missing record elements. I was contacted by **Mike Applebee** by phone and explained that I needed to know how he kept those record elements. He explained that they maintained a copy of the forestry notification that provided the unit maps and the specific crop information; and they maintained the supplier information in their accounts payable files. He said the job records had the information about the equipment used. I asked him to send an e-mail response to my message for the record.

License Review: Applebee Aviation was licensed as a Commercial Pesticide Operator with the Forestry category at the time of the applications.

David A McDaniel was licensed as a Commercial Pesticide Applicator with the Forestry category at the time of the applications.

Label Review:

Helena Velossa, EPA Reg #5905-579, active ingredient hexazinone, is labeled for forestry site preparation and release applications at rates between 1.66 to 5.0 quarts/acre. Personal Protective Equipment (PPE) required for applicators and handlers of this product was Long-sleeved shirt and long pants, Shoes plus socks, and Protective eyewear.

NuFarm Clean Slate, EPA Reg #228-491, active ingredient clopyralid is labeled for use on forestry sites either at site preparation or tree release with rates between 1/4 to 1 1/3 pints/acre. PPE required for applicators and handlers of this product was Long-sleeved shirt and long pants, Chemical-resistant gloves made of any waterproof material, Shoes plus socks, and Protective eyewear.

Drexel Atrazine 4L, EPA Reg #66222-36, active ingredient atrazine is labeled for use in conifers prior to transplanting, after transplanting or in established conifers at rates between 4-8 pints/acre. PPE required for mixers, loader, all other applicators (other that backpack applicators), flaggers, and other handlers must wear: Long-sleeved shirt and long pants, Chemical-resistant gloves made of any waterproof material such as polyethylene or polyvinyl chloride, shoes plus socks, Chemical-resistant apron when mixing/loading, cleaning up spills, cleaning equipment, or otherwise exposed to the concentrate. See engineering controls for additional requirements.

Engineering Controls: Mixers and loaders supporting aerial applications at a rate greater than 3 lbs. ai/A must use a closed system that meets the requirements for dermal protection listed in the Worker Protection Standard (WPS) for agricultural pesticides [40 CFR 170.240(d)(4)] and must: wear the personal protective equipment required for mixer and loaders, wear protective eyewear if the system operates under pressure, and be provided and have immediately available for use in an emergency such as a spill or equipment breakdown: chemical-resistant footwear.

Narrative

Pilot must use an enclosed cockpit in a manner that is consistent with the QPS for Agricultural Pesticides [40 CFR 170.240(d)(6)]. Pilots must wear the PPE required on this labeling for applicators, however, they do not need to wear chemical-resistant gloves when using an enclosed cockpit.

Dow AgroSciences Element 4, EPA Reg #62719-40, active ingredient Triclopyr is labeled for use in forests at rates between 1 to 6 quarts per acre for site preparation and release applications. PPE required for Applicators and other handlers who handle this pesticide must wear: Long-sleeved shirt and long pants, shoes plus socks.

Albaugh Agristar 2,4-D, EPA Reg #42750-20, active ingredient 2,4-D is labeled for Uses in Forest Management Conifer Release and Site Preparation with rates between 2/3 to 2 2/3 quarts per acre. PPE required for Applicators and other handlers must wear long-sleeved shirt and long pants, chemical-resistant gloves Category E, such as barrier laminate >= 14 mils, nitrile rubber >= 14 mils...shoes plus socks, protective eyewear, and chemical -resistant apron when cleaning equipment, mixing, or loading.

Dupont Velpar DF, EPA Reg #352-581, active ingredient hexazinone is labeled for Forestry site preparation and release at rates between 1 1/3 to 4 pounds/ acre. PPE required: Applicators and other handlers must wear: Long-sleeved shirt and long pants, shoes plus socks, and protective eyewear.

All of the above labels also stated: "Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application" and "**Agricultural Use Requirements** Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This Standard contains requirements for the protection of agricultural workers on farms, forests, nurseries, and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification, and emergency assistance. It also contains specific instructions and exceptions pertaining to the statement on this label about personal protective equipment (PPE) and restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application."

September 11, 2015: OR-OSHA's evidentiary case was made available for use by in the ODA case. OR-OSHA cited 11 violations pertaining to the worker protection standard, employee training and improper PPE.

Investigator Recommendations: On April 27, 2015 the Department received a notification from the Oregon Emergency Response System (OERS) concerning a possible exposure to pesticides by an employee of an aerial application business. The Department conducted a joint investigation with OR-OSHA. OR-OSHA was the lead agency due to statutory obligations.

Narrative

The Department found that **Applebee Aviation** Inc. violated **ORS 634.372(4)**, which states that **A person may not:... Perform pesticide application activities in a faulty, careless, or negligent manner.** Specifically, during the time frame of April 9 to April 26, 2015 Applebee Aviation Inc., acting through its agents or employees David McDaniel, Robert Taylor and Darryl Ivy, performed application activities including handling various herbicide products as it prepared mixtures and loaded mixtures onto a helicopter for application. During the herbicide applications, Applebee Aviation's agents or employees handled pesticide products and spray mixtures as they mixed loads and loaded the helicopter used to make the applications. The agents or employees had not been provided with pesticide safety training prior to these activities, nor were they, during the application activities, consistently provided with water or other decontamination materials. This training and provision of materials were required by the pesticide product labels, through their Agricultural Use Requirements boxes, which require compliance with the Worker Protection Standard, 40 CFR 170. Also during these activities the agents or employees were not consistently provided with, and did not consistently wear, the PPE required by the pesticide product labels. During these activities, Applebee Aviation used a pesticide mixture tank with a defective hatch seal, which presented the handlers with additional potential for exposure to pesticide mixtures.

The failure to follow label requirements, provide sufficient safety materials, and provide equipment and training, and using workers without required PPE, and having workers use improperly securable equipment, seriously endanger worker/handlers and thus the public's health or safety. These failures are also considered to be performing pesticide application activities in a faulty, careless or negligent manner.

Conclusion

The Oregon Department of Agriculture determines that Applebee Aviation, Inc. violated Oregon Revised Statutes (ORS) Chapter 634 as follows:

VIOLATION NO. 1

Applebee Aviation, Inc. violated **ORS 634.372(4),** which states **A person may not: … Perform pesticide application activities in a faulty, careless or negligent manner.** During or about April of 2015 Applebee Aviation used a crew or crews of its agents or employees to support and perform aerial (helicopter) pesticide applications onto forestlands in Douglas County, Oregon. During these application activities the crew handled various pesticides, including:

Velossa Selective Herbicide, EPA Reg. No. 5905-579

Clean Slate Selective Herbicide, EPA Reg. No. 228-491

Transline Specialty Herbicide, EPA Reg. No. 62719-259

Element 4 herbicide, EPA Reg. No. 62719-40, a.i. triclopyr

Agri Star 2,4-D LV6 Low Volatile Herbicide, EPA Reg. No. 42750-20

Weedone LV6 EC Broadleaf Herbicide, EPA Reg. No. 71368-11

Atrazine 4L Flowable Herbicide, EPA Reg. No. 35915-4-60063 (a Restricted Use Pesticide)

Atrazine 4L Herbicide, EPA Reg. No. 66222-36 (RUP)

Drexel Atrazine 4L Herbicide, EPA Reg. No. 19713-11 (RUP)

The product labels for all of these pesticide products state: "Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application." Further, each of these labels also has an AGRICULTURAL USE REQUIREMENTS box, which adopts the Worker Protection Standard requirements for protection of forest workers and handlers of pesticides. This standard requires that handlers be provided with training and decontamination materials.

During the pesticide application activities the agents or employees mixed the pesticides into loads and loaded the loads into the helicopter used to make the applications. The agents or employees had not been provided with pesticide safety training prior to these activities, nor were they, during the application activities, consistently provided with water or other decontamination materials. Also during these activities the agents or employees were not consistently provided with, and did not consistently wear, the PPE required by the pesticide product labels. The handlers also faced potential for pesticide exposure due to a defective hatch seal on a pesticide mixture tank. As of September 2015, according to a complaint to OR-OSHA, Applebee Aviation is still not complying with these worker safety requirements.

Conclusion

Performing, and continuing to perform, these pesticide application activities with a crew that had not been given the all the safety training and decontamination materials required by the Worker Protection Standard, and hence, by the pesticide product labels, and when the crew had not been given and did not consistently wear the Personal Protective Equipment required by the product labels, was pesticide application activity performed in a faulty, careless or negligent manner, in violation of ORS 634.372(4), and the continuation thereof seriously endangers the public's health or safety.

Attachments

Attachment Name	Type
Agristar 2,4-D LV6 Label -ODA file copy	Label
Applebee proposed NCIP and Order of Emergency License S...	Enforcement
Application Records	Records
Case E-mails folder	Correspondence
Case notes Ivy	Case notes
Clean Slate Label-ODA file copy	Label
Confidential- Oregon OSHA investigative case file- Confidential	Misc.
Confidential- Recording of Ivy Interview May 29, 2015 - Confidential	Misc.
Darryl Ivy update e-mail	Correspondence
DEQ complaint form from PARC	Correspondence
Drexel Atrazine 4L label - ODA file copy	Label
Element 4 label - ODA file copy	Label
EPA-DEQ e-mails	Correspondence
Ivy video disc 1 82percent humidity!! look at windshield its ...	Video
IVY video disc 1 chemical storage	Video
Ivy video disc 1 chemical...into vapors	Video
Ivy video disc 1 drift occuring all radio	Video
Ivy video disc 1 lady calls seneca rep and says dont spray in rain	Video
Ivy video disc 1 Robert says hes been sprayed	Video
Ivy video disc 1 Seneca aware humters in area and continues...	Video
Ivy video disc 1 seneca rep saying all the deer get sprayed	Video
Ivy video disc 1 Seneca reps dog licks chemical...in her truck...	Video
Ivy video disc 1 wow! seneca rep admitting... affect other prop...	Video
Ivy video Disc 2	Video
Ivy video disc 3 All the equipment, trucks sprayed	Video
Ivy video disc 3 batch truck leaking at creek bad seals	Video
Ivy video disc 3 how the helicopter is reloaded	Video
Ivy video disc 3 im at a loss for words!!! ng labels off, etc(3)	Video
Ivy video disc 3 im at a loss for words!!!! ng labels off, etc (5)	Video
Ivy video disc 3 leaking chemicals	Video
Ivy video disc 3 reforestation my ass	Video
Ivy video disc 3 reloading heli truck leaking seneca present	Video
Ivy video disc 3 rinsing barrels in field	Video
Ivy video disc 3 Roseburg emergency room	Video
Ivy video disc 3 sprayed in mouth	Video
Ivy video disc 3 torn glove chemical leaded thru	Video
Ivy video disc 3 trucks coated with chemicals	Video
Ivy video disc 3 welts, buying gloves at knecks auto	Video
Ivy video Disc 4	Video
Ivy video Disc 5	Video
OERS Report	Correspondence
Velossa label - ODA file copy	Label
Velpar DF Label - ODA file copy	Label

Enforcement Summary

Name	License Type	Prohibition Violated	Number of Actions	Action	Notice Issued	Notice Served	Orig CP Amount $	Hearing Reqsted	Informal Held	Final Order Issued	Actual CP Amount $
Applebee Aviation, Inc.	CPO	4	1	CP	09/25/15	09/25/15	$1,110.00				
Applebee Aviation, Inc.	CPO	4	1	LIC ACT	09/25/15	09/25/15					
McDaniel, David A.	CPA	NONE	1	NONE							
					TOTAL Orig CP Amount $		$1,110.00	**TOTAL Actual CP Amount $**			

Aerial Applicator's

MANUAL

A NATIONAL PESTICIDE APPLICATOR CERTIFICATION STUDY GUIDE

Aerial Applicator's Manual

A NATIONAL PESTICIDE APPLICATOR CERTIFICATION STUDY GUIDE

Written By

Patrick J. O'Connor-Marer, PhD

NASDARF

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CONTENTS

INTRODUCTION

Applying pesticides by air is an important part of many agricultural pest management activities. If you are a pilot and plan to engage in this type of work, you must become proficient in making safe, legal, accurate, and effective pesticide applications from an aircraft. However, before you begin applying federal *restricted-use* pesticides for hire, you have to demonstrate your skills and knowledge through a certification process administered by a pesticide regulatory agency.

Pesticide regulatory agencies within states, tribes, and territories, as well as federal departments or agencies, are responsible for certifying pilots who intend to apply restricted-use pesticides to agricultural crops from aircraft. This federally-mandated certification process applies to pilots who make applications of restricted-use pesticides for hire and those who work for commercial pest control operators. State, tribal, and territorial pesticide regulatory agencies may require certification of pilots who apply other pesticides as well. Many state pesticide regulatory agencies in the U.S. have adopted the National Aerial Pesticide Applicator Pilot Certification Examination as their tool for pilot certification.

In addition to the National Aerial Pesticide Applicator Pilot Certification Examination, state pesticide regulatory agencies may require pilots to pass a core examination and possibly one or more category-specific examinations (agriculture, forest, right-of-way, aquatic, etc.) as part of their certification process. Check with the pesticide regulatory agency in whose jurisdiction you will be working for complete certification requirements. (See Appendix 1 for pesticide regulatory agency contact information). Requirements may differ from one jurisdiction to another, and you may need to participate in separate certification processes for each jurisdiction. In addition to the aerial applicator pilot certification requirements, Chapter 1 of this book covers the general standards set by Federal regulations for certifying all commercial pesticide applicator pilots and aerial pest control operators who apply federal restricted-use pesticides for hire.

Robert Wolf—Kansas State University

THE NATIONAL EXAMINATION

A team of experienced pilots and business owners who are actively engaged in aerial application of pesticides participated with an examination specialist to develop the National Aerial Pesticide Applicator Pilot Certification Examination. This committee identified the essential knowledge and skills each entry-level pilot applicator needs to competently, safely, and legally perform all aspects of aerial pesticide application.

The committee developed a Detailed Content Outline, included on pages 3 through 7, which serves as the blueprint for all examination questions and for this study manual. Before taking the examination, review this document so you understand the scope of knowledge and skills expected of you as you apply pesticides from an aircraft. The examination tests you on this knowledge and required skills.

SCOPE OF THIS MANUAL

This manual focuses on how to apply pesticides properly and safely from an aircraft. It includes all the content found on the National Aerial Pesticide Applicator Pilot Certification Examination and consists of the following six chapters:

1 — *Laws and Regulations for the Aerial Applicator Pilot*

2 — *Operation and Application Safety*

3 — *Preventing Pesticide Drift*

4 — *Aerial Pesticide Dispersal Systems*

5 — *Calibrating Aerial Application Equipment*

6 — *Making an Aerial Pesticide Application*

Also included in this manual is a glossary of terms, an index, and several appendices that provide additional information that may prove useful as you prepare for the examination.

How to Use this Manual

Since this is a study manual, the end of each chapter has a number of review questions to help test your understanding of the information you just read. These review questions are similar to the types of questions on the actual examination so they will help you become familiar with the examination style and process. Each chapter begins with a set of objectives corresponding to certain skills and knowledge expected of you as an aerial pesticide applicator pilot.

John Mateski—Newberg, OR

Read a chapter and then test your understanding of the material presented by answering the review questions. Check your answers to these questions by turning to page 97. If you miss some questions, go back and review sections of the chapter that covers that information. Repeat this process for each of the chapters. Information of special interest is organized into sidebars throughout the manual. You may find this information helpful in your work as an aerial application pilot.

DETAILED CONTENT OUTLINE

FOR

LICENSED/CERTIFIED AERIAL APPLICATOR PILOTS

I. OPERATIONS

A. Federal and State Regulation Compliance

1. Maintain requirements for a commercial pilot's certification for aerial application (e.g., biennial flight review, medical)
2. Comply with all FAA regulations
3. Recognize an area that may be construed as congested by the FAA
4. Plan flight patterns to avoid passes over residences, schools, communities, field workers, or animals
5. Comply with state regulations regarding aerial pesticide applications
6. Operate according to government regulations while applying good judgment during each application
7. Maintain aircraft according to generally-accepted maintenance practices
8. Tailor application plans to the job situation and locale while addressing requirements of regulatory agencies
9. Obtain the required FAA Part 137 knowledge and skills endorsement from the business owner/operator
10. For agricultural operations, communicate with the business owner/operator and grower:
    a. regarding job scheduling, rescheduling, and special considerations to meet Worker Protection Standard regulations
    b. ensuring they have proper documentation (label) regarding the application as required by the Worker Protection Standard regulations
11. Ensure proper notification is given, including required field posting, before starting an application

B. Field Operations

1. Secure aircraft so it cannot be accessed or flown by unauthorized personnel
2. Ensure:
    a. ground-support crew members can implement their job responsibilities

b. the area to be treated is clear

c. unplanned conditions have not arisen at the time of an application

3. Resist pressure to apply a product that presents unacceptable risk for the pilot, aircraft, public, surrounding crops, or wildlife
4. Refuse jobs that are unsafe or illegal
5. Participate in pre-application planning sessions and in post-application debriefings
6. Document special precautions required to protect sensitive areas or situations

II. COMMUNICATIONS

A. Mixer/Loader Supervision

1. Review responsibilities of the mixing-loading crew at the base and satellite locations
2. Ensure the proper product is loaded into the aircraft for each application
3. Perform minor in-field repairs on ground-support equipment
4. React in a positive and helpful way in an emergency situation (e.g., broken loading hose)

B. Pilot and Ground Crew

1. Use radio transceivers to communicate with the ground crew
2. Communicate information on work order changes in the field directly between the customer/field men and the business owner/operator or crew leader
3. Contact appropriate personnel when uncertain about any aspect of an application
4. Practice procedures and contingency plans to ensure necessary communications are detailed, quick, and accurate
5. Develop a strategy to notify a pilot when an aircraft should not be flown because of maintenance problems

III. APPLICATION SAFETY

A. Emergency Planning

1. Anticipate types of accidents or incidents that can happen during the course of an aerial application or loading operation
2. Devise a contingency plan for evacuating the aircraft in case of emergency
3. Review pilot and ground crew procedures for an aircraft crash

B. Pre- and Post-Flight Preparations

1. Check aircraft fuel and oil levels
2. Seek local advice regarding topography and sensitive areas when an application will occur in an unfamiliar location
3. Review an application job order to determine whether the job can be accomplished safely and adequately with reasonable precautions and work procedures
4. Inspect flight suits, safety harnesses, and flight helmets for proper operating condition
5. Wear a proper aviation flight helmet

6. Check the operation of seat restraints
7. Inspect:
   a. the fire extinguisher
   b. dispersal equipment (e.g., nozzles, hoses, connections) for signs of leakage and mechanical damage
8. Develop a procedure to ensure contaminates are not carried on clothes into the cockpit
9. Maintain maps and aerial photos if available and mark any obstacles, hazards, and sensitive areas
10. Survey a field before treatment noting sensitive situations including
    - field crews
    - traffic or individuals
    - crops in the vicinity
    - domestic animals and wildlife
    - aquatic areas
    - private residences
11. Check each field for in-flight hazards (e.g., towers, power lines, guy wires, irrigation pipes, and vent pipes) before each application begins
12. Report equipment deficiencies to the business owner/operator
13. Ensure known equipment deficiencies have been addressed
14. Protect employees from chemical exposure while changing nozzles and spray equipment configurations

C. Scheduling

1. Implement work schedules that provide adequate rest periods
2. Perform the most difficult and sensitive jobs when rested
3. Help the business owner/operator plan equipment overhaul activities prior to periods of high demand

D. Pesticide Label

1. Comply with label requirements and restrictions for aerial application of pesticides including:
   a. spray volumes (Gallons per Acre — GPA)
   b. buffers and no-spray zones
   c. weather conditions specific to wind and inversions
2. Interpret labels that do not include a reference to aerial use

IV. DISPERSAL EQUIPMENT

A. Selection

1. Inspect dispersal system components for proper operating condition including hopper/tank, pump, filters, pipes, and fittings
2. Select proper nozzles for desirable coverage and drift minimization
3. Describe:
   a. major components of an aerial application liquid dispersal system
   b. desirable features of pesticide hoppers and tanks
   c. primary ways pumps are powered, and requirements for location and output capacity

d. features, advantages, and disadvantages of a fan-driven pump
e. desirable features of pipes and fittings in an aerial dispersal system

4. List primary types of spray patterns produced by hydraulic nozzles
5. Describe:
   a. features of filters and screens
   b. hollow cone and flat fan patterns
6. Determine the number of nozzles for required sprayer output using manufacturer's specified nozzle flow volume chart, aircraft speed, and swath width

B. Position

1. Describe where:
   a. filters/screens should be located in the system
   b. pressure gauges should be positioned
2. Ensure
   a. booms and nozzles are positioned to release spray into a laminar airflow
   b. nozzles are placed to compensate for uneven dispersal from uneven airflow from:
      - wing tip vortices
      - aircraft propeller turbulence
      - high or low helicopter rotor speeds
3. Drop nozzles to either side of, or below, airflow obstructions (e.g., landing gear, oil coolers, boom hangers, pumps and swath markers) to minimize distortion of the spray pattern
4. Place nozzles:
   a. in the air stream to produce the appropriate droplet size consistent with boom pressure to give acceptable performance for each job while adhering to label restrictions
   b. along the boom to produce a uniform deposition on the target when the aircraft is flown at the normal spraying airspeed and altitude
5. Check swath pattern uniformity for each nozzle configuration used for various flows

C. Maintenance

1. Check dispersal system pressure gauge accuracy
2. Maintain appropriate dispersal system filter cleaning schedule
3. Check nozzles for excessive wear
4. Correct leaking nozzles, fittings, and diaphragms on the ground during loading by cleaning or replacing parts as often as needed
5. Keep:
   a. spray system connections and fittings tight and in good repair to minimize leaks
   b. the boom suck-back valve adjusted and in working order to ensure a positive shut-off and safeguard against leaking nozzles

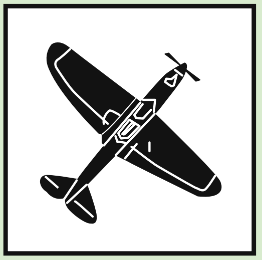
D. Performance Measurement and Adjustment

1. Change nozzle tips and orifices as required for various flows
2. Calculate required and actual flow volumes, and actual output
3. Verify flow volume using fixed timing, open timing, known distance, or a flow meter
4. Adjust and calibrate:
   a. the aircraft dispersal system prior to use on a job
   b. after any modification is made to the aircraft or dispersal system

V. APPLICATION CONSIDERATIONS

A. Site-Specific Meteorological Criteria

1. Recognize application limits imposed by weather
2. Determine wind velocity, direction, and air density at the job site
3. Identify climatic conditions that:
   a. can affect aircraft engine power, take-off distance, and climb rate
   b. promote spray droplet evaporation



4. Anticipate air temperature and humidity effects on spray droplet size
5. Describe conditions associated with:
   a. thermals
   b. a temperature inversion

B. Minimizing Off-Target Product Movement

1. Assess risks of off-target movement
2. Refer to USDA Agricultural Research Service spreadsheet information and nozzle manufacturer fact sheets to facilitate nozzle selection and spray droplet size
3. Select proper nozzles, operating pressure, orientation, and placement to minimize spray drift
4. Relate:
   a. volume-median-diameter (VMD) and relative span to desired deposition
   b. physical properties of a product to on-target deposition
5. Using a smoke generator, determine if the spray has a potential to drift
6. Evaluate vertical and horizontal smoke plumes to assess wind direction, speed, and concentration
7. Identify positive air movement away from critical areas
8. Relate dispersal equipment configurations to airflow around the aircraft
9. Select techniques (e.g., boom shut-offs, cross-wind applications, buffer zones) that minimize product movement out of the treatment area
10. Apply product to headlands and edges of fields when drift potential is minimal
11. Document special equipment configurations or flight patterns used to reduce off-target movement

C. Making the Application

1. Select a flight altitude that minimizes streaking and off-target movement
2. Choose a flight pattern that provides the best performance and safety level for job conditions and operation mode
3. Engage and disengage spray precisely when entering and exiting a predetermined swath pattern
4. Utilize swath marking tools (e.g., GPS, flags)
5. Continuously evaluate an application to ensure uniform dispersal
6. Document the product(s) applied and application conditions

Glenn Martin—Gettysburg, PA

CHAPTER 1

LAWS AND REGULATIONS FOR THE AERIAL APPLICATOR PILOT

LEARNING OBJECTIVES

Studying this chapter will help you to:

- Understand why you must comply with federal, state, and local regulations regarding aerial pesticide applications while using good judgment, best management, and safety practices during each application.
- Understand the requirements for applying for a private or commercial pilot certification for aerial application of pesticides and how to maintain a valid certificate.
- Know the requirements and processes for maintaining an aircraft according to applicable regulations, safety practices, and aircraft manufacturer guidelines and recommendations.
- Tailor aerial pesticide applications to the job situation and locale while following the requirements of regulatory agencies.
- Recognize congested areas and the importance of planning flight patterns that avoid passes over residences, schools, communities, field workers, and animals.
- Comply with label requirements and restrictions for aerial application of pesticides and interpreting labels that do not include specific use directions for aerial use.

As an aerial pesticide applicator pilot, you must abide by all regulatory requirements and restrictions that pertain to pesticide handling and aerial pesticide application. Only under an extreme emergency, where the public or environment may be in danger, can you vary from any legal flight and aircraft handling requirements. Federal, state, tribal, territorial, and sometimes local laws and regulations address the handling and application of pesticides in the United States. These laws and regulations help:

- Provide for the proper, safe, and efficient uses of pesticides essential for the production of food and fiber and protecting public health and safety.

- Protect the environment by prohibiting, regulating, or controlling certain pesticide uses.
- Assure agricultural and pest control workers of safe working conditions where pesticides are present.
- Assure that aerial agricultural pest control is performed by qualified, competent, and responsible individuals.
- Assure users that pesticides are appropriate for the use designated by the label.
- Require that pesticide and service containers are properly labeled.
- Encourage the development and implementation of pest management systems that stress the incorporation of biological and cultural pest control techniques with selective pesticide uses when necessary to achieve acceptable levels of control with the least possible harm to nontarget organisms and the environment.

Federal regulations applicable to the certification of people who apply pesticides and to pesticide handling and application are part of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The U.S. Environmental Protection Agency (EPA) and state, tribal, and territorial pesticide regulatory agencies enforce the provisions of FIFRA. EPA regulations focus on applicator (pilot) job knowledge including pesticide handling and protecting people and the environment. State licensing, use, storage, handling, and disposal regulations, as well as tribal, territorial, and local regulations, often further regulate application procedures and pesticide uses in order to protect people and vulnerable sensitive areas or organisms.

The U.S. Federal Aviation Administration (FAA) certifies agricultural aircraft operations and enforces Federal Aviation Regulations (FARS) pertaining to aircraft operation. FARS Section 14, part 137 of the Code of Federal Regulations specifically addresses agricultural aircraft operations. An agricultural aircraft operation is a business that operates aircraft for the purpose of:

- Dispensing any economic poison.
- Dispensing any other substance intended for plant nourishment, soil treatment, propagation of plant life, or pest control.
- Engaging in dispensing activities directly affecting agriculture, horticulture, or forest preservation.

FAA regulations concern such areas as aircraft operation, aircraft inspection and maintenance, ferrying routes, operation altitude, pilot licensing, and medical exams. Appendix 2 provides a summary of the FAA agricultural aircraft operator certification requirements and process.

REQUIREMENTS FOR PILOT CERTIFICATION

Applicants for aerial applicator pilot certification must hold and maintain a commercial pilot's license and have a current Class II Medical Certificate. If you work as a pilot-in-command for an agricultural aircraft operator, you also need an endorsement letter from that operator or a person designated by that operator. The aircraft you fly must be equipped with approved and properly labeled seat belts and shoulder harnesses for each pilot station.

EPA Requirements

State-administered EPA pesticide applicator certification determines the competency of individual pilots who will be applying pesticides. You must demonstrate your knowledge of general aspects of pesticide handling and application as well as your knowledge of the specialized area or areas of application where you intend to work, e.g., agricultural crops, forests, rights-of-way, public health pest control.

Determination of Competency

State pesticide regulatory agencies use written examinations to determine your competency in using and handling pesticides. State competency standards must, at a minimum, conform to federal regulations. To prepare for examinations testing your knowledge of general aspects of pesticide handling and application, obtain a copy of the National Pesticide Applicator Certification Core Manual published by the National Association of State Departments of Agriculture Research Foundation, Washington, DC. You can download PDF versions of manual chapters at http://www.nasda.org/StaticContent/workersafety/. The manual covers the general standards listed below. States may also have additional study materials available to assist in preparing for the exam.

General Standards for All Certified Commercial Applicators

To become a certified commercial applicator, you must demonstrate practical knowledge of the principles and practices of pest control and safe pesticide use and handling. General standards of competency include the following categories.

Label and Labeling Comprehension. You must know the format and terminology of pesticide labels and labeling, including:

- Understanding instructions, warnings, terms, symbols, and other information commonly appearing on pesticide labels.
- Recognizing product classification: "general-use" or "restricted-use."
- Adhering to the requirement to use pesticides consistent with their label instructions.

Safety Factors. Regulations require you to understand:

- Pesticide toxicity and hazards to people.
- Symptoms of pesticide poisoning.
- The usual pesticide exposure routes.
- Types and causes of common pesticide accidents.
- The precautions necessary to guard against injury to applicators and other individuals in or near treated areas.
- The need for and proper use of protective clothing and equipment.
- First aid and other procedures to follow in case of a pesticide accident.
- Proper identification, storage, transport, handling, mixing procedures, and disposal methods for pesticides and used pesticide containers, including precautions to prevent children from having access to pesticides and pesticide containers.

Environment. You must recognize how the following factors possibly influence the environmental fate of pesticides:

- Weather and other climatic conditions.
- Types of terrain, soil, or other substrate.
- Drainage patterns.
- Presence of fish, wildlife, and other non-target organisms.

Pests. For effective pest control, you need to be able to identify relevant pests and recognize the common characteristics of pest organisms and their damage symptoms and signs. You must also understand pest development and biology relevant to identification and control.

Pesticides. Your knowledge of pesticides must include:

- Knowing the general types of pesticides.
- Being familiar with various types of formulations.
- Understanding compatibility, synergism, persistence, and animal and plant toxicity of the formulations.

- Recognizing hazards and residues associated with use.
- Being aware of factors that influence effectiveness or lead to such problems as pesticide resistance.
- Knowing the proper procedures for diluting pesticide concentrates.

Equipment. You must demonstrate your familiarity with types of application and mixing equipment and know the advantages and limitations of each. You must be proficient in calibrating and maintaining pesticide application equipment.

Application Techniques. Regulations require you to demonstrate proper application methods for various formulations of pesticides, their solutions, and choose the correct application technique to use in a given situation. You must demonstrate how to prevent drift and pesticide loss into the environment.

Laws and Regulations. You must also demonstrate your knowledge of applicable state and federal laws and regulations. States may require certification (examinations) in additional categories over and above the general standards. These additional categories align with various pesticide uses, such as agricultural pest control, rights-of-way vegetation control, vector control, or forest pest control.

THE PESTICIDE LABEL

The pesticide container label and associated labeling are important legal documents that contain directions and restrictions you must follow when making an aerial application. Some labels refer to other documents, such as endangered species area protection maps or the Worker Protection Standard provisions of the Code of Federal Regulations applicable to agricultural operations (40 CFR part 170). These and other documents referred to on pesticide labels become part of the pesticide labeling.

Some labels and associated labeling contain information specifically applicable to aerial application. Other labels and associated labeling contain information pertaining to any type of application method and do not provide specific instructions or precautions for aerial application. Certain pesticide labels prohibit the aerial application of the labeled material, so you must never apply these materials by air, even when mixed with other pesticides approved for aerial application.

Labels having specific aerial application information are usually easier to interpret than those that only provide general information. Examples of

> The use of 80-degree or 110-degree flat-fan nozzles is highly recommended for optimum spray coverage and canopy penetration. To achieve uniform spray coverage, use nozzles and pressure that deliver MEDIUM spray droplets as indicated in nozzle manufacturer's catalogs and in accordance with ASAE standard S-572. Use screens that are 50 mesh or larger.
>
> **AERIAL APPLICATION**
>
> Herbicide should be applied in a minimum of 5 gallons of water per broadcast acre. Weed infestations should be treated before they become competitive with the crop.
>
> To achieve uniform spray coverage, use nozzles and pressure that deliver MEDIUM spray droplets as indicated in nozzle manufacturer's catalogs and in accordance with ASAE standard S-572. DO NOT use raindrop nozzles.
>
> Aerial applications with this product should be made at a maximum height of 10 feet above the crop with low drift nozzles at a maximum pressure of 40 psi. Avoid application under conditions where uniform coverage cannot be obtained or where excessive spray drift may occur.
>
> Flagmen and loaders should avoid inhalation of spray mist and prolonged contact with skin.
>
> See the ***SPRAY DRIFT MANAGEMENT*** section of this label for additional information on proper application of herbicide.
>
> **MIXING INSTRUCTIONS**
>
> Herbicide must be applied with clean and properly calibrated equipment. Prior to adding herbicide to the spray tank, ensure that the spray tank, filters, and nozzles have been thoroughly cleaned. In-line strainers and nozzle screens should be 50 mesh or coarser.

aerial-specific information covered in labels may include:

- Statements that refer to or allow aerial application.
- Specific use directions, such as for rate and dilution that apply directly to aerial applications without interpretation or calculations.
- Allowable weather conditions for applications.
- Restrictions pertaining to spray volume and dilution.
- Droplet size information based on ASABE S-572.1 (see Page 37) Spray Nozzle Classification by Droplet Spectra.
- Drift management requirements.
- Off-target and especially sensitive area precautions.
- Buffer zone requirements.

Manufacturers must register pesticide products with the EPA before anyone can buy or use them. The EPA registers specific products, not generic pesticide materials. This registration procedure protects people and the environment from ineffective or harmful chemicals. The registration procedure includes an evaluation of each chemical and establishes how the EPA classifies the material at the federal level. This evaluation determines whether the EPA classifies a pesticide as restricted-use or general-use. Only certified pesticide applicators can buy, use, or supervise the use of a federal restricted-use pesticide (RUP). States may also have specific registration and labeling requirements and may restrict the use of other products not classified as restricted-use by the EPA.

Regulations set the format for pesticide labels and prescribe what information they contain. Some pesticide containers are too small, however, to have all this information printed on them. In these cases, the EPA requires registrants or manufacturers to attach additional labeling. On metal and plastic containers, registrants or manufactures put such packets into plastic sleeves glued to the sides of the containers. Paper packages usually have label directions inserted under the bottom flaps of the package.

States or local regulatory agencies may impose additional restrictions or prohibitions on aerial applications that may or may not be included on the pesticide label. For example, local regulations may be more restrictive on requirements such as buffer areas, no-spray zones, and dilution rates. Always follow the requirements that are most restrictive in the location where you are making an application. For example, local agencies might prohibit aerial applications regardless of label use directions, or they might prohibit fixed-wing applications under certain circumstances and require that only rotary-winged aircraft make aerial applications in these situations.

Professional Aerial Applicator's Support System (PAASS)

A pesticide drift mitigation and education project initiated in 1996 by the National Agricultural Aviation Association (NAAA). PAASS is an industry-based collaborative educational effort that focuses on outreach to pilots and operators of aerial applicator businesses. The program's primary goals are to reduce the number of pesticide agricultural aviation accidents, improve pilot safety, and reduce pesticide drift incidents by fostering professionally-sound decision-making.

The PAASS interactive program improves critical decision-making skills sensitive to environmental factors. The agricultural aviation industry regards the PAASS program as the single relevant recurring training source for modern agricultural aviation pilots. Many companies providing insurance to agricultural aviators require pilots to participate in this training as a condition of insurability.

Statistics show that aerial application accidents and drift incidents have notably declined since the PAASS program first began.

Review Questions

CHAPTER 1: Laws and Regulations for the Aerial Applicator Pilot

1. Pesticide laws and regulations help to:

- **A.** Encourage pesticide use.
- **B.** Protect the environment.
- **C.** Avoid dependence on alternative pest control methods.
- **D.** Prevent pests from developing control resistance.

2. Knowing the proper procedures for diluting pesticide concentrates is:

- **A.** An FAA requirement.
- **B.** The requirement of local pesticide regulatory agencies.
- **C.** Part of the federal Worker Protection Standard provisions.
- **D.** An EPA general standard for certified applicators.

3. The format of pesticide labels is established by:

- **A.** Pesticide manufacturer guidelines.
- **B.** Federal regulations.
- **C.** State laws.
- **D.** ASABE professional standards.

4. Knowing how to properly handle, mix, store, and dispose of pesticides is a requirement of the:

- **A.** Environmental Protection Agency (EPA).
- **B.** Occupational Safety and Health Administration (OSHA).
- **C.** United States Department of Agriculture (USDA).
- **D.** Federal Aviation Administration (FAA).

5. One purpose of federal pesticide regulations is to:

- **A.** Require public notification about pesticide applications.
- **B.** Provide health benefits to agricultural workers.
- **C.** Establish safety standards for pesticide application equipment.
- **D.** Prevent agricultural workers from handling pesticides or working in pesticide-treated areas.

6. State pesticide regulatory agencies generally have the responsibility for:

- **A.** Certifying commercial pesticide applicators.
- **B.** Determining the personal protective equipment required on pesticide labels.
- **C.** Developing material safety data sheets (MSDS).
- **D.** Identifying endangered species.

7. In addition to the actual pesticide label, which of the following is part of the pesticide labeling?

- **A.** Any product sales brochures.
- **B.** The job work order.
- **C.** Worker Protection Standard provisions.
- **D.** The Material Safety Data Sheet.

8. Which of the following is one of the requirements for pesticide applicator certification?

- **A.** Knowing how to use appropriate application methods for various pesticide formulations.
- **B.** Demonstrating safe aircraft operation.
- **C.** Following recommended aircraft inspection and maintenance schedules.
- **D.** Making applications at altitudes specified in regulations.

9. From the choices below, what pesticide use information found on a product label would be specific to an aerial application?

- **A.** PPE requirements.
- **B.** ASABE droplet size requirements.
- **C.** Field posting requirements.
- **D.** Restricted-entry interval requirements.

10. Having a current Class II Medical Certificate is a requirement of the ____________ for all pilots making aerial pesticide applications.

- **A.** U.S. Environmental Protection Agency (EPA).
- **B.** State Lead Agency (SLA).
- **C.** Federal Aviation Agency (FAA).
- **D.** National Transportation Safety Board (NTSB).

REVIEW QUESTION ANSWERS ON PAGE 97

CHAPTER 2

OPERATION AND APPLICATION SAFETY

LEARNING OBJECTIVES

This chapter will assist you to:

- Understand the importance of preventing security threats to the operations and reducing hazards to the public from unauthorized or illegal access to the aircraft, pesticide materials, and equipment.
- Understand the importance of protecting people and the environment from hazards associated with aerial application of pesticides.
- Know steps to make pesticide applications that are safe for you and the ground operations crew.
- Understand what precautions to take to protect sensitive areas while making pesticide applications from an aircraft.
- Recognize the importance of good communications with the ground operations crew and others before, during, and after making pesticide applications.
- Prepare for emergencies, including knowing proper first-aid procedures for pesticide exposure and related illnesses or injuries, and heat-related illnesses.

Safety awareness and practices in all as-pects of an aerial pesticide application operation protects employees, the public, and the environment. Your operation needs procedures to secure the aircraft, ground equipment, and pesticide materials when not in use to prevent unauthorized access. Unauthorized access can range from individuals wanting to damage or burglarize property to crimes of opportunity, such as unplanned acts of vandalism. There is also the possibility that people are unaware of the hazards associated with a pesticide application operation while inadvertently gaining access to the facility. An example would be children who might be curious about and attracted to aircraft or other pesticide use equipment, thereby trespassing to inspect the equipment when company personnel are not at the facility. In addition to securing the facility, you can protect people and the environment by carefully planning each function of the application operation to avoid accidents and hazards. Provide safety training to ground crew members so they know how to handle pesticides properly and work carefully around aircraft and other associated equipment.

Make sure each person involved in the application operation is well rested, alert, and not under the influence of alcohol or drugs. Develop reliable methods of communication between you, the customers, and ground operations. In case an accident or mishap should occur, take immediate steps to reduce damage and injury, including performing proper first aid and decontamination procedures for pesticide exposure.

AIRCRAFT AND PESTICIDE SECURITY

Progressive and conscientious operations that handle pesticides work to actively manage risks to ensure the safety of their employees, their customers, and their communities. They focus on safely operating aircraft and mixing-loading equipment. To achieve these goals, they use preventative maintenance, up-to-date operating procedures, and well-trained staff. Because of heightened concerns about terrorism and sabotage, the operation must also pay more attention to the security of aerial application equipment, facility sites, and pesticide storage areas. All aerial application operations need some measure of site security in place to minimize crime, prevent unauthorized access, and protect company assets.

While many of the steps you take to ensure an effective security program seem routine, they are important to the health and safety of the aerial application operation staff and the surrounding community. Without effective security procedures, the business risks being vulnerable to both internal and external threats, which can pose hazards to you and the employees, sensitive business information, the facilities and equipment, and stored pesticides.

Evaluating Aerial Application Operation Security

There are several important security needs and critical control points for an aerial application operation.

Securing Facilities, Storage Areas, and Surrounding Property

One of the most fundamental security needs is keeping intruders out of areas used for pesticide storage. Elements of an effective security plan can range from basic fencing, lighting, and locks, to intrusion detection systems and cameras. Inventory management policies help limit the amount of pesticides stored on site, reducing the risks of accidental or intentional release or theft.

Securing Pesticide Application Aircraft, Vehicles, and Equipment

The operation you work for needs appropriate security protections to prevent intruder access to equipment used for mixing, loading, and applying pesticides. Accepted methods to prevent unauthorized flying of aircraft include installing hidden electrical system shut-off switches, parking disabled trucks or other equipment in front and back of aircraft, removing batteries from aircraft, using devices that lock propellers or rotors, and disabling engines in unused aircraft. Use similar methods to prevent intruders from operating ground vehicles, such as trucks, tractors, forklifts, and other motorized equipment. Always park the aircraft in a secure place when it is not in use. In addition, establish methods to know at all times the location and status of all equipment used in the operation. Routinely update equipment records.

Security awareness is particularly important for large-scale pesticide application equipment, like aircraft. The Federal Bureau of Investigations (FBI) requests that aerial operators be vigilant to any suspicious activity relative to the use, training in, or acquisition of dangerous pesticide chemicals or airborne application of these materials. This includes threats, unusual purchases, suspicious behavior by employees or customers, and unusual contacts with the public. If you observe any suspicious behavior, irregular circumstances, or unusual requests for information, immediately report this to a local law enforcement agency and the FBI.

Minnesota Department of Agriculture

Employees

Effective hiring and labor relations policies are important to obtain and retain good employees who will support and follow the operation's safety precautions. The hiring process should ensure that pesticide handlers have all requisite training necessary to handle pesticides safely. Background checks of employees who will have access to secure areas, particularly those areas where pesticides are stored, can be an important employee selection tool.

Emergency Response

Effective emergency response procedures help to ensure that the operation manager and employees understand how to respond and whom to contact in the case of an emergency. Aside from accidents, such plans need to consider vandalism, burglary, arson and bomb threats that target the operation, and potential widespread terrorist activity that involves the equipment or pesticides.

Timely Coordination with Authorities

If a breach of security or suspicious activity does occur, immediately contact the local police or sheriff's department. The U.S. Department of Homeland Security requests that operations also report security breaches, threats, or suspicious behavior to the local FBI field office. Information on the location of the nearest FBI office is available at http://www.fbi.gov.

PROTECTING PEOPLE AND THE ENVIRONMENT

The aerial application operation you work for depends on your piloting skills as well as competent ground crew members who safely and responsibly carry out their duties. Proper training and enforcing safety practices within the operation help reduce hazards to ground crew members working around equipment and aircraft. In addition, a well-developed safety program provides the structure to protect the public and nontarget areas from pesticide exposure. Providing training, assuring good employee habits, checking areas before an application, and resisting pressure to make unsafe or illegal applications are important components of the operation that protect people, areas surrounding treatment sites, and the environment.

Employee Training

States have Occupational Safety and Health Administration (OSHA) regulations that require employers to train employees on how to safely operate equipment and avoid hazards associated with their work. The EPA Worker Protection Standard (WPS) mandates specific training requirements for employees who handle pesticides in agricultural operations. According to this regulation, a pesticide handler in an aerial application operation is any employee who:

- Mixes, loads, transfers, or applies pesticides.
- Maintains, services, repairs, cleans, or handles equipment that may contain residues or that has been used in pesticide mixing or application activities.
- Works with opened pesticide containers, including emptied but not rinsed containers.

California Agricultural Aircraft Association

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- Flags during aerial applications.

The Worker Protection Standard requires that employers in agricultural operations provide training to pesticide handlers working in their operations. Employers must either provide the training themselves or arrange for someone else to provide it.

The Training Program

The WPS requires that a pesticide handler training program address the following topics as they apply to the specific pesticide materials employees handle:

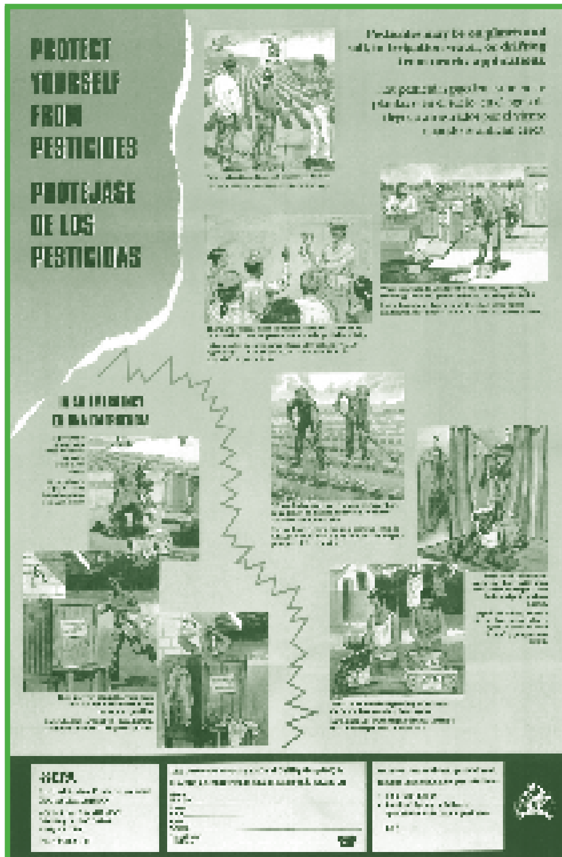
- Understanding the format and meaning of information, such as precautionary statements about human health hazards, contained in the labeling of the pesticide products.
- Understanding the health hazards associated with pesticides handled by employees, including acute and chronic effects, delayed effects, and sensitization, as identified in pesticide product labeling.
- Knowing the routes by which pesticides can enter the body.
- Recognizing how exposure occurs and being familiar with signs and symptoms of exposure-related injury or illness.
- Knowing specific emergency first-aid procedures for overexposure to the pesticides that employees handle.
- Knowing how to obtain emergency medical care when a pesticide injury or illness occurs.
- Knowing routine and emergency decontamination procedures, including spill clean up and the need to thoroughly shower with soap and warm water after the pesticide handling exposure period.
- Understanding the pesticide label requirements for using personal protective equipment (PPE), recognizing its limitations, knowing how to use and clean it properly, and knowing how and when to repair or replace it.
- Knowing how to prevent, recognize, and provide first aid for heat-related illness.
- Understanding safety requirements and procedures for pesticide handling, including the use of engineering controls (such as closed mixing systems and enclosed cabs), and proper ways to transport, store, and dispose of pesticides and properly rinsed containers.
- Recognizing how drift and runoff cause environmental damage and hazards to wildlife.
- Understanding why it is unsafe to take pesticides or pesticide containers home.
- Knowing what is required to handle pesticides safely.

- Knowing the employee's rights, including the right:
  - To personally receive information about pesticides to which he or she may be exposed.
  - For his or her physician or employee representative to receive information about pesticides to which he or she may be exposed.
  - To be protected against retaliatory action due to the exercise of any of his or her rights.

Other Important Topics

Training must include the following general pesticide handling procedures that apply to all pesticide products:

- Understanding the importance of wearing clean work clothing daily.
- Knowing how to properly and safely handle, open, and lift containers.
- Knowing how to properly pour pesticides out of containers.
- Knowing how to operate mixing and application equipment.
- Knowing procedures for triple rinsing containers.
- Knowing how to legally recycle or dispose of empty containers.
- Knowing how to confine spray to the target area.
- Knowing how to avoid contaminating people, animals, waterways, and other non-target objects and areas.
- Knowing how and where to properly and safely store containers that hold pesticides or have been emptied but not rinsed.
- Understanding and following procedures to prevent unauthorized access when containers cannot be locked up or otherwise secured.
- Understanding the importance of washing hands thoroughly before eating, smoking, drinking, or using the restroom.



Consult with your state pesticide regulatory agency to see if there are any additional training requirements for pesticide handlers.

Federal WPS regulations require pesticide handlers receive training every five years at a minimum. States may require more frequent training. Training must take place before any pesticide handling activities. Employees who are certified as pesticide applicators are exempt from this training requirement.

Employee Habits

Every aerial pesticide application requires alertness and attention to detail. Before and during work periods, you and the ground crew members should never use alcohol or any drugs or medications that impair judgment or decrease mental alertness. Employees who wear personal protective equipment must also take steps to avoid heat-related illnesses.

Avoiding Use of Alcohol and Drugs

Alcohol, drugs, and certain over-the-counter and prescription medications cause drowsiness, impair judgment, and often influence the ability to handle or apply pesticides safely. These substances may also alter the toxicity of pesticides in case of exposure. Make your physician aware of your occupation handling pesticides so that is considered when prescribing medications. Do not use alcohol or drugs before, during, or immediately after handling pesticides, or before or during flight operations.

Staying Alert

Physical and mental alertness requires that you and the ground crew get sufficient sleep before an application operation and avoid other activities prior to the operation that cause fatigue. In addition, stress from work or personal activities distracts and interferes with alertness. Therefore, individuals experiencing high levels of stress should not participate in aerial application operations.

Preventing Dehydration and Heat-Related Illness

Drinking insufficient water coupled with wearing personal protective equipment during hot weather may lead to heat-related illness that may mimic certain types of pesticide poisoning. Symptoms of heat illness include tiredness, weakness, headache, sweating, nausea, dizziness, and fainting. Severe heat illness can cause a person to act confused, get angry easily, or behave strangely. Along with training on recognizing pesticide illness, WPS regulations require that pesticide handlers receive training on recognizing, avoiding, and treating heat stress. Appendix 3 describes useful methods to avoid and treat heat stress.

APPLICATION SAFETY

Aerial application safety processes and procedures involve the highly important components of the aircraft, the pesticide dispersal system installed on the aircraft, and ground equipment used to mix pesticides and load them into the aircraft.

Each pesticide application you make is possibly unique for you because of differences between application site locations, obstacles, non-target areas, weather, pesticide materials, crops or target areas, and other variables. Therefore, you and the ground crew must begin by clearly understanding the work order and the pesticide label. Arrange to scout the target site and surrounding areas so you can plan the application before scheduling it. Review the pesticide label to understand application restrictions and precautions and to prepare for emergencies or other problems. Some pesticide materials may have local application restrictions such as time of use, height of application, prohibitions due to nearby sensitive crops, and requirements for buffer zones. Check with state or local pesticide regulatory agencies if you need information about additional restrictions.

Glenn Martin—Gettysburg, PA

The Equipment

As a pilot, you must understand the importance of, and legal requirements for, scheduled inspections, servicing, and maintenance of the aircraft you fly. Take responsibility to assure the aircraft meets these requirements. This includes a preflight fuel and oil check, taking responsibility for proper fueling of the aircraft, and inspecting the aircraft for maintenance items each time you stop the operation for the day or for a rest break. In addition, any aircraft you operate over congested areas must have had, within the preceding 100 hours of time in service, a 100-hour or annual inspection by an authorized person, or been inspected under a progressive inspection system. Congested areas include populated areas where chances of personal injury or property damage are greater if the aircraft should crash or if you must dump the pesticide load.

Have the aircraft's application equipment inspected and maintained regularly to assure that it functions properly and accurately and does not have leaks or other problems. When something malfunctions, repair it immediately. Make a daily inspection of the aircraft's application equipment, the same as you do for the aircraft. After winter storage of the aircraft's dispersal system, carefully inspect it for wear and leaks. Make sure all hoses are in good condition and tighten all fittings. Look for seepage around the pump housing that indicates a leaking gasket or loose connections.

Also, establish an inspection and maintenance program for ground equipment used for mixing and loading pesticide materials into the aircraft, as well as ground vehicles used to transport people, pesticides, and equipment. Keep all associated equipment in good repair. Any breakdown in this equipment will delay the pesticide application, wreak havoc with scheduling, and could be costly to the business and customers.

Keep on hand spare parts and supplies, such as nozzles, hoses, fittings, drive belts, fuel, lubricants, and other components that are critical to the operation. Replace spare parts and supplies used during a breakdown so you always are ready for future operations.

Understanding the Work Order

Review the work order carefully to be certain you can make the application safely, correctly, and legally, according to the label and state and federal regulations. You should be able to perform the requested work with reasonable precaution and within the expectations of normal work procedures for both yourself and the ground crew. Take into account the following factors when evaluating a work order.

Features and Limitations of the Aircraft

The aircraft must be operationally ready to perform the aerial pesticide application. Be sure that the operator you work for has a procedure in place to prevent use of an unsafe aircraft or faulty dispersal equipment and to notify you in situations when you or others should not fly the aircraft due to maintenance issues or mechanical malfunctions. This includes involving the company's job scheduler in all company procedures for grounding an aircraft. Take responsibility for notifying the operator of problems that may affect the safety or efficient operation of the aircraft or involve your safety equipment. This includes:

- Developing a way to communicate details of the problem to the person in charge.
- Establishing a timeline in which the problem needs to be corrected.
- Verifying that the problem is corrected before putting the aircraft or equipment back into service.

The aircraft must be capable of safely delivering the appropriate amount of pesticide to the target site. It must:

- Have the power and performance capabilities for the routine maneuvers needed to carry out the application, as well as being able to perform emergency maneuvers.
- Have a maximum load capacity that will accommodate the weight of the pesticide and, if needed, be able to handle takeoffs and landings from short, rough, or temporary airstrips.
- Be properly equipped to discharge the recommended amount of pesticide product per unit (acre) of target site area.
- Be able to produce and deliver spray droplets that provide an effective application and have low spray drift potential at the intended location.

Pilot Qualifications and Limitations

Your competence, alertness, and capacity for timely and accurate judgment largely determine the safety of the operation and the quality of the application. In addition, your attitude about making safe and legal applications goes a long way in positively influencing others to accept and follow the safety procedures. You must be:

- Aware of your personal limitations in operating the aircraft and be fully aware of the features and limitations of the aircraft.

California Agricultural Aircraft Association

Robert Wolf—Kansas State University

- Capable of executing emergency maneuvers appropriate to common emergency situations that you might experience.
- Capable of safely maneuvering the aircraft under normal flight conditions when it is loaded to its maximum legal weight.
- Able to determine the best direction in which to apply the pesticide to reduce its off-target movement.
- Capable of immediate and clear communication exchanges with on-site ground crew members and others.
- Sufficiently rested to accomplish the job safely.
- Able to establish and follow realistic task deadlines and work patterns.
- Knowledgeable of weather factors and their influence on aerial application work.
- Able to correctly interpret and follow the pesticide label directions and work order and observe any state regulations regarding aircraft setup or product restrictions.
- Familiar with each pesticide product label to know first-aid measures in the event of accidental overexposure, special precautions required for aerial application, and registered crops or sites.
- Able to recognize different types of crops from the air in order to ensure the correct site is treated.
- Able to delineate boundaries of adjacent nontarget areas.

Take the following measures to reduce the potential for spray droplets to drift off the application site:

- Use a nozzle type, size, pressure, and orientation that maintains the desired droplet spectrum.
- Ensure that positive shut-off valves are working properly.
- Achieve good field-end coverage on initial spray runs (crossing the ends of fields that are bordered by trees or other obstacles usually means flying higher and increasing the chance of drift).
- Maintain applications at the appropriate height for the aircraft type and speed.
- Use a boom length that does not exceed 75% of the wingspan of

fixed-wing aircraft or the rotor diameter of rotary-wing aircraft in order to reduce drift caused by wing tip and rotor vortices.

- Consult the pesticide label for recommendations on boom type and setup requirements.

Scouting the Target Site

Each application site may contain unique obstacles and hazards. Before committing to make an application, someone from the operation should visit the target site to identify obstacles, hazards, and sensitive areas. Do this by ground, by air, or both. Afterwards, coordinate visual observations with maps and photographs of the area. Should the application site and surroundings be unfamiliar, seek more information regarding weather patterns, topography, and sensitive areas from the property operator and other people familiar with the area. During scouting, collect information about the:

- Location of the site and the size and shape of the area to be treated.
- Types of crops adjacent to the application site.
- Proximity of the site to adjacent fields and other areas where field workers may be present.
- General local weather conditions.
- Proximity of the site to areas used or inhabited by people, including residences, parks, schools, playgrounds, shopping centers, businesses, roadways, adjacent fields, work crews, and other areas.
- Proximity of the site to environmentally sensitive areas such as lakes, streams, ponds, irrigation canals, riparian zones, wildlife habitats, sensitive plants, nearby crops, and organic farms.
- Proximity of the site to farms, ranches, or other businesses with livestock or other domestic animals, such as dairies, feedlots, swine operations, dog kennels, and horse stables.

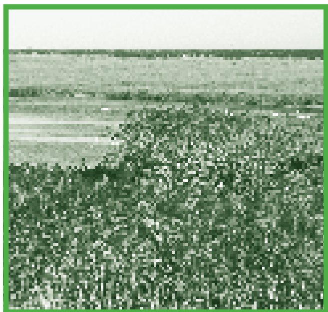
USDA—ARS Image Library

- Proximity of the site to honey bee hives and other commercial pollinating insects.
- Safety hazards such as power lines, guy wires, vent pipes, antennas, towers, trees, and other obstacles adjacent to the site and within the site itself.
- Current cultural practices taking place at the site and other adjacent agricultural areas.
- Possible limitations to the operation, such as ground crew access to the site.

Charting all sensitive areas and obstacles will prove useful during the operation and for future reference. Established aerial pest control operators often have a collection of maps and aerial photographs that identify hazards and sensitive areas. Be sure to keep these up-to-date. Prior to the actual application, make a final check to confirm there are no recent changes that would put you, other people, the property, or the surrounding areas at risk.

Understanding Pesticide Label Restrictions

Review the pesticide label to understand the legal requirements and use restrictions for that material and designations of which type of aircraft is or is not acceptable. If the recommendation or work order calls for a tank mix of two or more pesticide products, review the labels of all the products to ensure you can combine them legally and that there are no compatibility issues. Follow the directions of each label having the most restrictive requirements for application, mixing, personal protective equipment, and other factors. You must understand the pesticide label.



P. O'Connor-Marer—Roseville, CA

PREVENTING ENVIRONMENTAL HAZARDS

Application Instructions

Confirm that there are no prohibitions to applying any of the prescribed materials by air. Check to see if there are restrictions such as buffer areas, spray material dilution parameters, air temperature requirements during application, and time of day spraying.

Personal Protective Equipment Requirements

Understand the PPE requirements on the label or labels and have available the most restrictive PPE required for handlers and you when you are outside of the aircraft cockpit. Make sure your flight suit, safety harness, and flight helmet are in good condition. Remove pesticide PPE before entering the aircraft cockpit.

First Aid and Decontamination Requirements

Read the label or labels for instructions on what type of first aid and decontamination procedures to follow in case of pesticide exposure.

Sensitive Crop Restrictions

Review all label precautions regarding applying the material onto or near sensitive crops or other plants.

Notification and Posting Requirements

Understand the responsibilities for informing people about hazards prior to making an application and any requirements for preventing entry by workers or people from the surrounding areas. Pesticide labels may require oral notification, field posting, or both. According to the Worker Protection Standard, agricultural employers are responsible for this notification and, when required, posting. However, aerial operations often post fields as a service to their clients. Never begin an application until the grower, property manager, or you meet the notification and posting requirements.

Honey Bee and Other Pollinating Insect Restrictions

Check the labels to see if the materials you are applying are harmful to foraging honey bees and other pollinating insects. If the label has such warnings or restrictions, adjust the application time to coincide with times these insects are most predictably not in the field you are treating.

Environmental Hazards

Check for precautions relating to environmentally sensitive areas, protecting natural enemies and beneficial insects, and other environmental hazards.

Cleaning Application Equipment

After each use, clean and decontaminate application equipment. Even some very small quantities of residues remaining in a tank can contaminate subsequent pesticide mixtures resulting in crop damage. Other times residues may affect tank mix compatibility or the toxicity of a subsequent product. Be particularly careful and clean between herbicides. Some herbicide labels bear explicit instructions on tank cleaning; make sure you follow their instructions and use their prescribed cleaning materials.

Rinse the inside of the tank with water. If necessary, decontaminate it by using an appropriate tank cleaning material; common cleaners are ammonia or commercial tank cleaning product (e.g., 1 quart of household ammonia to each 25 gallons of water). Buy commercial pesticide tank cleaning and neutralizing compounds from chemical suppliers and farm equipment dealers. Be sure to check the pesticide label for any precautions regarding the use and disposal of cleaning and decontaminating chemicals. Follow the directions for the amount of cleaner to use for your spray tank. Be sure to run pumps and agitators, and flush all hoses and booms. Wear appropriate PPE and eye protection.

Pesticide residue on the outside of application equipment can be hazardous to people who must operate or repair this equipment. Wash the outside of spray equipment with water, using a small amount of detergent if necessary. Clean equipment in an area where you can contain runoff. Otherwise, clean the equipment at the application site.

Resolving Conflicts

If the work order appears to be in conflict with any of the previously-listed factors, or if you or others have any safety concerns, delay the application until you and the property manager agree on modifications that resolve the conflicts and concerns. Resist pressure to perform an aerial application that presents high levels of risk. Also, refuse any job that is clearly illegal or not in compliance with any of the pesticide labels. Never apply a material for pest control that the EPA has not registered as a pesticide. This includes household and other products whose labels do not have EPA Registration numbers, such as soaps, spices, and vinegars.

Reviewing and Documenting the Application

After completing an application, especially a challenging one, spend time with the ground crew to identify parts of the operation that went especially well and things you could improve when working in another similar situation. Examine possibilities of better planning, better communication, making different adjustments to the equipment, using different equipment, becoming more familiar with the target site, or changing other aspects of the application process. A debriefing such as this will take a little time, but will improve efficiency and fine-tune future operations.

Record Keeping

Keep records of every application. Federal regulations require keeping records of certain information when you make applications of federally restricted-use pesticides, and some states require keeping records of all agricultural pesticide applications—restricted- and general-use (www.pesticidestewardship.org). To comply with federal record keeping when you make an application of federally restricted-use pesticides, you must have a record of the:

- Date (month, day, and year) of the application.
- Brand or product name of the pesticide material applied.
- EPA registration number.
- Total quantity of pesticide product used.
- Location where you made the application.
- Size of the treated area.
- Name and certification number of the applicator.

Regulations require the operator to provide this information to the grower or property manager for whom you made the application within 30 days of the application. Federal regulations require the operator to keep copies of these records for a minimum of two years; state requirements may differ.

In addition to meeting federal and state requirements, application records are useful and important information for future reference and should questions or problems show up after an application. Consider including in the application records some or all of the following additional or more detailed information about the application. This documentation will serve in your defense in case of possible legal action due to crop damage or off-target movement of the pesticide:

- Description of the application site, including type of site or crop treated.
- Proximity of the treated area to roads, structures, other crops, field workers, hazards, and sensitive sites.
- Recent or ongoing cultural practices (such as irrigation) at the application site.
- The date and time the application started and the time the application finished.

- Weather conditions at the time of application—air stability, temperature, humidity, wind speed, and wind direction recorded in degrees using a compass.
- Any changes in weather conditions occurring during the application.
- Names and amounts of all pesticides and adjuvants applied, and the dilution rate.
- Application equipment configuration, including nozzle type, size, spacing, pressure, and orientation.
- Application pattern and directions in which you flew the swaths.
- Application speed and height.
- Precautions taken to protect sensitive areas.
- Location of the mixing-loading site.
- Routes taken for ferrying between the loading site and target area.
- Names of ground crew members and people present at the site during the application.
- Observations made by you, the ground crew, or others that may have had any influence on the operation.

Save all electronic files from an application, including flight data and the **as-applied** map files from the GPS system. These files serve as documentation for much of the information included in your records.

PLANNING FOR EMERGENCIES

A very important part of the application planning includes being prepared for any emergency that might occur during the operation. Having a written emergency response plan, and sharing and discussing this plan with the ground crew, helps everyone know how to respond and reduces the possibility of injury or death. Emergency planning must include providing ground crew members at the loading zone and satellite strips with emergency telephone numbers. Equip the aircraft and loading areas with first-aid kits and ensure the aircraft has a working and properly-labeled fire extinguisher. Have a complete spill cleanup kit at the loading area. Develop a plan of action for ground crew members to follow in case your aircraft is overdue at the loading site or home base.

Train everyone in emergency response by actually play acting on how to deal with different emergency situations. Practicing also helps to point out deficiencies in the emergency response plan so you and the ground crew can correct them.

Emergency Information

Locate the nearest medical facility to the application site and provide each crewmember with instructions on how to get there. A good strategy is to discuss the type of operation and its hazards with staff of nearby medical facilities to prepare them in advance for possible pesticide emergencies. Train all members of the ground crew how to direct emergency responders to the application or mixing-loading site. Equip members of the application operation with cell phones or radios to call for emergency help or to arrange transport of an injured person to a medical facility. Provide them with telephone numbers of the local hospital, fire department, police or sheriff's department, and local Flight Standards District Office (FSDO). These numbers may change when using different landing areas, so prepare lists for each specific location.

Flight Hazards

Whenever possible, have a ground crew member present at the application site who is able to communicate with you during the entire operation. This person can warn you of hazards and notify you of problems on the ground that require stopping or delaying the application. The ground crew member should communicate with anyone on the ground who might be at risk during the application, and take action to warn them or escort them from the area. Provide this ground crew member with a map that shows the hazards and sensitive areas within the application site and in surrounding areas.

Plans in Case of Aircraft Crash

Make emergency plans for catastrophic events such as aircraft engine or landing gear failure leading to a forced landing or crash. This requires training every member of the ground crew to respond immediately, act promptly, stay calm, and focus on helping you. Should a crash occur, switch off the aircraft's batteries and shut off its fuel line. If you are uninjured yet unable to open the cockpit door, break open a window and exit the aircraft as quickly as possible. Instruct ground crew to get to the crash site immediately with a fire extinguisher and to communicate the exact location of the site to emergency responders and others by cell phone or radio.

Application Equipment Malfunction

Application equipment malfunction could include ruptured hoses or lines, a tank leak, pump failure, nozzle and check valve leaks, or electronic controller failure. Any of these problems risk contaminating areas outside of the target area and may require a load jettison before the aircraft can return to an airport for repairs. Prepare for this type of emergency by locating possible places to jettison the load or to set down the aircraft. Any route you take with an aircraft having a pesticide leak should be over areas not occupied by people or animals. To protect the public when experiencing any emergency of this type, FAA regulations permit you to deviate from required flight patterns and other restrictions.

Ground Crew Emergencies

Ground crew emergencies include leaks and spills of concentrated pesticides or diluted spray materials as well as splashes or spills that contaminate one or more of the ground crew members. It could also be a fire involving pesticide materials. These serious problems require immediate action to protect people and the environment. Regulations require that pesticide labels be at the use site, which includes the area you are spraying, in addition to the mixing-loading site. There is an exemption to this requirement for aerial applications as long as you maintain radio contact with the ground crew and any flaggers. Labels serve as references for emergency personnel responding to accidents involving spills and they provide first-aid information in case of pesticide exposure.

The ground crew must first take steps to prevent any human exposure and then immediately control, contain, and clean up spills or leaks to prevent further contamination of the mixing-loading area. Preparations for a leak or spill emergency includes training and practicing cleanup procedures and having an adequately equipped spill cleanup kit at the mixing-loading site at all times. Train handlers performing the mixing-loading jobs on proper ways to clean up a spill (see Appendix 4). Provide them with a cell phone or radio to summon help for major spills or in case of a pesticide fire or other emergency. Keep instruction sheets at the mixing-loading site for cleaning up spills, dealing with pesticide fires, and situations requiring assistance from fire fighters or emergency medical technicians.

Train handlers how to follow the first-aid information on the pesticide label if someone involved in mixing-loading activities gets exposed to a pesticide. Be sure there is sufficient clean water for emergency eye washing and decontamination of the entire body. Have soap and single use towels available at the mixing-loading site along with changes of clothing for each crew member.

Overspray, Drift, and Other Misapplication

As the applicator, you assume responsibility for any pesticide misapplication. Overspray, off-target movement, and other types of misapplication may damage surrounding crops, residential plantings, landscapes, and other property, as well as cause environmental contamination. These are all violations of pesticide labels as well as many state pesticide control laws. Train ground crews to be alert during an application and quickly communicate with you if they spot any potential for such problems. Considerable financial liability and legal consequences may result from any damage caused by misapplication.

Spray or Dust Contacting Bystanders or Vehicles

It is illegal to apply any pesticide in a manner that exposes people, livestock, vehicles, and other objects to the spray or dust. Unfortunately, farm workers, joggers, trespassers, and others may not recognize the hazard of entering an area until an aircraft making an application flies over them. Weather patterns, especially wind direction, can also change rapidly, causing pesticide from the application to move off site and possibly onto workers or other people nearby. For example, you might plan and begin an application based on the wind blowing away from nearby areas where people are present. However, during the application the wind direction could change and blow towards these areas. Therefore, develop a plan that includes communication between you and the ground crew to delay or stop the application if anyone spots people nearby, and only make applications if no one is in adjacent areas where they might be subject to exposure. Inspect the application site and adjoining areas before beginning an application to confirm no one is around the site.

In the emergency plan, include instructions to follow if spray contacts bystanders. This should involve decontamination methods and procedures for obtaining medical care for exposure victims.

COMMUNICATIONS

Operational problems can result from poor communications or sketchy information about jobs the ground crew performs. It is risky to assume that ground crew employees already possess all the vital information they need to carry out their jobs safely. Job delays, having to return for forgotten materials, treating the wrong fields, or spraying improper pesticide types, formulations, or concentrations are examples of mistakes that may occur when ground crew employees are operating with incomplete information.

Involve the supervisor and ground crew in:

- Developing maps of all areas to be treated and charting all hazards, adjacent crops, and environmental sensitive areas.
- Scouting all new areas and keeping maps up to date so you can identify new obstacles or changes in conditions promptly.
- Developing a system for accepting or transmitting information between you and the ground crew on work order changes in the field.
- Filling out mix sheets and determining the order of mixing spray batches.
- Ensuring that mixer/loaders are trained in calculating tank batches, pesticide handling procedures, and the use and care of personal protective equipment.

Provide the ground crew with essential site-specific job information and make sure they have a checklist outlining the steps to take to comply with applicable regulations and company policies. Develop and complete an up-to-date Standard Operating Procedures (SOP) for ground crew members to use and make sure it is available at the loading site. This is especially useful when communication with you is impaired and ground crew members disagree or are uncertain about procedures such as mixing batches of pesticide spray.

Review Questions

CHAPTER 2: Operation and Application Safety

1. **The type of first aid given to a pesticide exposure victim depends on the:**
   - **A.** Type of exposure.
   - **B.** Age of the victim.
   - **C.** Training of the person administering first aid.
   - **D.** Work situation where the person received the exposure.

2. **If a person shows signs of pesticide poisoning, he or she should:**
   - **A.** Stop working for the day.
   - **B.** Receive immediate medical attention.
   - **C.** Be assigned to another job not involving pesticides.
   - **D.** Be scheduled for a blood test.

3. **If a person spills liquid pesticide onto his or her arm, the amount of exposure and injury can often be reduced by:**
   - **A.** Wiping arm with antibacterial wipes.
   - **B.** Wiping the liquid off the person's arm.
   - **C.** Covering the exposed area with a damp cloth.
   - **D.** Washing the exposed area with soap and water.

4. **During an application operation, pilots must wear the label-required personal protective equipment for pesticide handlers:**
   - **A.** Only while making an aerial application.
   - **B.** Anytime they are in the aircraft cockpit.
   - **C.** While making nozzle adjustments.
   - **D.** Only when mixing and loading.

5. **First-aid instructions to use for pesticide exposure is found on:**
   - **A.** Pesticide labels.
   - **B.** OSHA's Emergency Response website.
   - **C.** Supplemental labeling.
   - **D.** Manufacturer literature.

6. **An up-to-date Standard Operating Procedures (SOP) document is useful to ground crew members especially when:**
   - **A.** The communication channel with the pilot is lost.
   - **B.** The pilot begins applying the pesticide in a manner inconsistent with the work order.
   - **C.** Trying to determine the best time for applying the pesticide.
   - **D.** The pilot applies the pesticide to a site not listed on the label.

7. **For protection of the surrounding community, a good reason for securing pesticide application aircraft and other equipment when not in use is to:**
   - **A.** Prevent weather damage to the equipment.
   - **B.** Protect employees from pesticide exposure.
   - **C.** Prevent intruder access to the equipment.
   - **D.** Comply with regulatory agency mandates.

8. At a minimum, the training that ground crews must receive as pesticide handlers is required to be performed:

- **A.** At the beginning of each operation.
- **B.** Annually, before performing handling activities.
- **C.** Every two years, before performing handling activities.
- **D.** Every five years, before performing handling activities.

9. Chances of pesticide exposure greatly increases if a pesticide handler fails to:

- **A.** Read the Statement of Practical Treatment on the pesticide label.
- **B.** Take frequent breaks during handling activities.
- **C.** Drink adequate water during handling activities.
- **D.** Wear the required personal protective equipment.

10. Good communication with the ground crew before and during an application operation may result in:

- **A.** Greater chances of accidents.
- **B.** Inability for the ground crew to perform their tasks properly.
- **C.** Fewer job delays.
- **D.** Improper spray mixes.

REVIEW QUESTION ANSWERS ON PAGE 97

CHAPTER 3

PREVENTING PESTICIDE DRIFT

LEARNING OBJECTIVES

This chapter will assist you to:

- Understand what off-target pesticide movement is and knowing the difference between drift and off-target pesticide movement.
- Recognize the way droplet size contributes to drift or reduces drift potential.
- Recognize the factors and conditions that contribute to drift and off-target pesticide movement.
- Learn how to minimize drift and off-target pesticide movement.

Pesticides are essential tools in managing pests in a particular location, but confining the pesticide to the intended target during application is an important responsibility. Reducing drift and off-target pesticide movement is necessary when you make any type of pesticide application because, if not controlled, this off-target movement can contribute significantly to the pesticide load in the environment. However, you must take steps to control drift of the pesticide material away from the target area during an application.

Off-target movement of pesticides is the condition where pesticides or pesticide residues leave the application site at any time and in any manner other than during a pesticide application. Often the physical and chemical characteristics of the pesticide contribute to or reduce the chances that the material may move offsite after an application. For example, pesticides that break down quickly after you have applied them will be less likely to move off the application site than pesticides that are highly persistent in the environment.

Pesticides and pesticide residues can move off the application site in several ways after they are applied. These include:

- Post-application volatilization into the atmosphere of the pesticide that adhered to treated surfaces, the crop plants, the soil in between the plants, or bare ground—pesticides with high volatility are more likely move off the application site than pesticides with low volatility.
- Leaching through the soil at the application site and moving into surface or ground water after application—pesticides with low solubility in water will not leach as much as those that are very soluble in water.

- Rainfall or irrigation water washing residues off the application site into surface waters after application—pesticides that have a high absorption potential are less likely to wash off plant surfaces.
- Blowing off the site attached to soil particles or dead plant material after application.
- Leaving the application site as residues on harvested crops.
- Being carried off the application site on vehicles, equipment, animals, and people.
- Being carried off the application site as fine droplets in an inversion cloud.

The National Coalition on Drift Minimization (NCODM) defines **spray drift** to be "the movement of pesticide through the air at the time of pesticide application or soon thereafter from the target site to any non- or off-target site, excluding pesticide movements by erosion, migration, volatility, or windblown soil particles after application." Pesticide drift includes pesticide droplets, vapors, or dust particles that move off the application site after leaving the dispersal system but before adhering to the intended treatment site during a pesticide application. This includes vapor or droplets that concentrate in an inversion layer during an application.

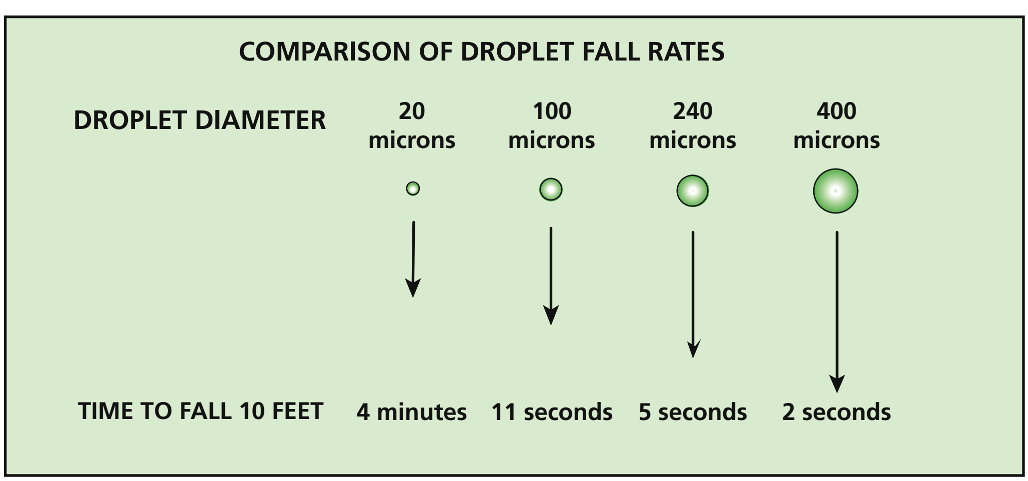
During any application, a certain percentage of the spray droplets will drift. If this drift is confined to the treatment site so that it is part of the pesticide application, there is generally little hazard to the surrounding areas that are not part of the application. Pesticide drift, however, increases the hazard to people and other living organisms outside of the treatment site. The following information pertains to recognizing the causes of pesticide drift and ways to reduce this problem.

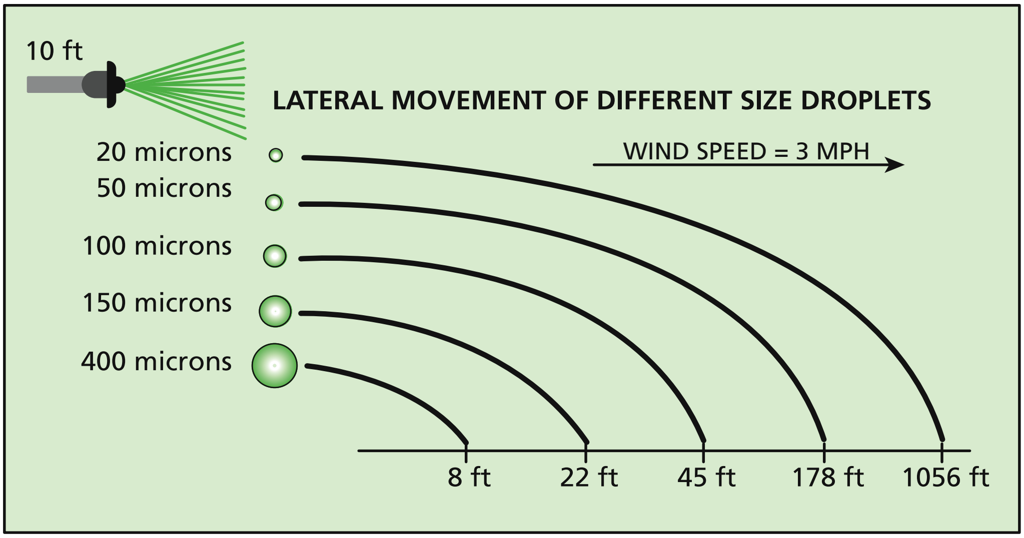
FACTORS THAT CONTRIBUTE TO DRIFT

The spray droplets and the percentage of droplets within a certain size range are the key factors affecting off-target drift. You can control some of these factors when making aerial applications.

The unit of measure for the diameter of a spray droplet is a **micron** (also referred to as a micrometer). The mathematical symbol for a micron or micrometer is µ. One micron is 1/25,000 or 0.00003937 of an inch. To illustrate the relative size of one micron, a single sheet of paper is about 100 microns thick.

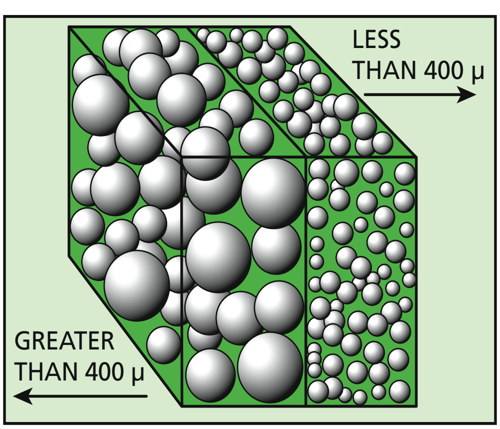
The longer a spray droplet remains airborne or suspended in the air, the greater the chance it will drift from the application site. A small spray droplet is more susceptible to drift than a larger droplet because the small droplet is lighter and therefore remains airborne much longer. For example, while it takes approximately 4 minutes for a





20-micron droplet to fall a vertical distance of 10 feet, it takes only 2 seconds for a 400-micron droplet to travel the same distance.

There is a rapid decrease in the drift potential of droplets larger than about 200 microns. Conversely, research has proven that droplets smaller than 200 microns are very prone to drift. People who study drift classify droplets that are 150 to 200 microns or smaller as **driftable fines**. In wind speeds ranging from 1 to 9 mph, droplets that are 200 microns or larger have an insignificant drift potential. For example, the theoretical distance that spray droplets move laterally while falling from 10 feet above the ground in air moving at 3 mph would be only about 8 feet for 400-micron droplets. However, this distance increases to about 1,000 feet for 20-micron droplets. Higher velocity winds increase the drift potential of all droplets.



Volume Median Diameter = 400 Microns

Droplets below 50 microns in diameter remain suspended in the air indefinitely or until they evaporate. Droplets of this size have no benefit to a pest control program, other than certain vector control operations, because they are never likely to reach target surfaces. Avoid using nozzles or nozzle orientations and configurations that produce droplets in this size range because there is no way to assure that these droplets will remain on or near the application site.

Classification of Droplet Size

All nozzles produce a range of droplet sizes, known as the **droplet-size spectrum**. This means that even when you use a nozzle having a large orifice that mainly produces large droplets, some percentage of the droplets in the spray are going to be small enough to be prone to drift.

A common classification method used to describe the droplet-size spectrum produced by a nozzle is the **volume median diameter** (VMD). This means that half of the total spray volume of that nozzle consists of spray droplets smaller than the VMD numerical value, while the other half is larger than the VMD numerical value. For instance, a nozzle with a VMD of 400 microns sprays out half its total volume in droplets having a diameter greater than 400 microns and the other half in droplets having a diameter smaller than 400 microns. However, this does not tell you how much of the spray volume is made up of droplets that are smaller than 200 microns.

Another way of classifying the droplet sizes produced by a nozzle is to identify the percentage of the total spray volume that contains droplets smaller or larger than a specific diameter, usually 200 microns. This directly addresses those droplets at risk for drift. For instance, a nozzle may produce 2 percent of its total spray volume in droplets smaller than 200 microns in diameter. This means that only a small portion of the droplets produced by this nozzle are at risk for drift. This type of description, however, tells nothing about the size of the remaining droplets produced, which is the information you need to determine the type of coverage you can expect.

The most useful way to describe the droplet sizes produced by a nozzle is to use droplet-size categories based on the entire droplet-size spectrum of a nozzle, rather than just the VMD or a specific size droplet by percentage of volume. This spray-classification system is the American Society of Agricultural and Biological Engineers (ASABE) standard *S-572.1: Spray Nozzle Classification by Droplet Spectra*. This classification system has eight categories: extra fine, very fine, fine, medium, coarse, very coarse, extra coarse, and ultra coarse (see chart on next page). Using these categories, you can select a nozzle, orifice size, and operating pressure that produces the label-recommended droplet-size spectrum.

All pesticide labels will eventually contain nozzle specifications and/or the required droplet-size spectrum. The chart on page 37 shows the standard droplet size categories and color coding.

Consult the pesticide label for specific instructions when selecting nozzles. Using the droplet-size spectrum categories, determine which nozzle to use to reduce drift and provide adequate coverage in a particular application operation. By selecting the appropriate category based on the type and use of a pesticide, you get acceptable results while keeping the risk of drift to a minimum.

Spray Mixture Physical Properties

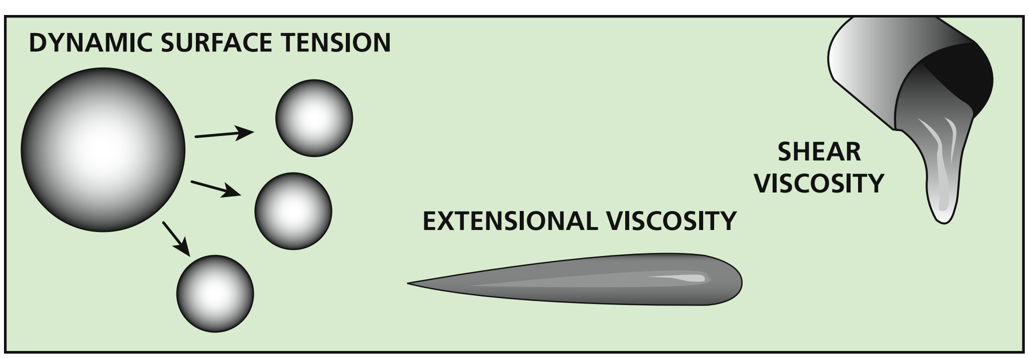
Three key physical properties of a spray mixture have a significant effect on droplet size in aerial applications.

Dynamic Surface Tension

Surface tension is the force that keeps a droplet together. When the fluid that makes up the droplet contains adjuvants or other substances the normal surface tension changes, but it takes a certain amount of time for the molecules in the adjuvants to move to the surface of the droplets. Therefore, the surface tension of spray droplets can change after the droplets are formed, causing a larger droplet to split into smaller droplets.

Extensional Viscosity

When the pump forces spray liquid through a nozzle orifice, it stretches to a certain point before breaking off to form a droplet. The amount of stretching or "stringiness" is the extensional viscosity. Pressure in the system, which regulates the ejection speed of the liquid, affects the extensional viscosity. Higher pressure lowers this viscosity, therefore producing smaller droplets.



Droplet Spectrum Category	Symbol	Color Code
Extra Fine	XF	**PURPLE**
Very fine	VF	**RED**
Fine	F	**ORANGE**
Medium	M	**YELLOW**
Coarse	C	**BLUE**
Very Coarse	VC	**GREEN**
Extra Coarse	XC	**WHITE**
Ultra Coarse	UC	**BLACK**

ASABE STANDARD S-572.1
Spray Droplet Spectrum Categories

This standard defines droplet spectrum categories for the classification of spray nozzles relative to the specified reference fan nozzle. The purpose of this classification is to provide the nozzle user with droplet size information primarily to indicate off-site spray drift potential and secondarily for application efficacy.

Refer to product labels for specific guidelines on a droplet spectra category required for a given application situation.

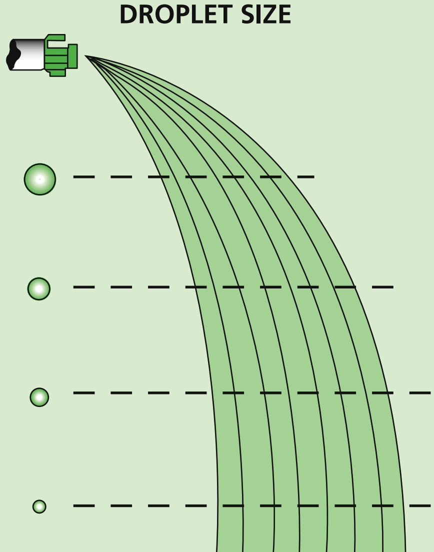
Nozzle manufacturers provide information necessary to place nozzle types into a droplet spectrum category based at least on orifice size and pressure. The color code is an industry standard.

Shear Viscosity

Shear viscosity is a liquid's resistance to flow. Some liquids are thicker and therefore resist flow or flow more slowly than less thick, or less viscous, liquids.

Spray drift control adjuvants, when added to the spray mixture, may help reduce the number of driftable droplets under certain conditions. However, reports indicate that some types of drift control agents lose their effectiveness when circulated through a sprayer pump. Studies show that some materials sold as drift control adjuvants actually do not perform as such. Spray drift control adjuvants are a specific class of chemical adjuvants, so do not confuse these with other adjuvants such as surfactants, wetting agents, spreaders, and stickers. These other adjuvants, and formulations containing alcohol or certain water miscible solvents, tend to reduce the dynamic surface tension of spray droplets, resulting in smaller droplet sizes.

EFFECTS OF EVAPORATION ON DROPLET SIZE



External Factors Affecting Droplet Size and Drift

Certain factors remain beyond your control. These external factors include weather such as humidity, rain, extremely high or low temperatures, wind, or conditions leading to an inversion layer.

Effects of Evaporation on Droplet Size

Once exposed to the atmosphere, individual spray droplets will generally begin to evaporate. Evaporation removes water or other carriers, making the spray droplet smaller than it was when it left the nozzle. As the droplet becomes smaller, it becomes more prone to drift. Conditions that contribute to evaporation include:

- *Air temperature*–evaporation is more rapid as temperature increases.

- *Humidity*—evaporation is more rapid as humidity decreases.
- *Air movement*—evaporation is more rapid as air movement increases.
- *Distance from discharge to the target*—the further the droplet has to fall the more time is available for evaporation.
- *Spray carrier*—water will evaporate faster than oil carriers.

The optimum time to make an aerial application when evaporation of spray droplets is a concern is during the coolest part of the day. Early morning is usually ideal because it is generally more humid at this time and wind speeds are often low. However, **temperature inversion conditions** may be greater during early mornings. Avoid making applications during hot, dry periods of the day. Keep the application height between 8 and 12 feet from the target to shorten the distance that spray droplets must fall. To minimize the risk of drift caused by evaporation, small droplet sprays require lower application heights.

Co-Distillation

Pesticides can also move offsite through a process called **co-distillation**. This phenomenon occurs when the pesticide contacts very hot surfaces, usually soil with no vegetation. Pesticides, even those that are not highly volatile, leave the soil surface with water molecules during rapid evaporation that occurs immediately after irrigation. Fog also is able to pick up pesticides from the application site and carry them offsite.

Effect of Wind and Thermals on Drift and Off-Target Movement

Air movement from wind or thermals is a major contributing factor to off-target pesticide drift. Wind carries lighter and smaller droplets away from the target site where they accumulate until they saturate a given volume of air with the pesticide. As winds become stronger, the air traps more and more larger droplets and may move them away from the target before they return to the ground.

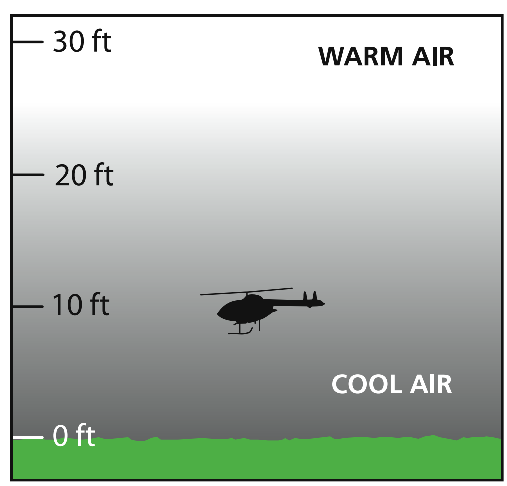
Upward air movement caused by thermals also entraps and moves small droplets, increasing the probability that they will drift away from the application site. Thermals occur as the ground heats up, usually in the afternoon, and especially after cool night temperatures. This causes air near the ground to rise, since warm air is lighter (molecules are further apart) than cool air.

Temperature Inversions

Differing air temperatures in stratified layers of the atmosphere are responsible for the inversion phenomenon that can exacerbate the problem of off-target pesticide drift. Inversions occur when an upper layer of air is warmer than the air below it. This warm air cap may start at 20 to 100 or more feet above the ground and block the cooler air below it, preventing vertical air movement.

Over a wide area, it may be possible to identify the presence of an inversion condition by checking with the National Weather Service. In some areas, during certain times of the year, temperature inversions occur regularly. One method for detecting a temperature inversion in a localized area is to observe a column of smoke rising into the air. Sometimes, dust from agricultural operations may serve the same purpose. If the rising smoke column or dust cloud flattens and begins moving sideways or collects in one area above the ground, an inversion condition probably exists.

Do not make applications during an inversion condition because the inversion layer traps fine spray



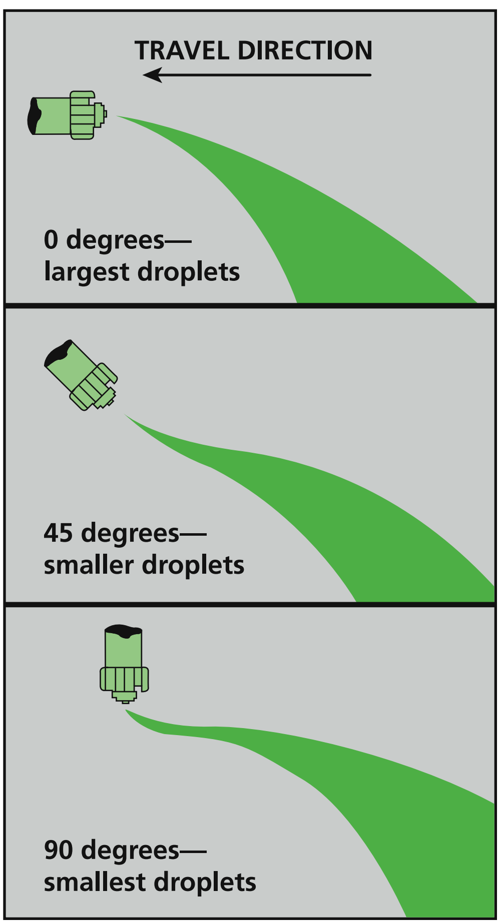
TEMPERATURE INVERSION

droplets and pesticide vapors. These become concentrated, similar to smoke particles in the smoke column. Rather than dispersing somewhat evenly throughout the atmosphere over a relatively large area, the pesticide often moves as a concentrated cloud away from the treatment site. Afterwards, the concentrated pesticide cloud will return to the ground and may cause problems for people, non-treated crops, and other living organisms.

An inversion condition can occur when the air is calm with very little air mixing. This condition makes it possible for the cloud of spray droplets or vapor to move slowly downwind. Temperature inversions generally begin before sunset and remain into early morning or near bodies of water.

MINIMIZING OFF-TARGET DRIFT

Drift research shows that nozzles and other spray components can produce large spray droplets that have less of a tendency to drift. However, when improperly used, wind shear effects on nozzles result in drift-prone smaller droplets. Appropriate airspeed and proper nozzle orientation are the two factors that reduce wind shear effects. You need to find a balance between the aircraft's minimum airspeed needed for covering the desired acreage in a given period and the maximum airspeed before wind shear impacts the size of spray droplets.



In addition to selecting proper nozzles and finding the balance between proper airspeed to minimize atomization of large droplets, the other challenge you face is to find a balance between drift reduction provided by large droplets and good coverage associated with smaller droplets.

Research conducted by pesticide manufacturers, the pesticide application industry, universities, and state and federal regulatory agencies demonstrate that you can minimize off-target pesticide drift during any application operation by:

- Selecting nozzle types with orifice sizes that produce large droplets—wider spray angles typically produce finer sprays.
- Using a nozzle orientation straight back in relation to the aircraft's level flight line so that the discharged spray is least affected by wind shear across the nozzle face, therefore maintaining the rated desired droplet size (some research is showing that a slight angle of about 5 degrees allows the spray to be directed downward without affecting droplet size).
- Confining boom length to no more than 75 percent of the wingspan of a fixed-wing aircraft or the rotor diameter on rotary-wing aircraft, to reduce drift caused by wing tip and rotor vortices.
- Increasing system pressure when flying at faster speeds to reduce the amount of smaller droplets.

- Making sure the positive shut-off and suck-back systems are working properly.
- Accurately calibrating application equipment, including using a system pressure that is appropriate to the airspeed of the aircraft for maintaining a droplet size that results in optimal spray coverage.
- Using spray drift control adjuvants when appropriate to increase spray droplet size.

Spray droplets are normally finer at greater flight speeds, especially when using wide-angle fan nozzles or a nozzle orientation that is not straight back in relation to the level flight of the aircraft. However, for applications using straight stream or narrow angle (20 to 40°) flat fan nozzles pointed backward, increasing the spray pressure can actually result in a coarser spray if the exit velocity from the nozzle becomes closer to the speed of the aircraft. Doing this reduces the air shear effect.

Application Techniques

Some application techniques for reducing off-target pesticide drift during an aerial application include:

- Leaving untreated buffer zones one, two, or more swath passes wide within the treated site or field, along the downwind edges so that any pesticide that drifts will stay on the treated site; treat these buffer zones later, when the wind direction reverses into the field.
- Getting good field-end coverage on initial spray runs; end passes made to fields that are bordered by trees or other obstacles usually means flying higher, which increases the chance of drift.
- Flying at the optimum airspeed that will, when combined with pump output pressure, help to maintain larger droplets.
- Keeping application height between 8 and 12 feet above the target crop.
- Avoiding applications during weather conditions that promote off-target drift, such as high winds or inversion conditions.

Smoke Generators

You use smoke generators on the aircraft to visualize air movement at the application site. You can also use it to identify inversion conditions below the application height. The smoke generator injects oil into the aircraft's exhaust system, which burns to produce smoke. You control the oil injector with a switch inside the cockpit.

When you activate the smoke generator, you can watch the smoke movement to estimate the off-site movement potential for spray you are applying. Although of limited effectiveness, you can also use the smoke to locate the position of the previous pass to estimate where to begin the next pass. However, due to possible movement of the smoke in air currents, this method is less reliable for swath marking.

Smoke generators are a common part of the onboard equipment found on most agricultural aircraft. One reason for this is that GPS systems have eliminated the need for human flaggers at the application site to position the aircraft for each swath. However, a flagger typically also provided you with information about wind speed and direction. Since off-target pesticide drift is a major concern during aerial applications, a smoke generator provides a better visual picture of wind direction and relative wind speed at the time of spray release. Using a smoke generator before beginning the first pass of an application allows you to make immediate local wind condition evaluations without depending on someone on the ground.

Review Questions

CHAPTER 3: Preventing Pesticide Drift

1. Managing off-target pesticide drift during an aerial application is:

- **A.** The ground crew's responsibility.
- **B.** The property owner's responsibility.
- **C.** The pilot's responsibility.
- **D.** A requirement of a pilot's FAA licensing.

2. Off-target pesticide drift is the offsite movement of the pesticide that occurs:

- **A.** Any time after an application.
- **B.** At the time of pesticide application or soon thereafter.
- **C.** As residues on objects moving from the application site.
- **D.** Several hours to several days after an application.

3. The color code for a nozzle that produces spray droplets in the extra fine category is:

- **A.** Black.
- **B.** Red.
- **C.** Purple.
- **D.** Orange.

4. Generally, the optimum time for making an aerial application of a liquid when droplet evaporation is a concern is:

- **A.** Early morning.
- **B.** Mid morning.
- **C.** Early afternoon.
- **D.** Late afternoon.

5. Which of the following factors has NO effect on off-target pesticide drift?

- **A.** Nozzle orientation.
- **B.** Spray pressure.
- **C.** Constant 3 mph wind.
- **D.** Physical properties of the spray mixture.

6. Wider-angle spray nozzles usually produce ________ droplets than narrower spray nozzles.

- **A.** Coarser.
- **B.** More uniform.
- **C.** Less uniform.
- **D.** Finer.

7. The most effective boom lengths for reducing the amount of drift are:

- **A.** 90% of the wingspan or the rotor span.
- **B.** 75% of the wingspan or the rotor span.
- **C.** 65% of the wingspan or the rotor span.
- **D.** 50% of the wingspan or the rotor span.

8. Aside from external factors, the most important factors affecting off-target drift are:

- **A.** Physical properties of the spray mixture.
- **B.** Extremely high or low temperatures.
- **C.** The size of the spray droplets and the percentage of droplets within a certain size range.
- **D.** Conditions leading to a temperature inversion layer.

9. Driftable fines are droplets in the size range of:

- **A.** Larger than 500 microns.
- **B.** 300 to 500 microns.
- **C.** 200 to 300 microns.
- **D.** 50 to 200 microns.

10. The droplet size at which spray drift becomes a concern is:

- **A.** 50 microns and below.
- **B.** 100 microns and below.
- **C.** 200 microns and below.
- **D.** 300 microns and below.

REVIEW QUESTION ANSWERS ON PAGE 97

CHAPTER 4

AERIAL PESTICIDE DISPERSAL SYSTEMS

LEARNING OBJECTIVES

This chapter will assist you to:

- Understand the desirable requirements of an aircraft pesticide dispersal system for liquid and dry pesticide formulations.
- Become familiar with the components of an aircraft pesticide dispersal system for liquid and dry pesticide formulations.
- Understand the importance of inspecting, servicing, and maintaining dispersal systems.
- Become familiar with spray nozzles and how to correctly position them on spray booms.
- Know how to test dispersal systems for appropriate spray patterns.
- Understand the features of, and how to change the settings on, dry material spreaders.

Accurate metering and application of pesticides are the key purpose of all aircraft dispersal systems. Dispersal equipment has to deliver the labeled rate of a liquid or dry pesticide formulation uniformly and accurately.

Pesticide materials and the dispersal system add considerable weight, requiring aircraft that can safely lift, transport, and make applications when fully loaded. Fixed-wing aircraft used for pesticide application are fast, maneuverable, and carry heavier loads than rotary-wing craft. A limitation of a fixed-wing aircraft is the need for a designated landing area, which may not always be close to the application site. Rotary-wing aircraft used for pesticide application are more maneuverable but slower than fixed-wing aircraft, and can operate over a range of speeds and in almost any area since they do not require a runway for takeoff or landing. This allows ground crews to perform loading operations at or near the application site.

DISPERSAL SYSTEM REQUIREMENTS

The main function of a dispersal system is to allow you to apply an accurate and uniform amount of pesticide material over the application site as efficiently as possible. Liquid dispersal systems include a pump, a tank or hopper, hoses and/or metal lines, control valves with suck-back features, a pressure gauge, filters, one or more booms, and nozzles. Pumps in these systems may be electric or hydraulic motor powered, wind-driven, or directly powered from the aircraft engine.

Equipment and Component Factors

Consider several factors for dispersal equipment and components used for aerial application of pesticides. They must be durable.

Corrosion Resistant

Many pesticide materials are corrosive, so only use corrosion resistant components in the dispersal system. Stainless steel, fiberglass, polyethylene, and polypropylene are non-corrosive, while steel, iron, and aluminum will corrode. In addition, acidic liquids may react with steel or iron to produce highly explosive hydrogen gas. Even though application components are corrosion resistant, the rest of the aircraft may not be, so regularly clean, inspect, maintain, and protect these parts.

Leak Proof

Make sure all components of the aircraft's pesticide dispersal system can resist leaks during the rigors of takeoffs, landings, and flight. This includes tanks, pumps, agitators, bearings and seals, hoses, and hose fittings. The presence of pesticide residues on the belly of the aircraft could be an indicator of a leaking hose or connection somewhere in the system. Leaks endanger you and can damage parts of the aircraft. In addition, leaks can expose workers to pesticide materials, contaminate places and objects used by people, and render runways, hangars, and other areas unusable until decontaminated. Leaks may also cause damage to crops and other plantings outside of the treatment area.

Allow You to Make Accurate Volume Measurements

The dispersal equipment has to include a way to measure accurate volumes of pesticide materials in order for you to apply the correct amount to the treated area.

Able to Produce Uniform Flow Volumes

The dispersal system should provide a uniform flow of the pesticide through the nozzles for even distribution of liquid sprays over treatment areas. Systems that adjust the flow volume according to the application air speed (referred to as flow control) provide the greatest application volume uniformity, but can affect droplet size.

LIQUID DISPERSAL SYSTEM COMPONENTS

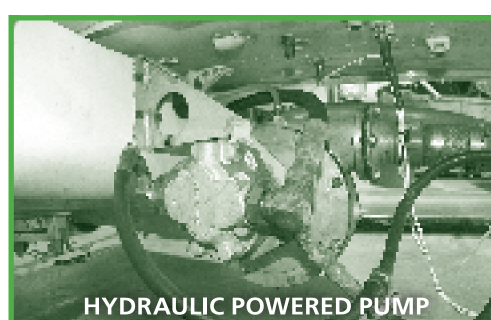
Important qualities of liquid dispersal systems include being dependable and durable, as well as being uncomplicated to service and repair. Descriptions of major dispersal system components follow.

Spray Pumps

The spray pump maintains the pressure in the system to ensure a uniform flow volume and proper atomization by the nozzles. The pump also may power the tank agitation system

FAN DRIVEN PUMP

Tom Hoffmann—Washington State Department of Agriculture



HYDRAULIC POWERED PUMP

M. J. Weaver—Virginia Tech

that keeps the pesticide mixture in suspension. On fixed-wing aircraft, the most common power source for the pump is a fan mounted under the aircraft, below the tank. The aircraft's propeller slipstream drives this fan. Some fan-driven pumps have variable pitch blades so you can change the pump speed, and thus output, for different application requirements. Ultra low volume (ULV) applications may require modifications to the pumping system to make it suitable for such low output.

Other types of power sources for aircraft spray pumps include the aircraft's hydraulic system or an electric motor that drives the pump.

Pumps need enough power and capacity to meet the system's nozzle pressure, flow volume, and tank agitation requirements. The pump needs some extra capacity to make up for pressure loss due to friction in the lines and to operate nozzle anti-drip check valves. If you use a pump with too little capacity, you need to reduce the swath width to get adequate uniform coverage. However, this wastes time and fuel.

The centrifugal pumps commonly used on aircraft produce high volumes of spray material (up to 200 gallons per minute or more, depending on the size of the pump) at low pressure, usually ranging between 10 and 70 pounds per square inch (psi). Centrifugal pumps made from aluminum with bronze or steel internal parts are most common. Centrifugal pumps have a high range of applications, including spraying abrasive wettable powders and flowable formulations, because there is no close contact between moving parts. These pumps usually require operating speeds between 1,000 and 5,000 revolutions per minute (rpm).

Pesticide Tanks and Hoppers

Tanks and hoppers have to be corrosion resistant, and most tanks used in aircraft are fiberglass. Other materials used for tanks and hoppers include stainless steel, high-density polypropylene, or polyethylene. Stainless steel tanks or hoppers generally are more durable than plastic or fiberglass, but they are heavier, therefore adding additional weight to the aircraft. Overall, tanks and hoppers made of stainless steel require less maintenance and can withstand rougher handling than those made of plastic or fiberglass. Although most popular because of less weight, a disadvantage of fiberglass is that it absorbs pesticide liquids if its surface is scratched or abraded, possibly contaminating future tank loads. However, scratches, small cracks, or punctures in fiberglass are easy to repair, while cracks or punctures in polypropylene and polyethylene tanks are difficult to fix.

EXTERNAL SPRAY TANK WITH QUICK COUPLING DISCONNECT

M. J. Weaver—Virginia Tech

Most tanks serve a dual use: they hold liquids for spraying and are hoppers for dry materials such as granular pesticides, fertilizers, and seeds. Tanks have top openings for filling, but it is easier to pump liquids through a pipe that has a quick coupling disconnect protruding through the side of the aircraft fuselage.

A gauge or visual level that shows the amount of material in the tank or hopper is necessary. This gauge has to be conveniently located so it is visible from the cockpit.

Interior baffles in tanks limit the sloshing of liquid during flight and dampen the effect of load shift on the aircraft's stability. In case of an emergency when a load must be dumped in a matter of seconds, the tank needs a large valve or port at the bottom that you can open quickly. Tank vents are necessary and these should accommodate a large enough passage of air to prevent a vacuum that would slow or stop the normal flow of liquid through the nozzles or bottom port. Adequate ventilation of the tank also prevents the buildup of hazardous fumes, explosive gases, or dusts that could damage the aircraft and even endanger your life.

On fixed-wing aircraft, mounting the tank or hopper in front of the cockpit and as close as possible to the

California Agricultural Aircraft Association

aircraft's center of gravity reduces the effect on the aircraft's trim as the tank empties. Small rotary-wing aircraft have either a pair of tanks, with one mounted on each side of the fuselage, or a single belly tank. With two tanks, a pipe or hose connects them and allows the pump to draw the spray mixture equally from both, keeping the aircraft balanced. Larger rotary-wing aircraft have a tank mounted on the inside. Tank or hopper size depends on the load capacity of the aircraft.

Tank Agitation

Many pesticide formulations, such as emulsifiable concentrates, wettable powders, and flowables, require agitation of the liquid mixture in the spray tank to maintain uniformity. Without agitation, the pesticide product may settle out from the water with which it is mixed. A common method of tank agitation is the recirculation of all or part of the pump output back into the tank (hydraulic agitation). A valve that diverts the flow from the spray boom back into the tank or hopper usually does this. Commonly, this boom valve provides a low negative pressure, or suck-back, to the boom when in the closed position. In another type of agitator, some external source powers a propeller mounted inside the tank (mechanical agitation). Mechanical agitation is not common on aircraft because the power required robs engine performance and adds extra weight.

Keep agitators running during ferrying to the worksite and during turnarounds. When the pump has sufficient capacity, some of the pump output recirculates back into the tank during spraying as well. Recirculated material enters near the bottom of the tank to prevent settling of the spray mixture.

If you apply dusts or powders, be aware that fine dry materials (60-mesh and above) in the aircraft hopper may also require mechanical agitation to prevent packing or caking on the top surface of the material during flight. This occurrence, known as bridging, creates voids under this top layer and leads to uneven flow of the dry material from the hopper.

Filters and Screens

Filters and screens protect the dispersal system from damage and keep nozzles from clogging. Clogged filters result in uneven applications. Screens require daily cleaning during spray operations and additional cleaning any time flow volume or change in system pressure indicates clogging. Filter screens range in size from 10 to 200 mesh. A 10-mesh size denotes 10 openings per inch, therefore the larger the mesh number the finer the screen.

Nozzle Screens

Generally, agricultural aircraft do not use nozzle screens because aerial applications call for larger nozzle orifice sizes than ground applications do. However, certain types of nozzles and nozzles with smaller orifice sizes require screens or slotted strainers. The nozzle orifice size and the type of liquid you are spraying also determine the size of the nozzle screen.

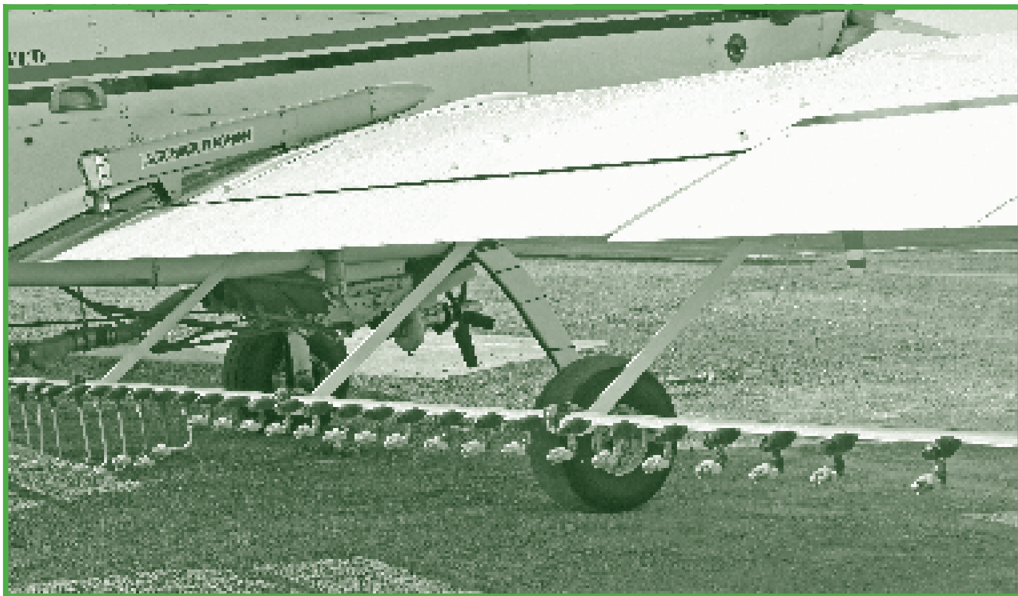
Line Screens

When using a centrifugal pump, place a line screen on the output side of the pump, in the line between the pump and the spray boom. For other types of pumps, locate the line screen on the suction side of the pump to help prevent damage from sand or other foreign particles, which can also cause nozzle check valves to leak.

Never store the dispersal system at the end of a season without thoroughly flushing out the booms. This reduces the likelihood of material accumulating on the inside surfaces of booms downstream from the line screen. This material can flake off later and clog nozzles or nozzle screens.

Pipes, Hoses, and Fittings

Main piping and fittings should be of a large diameter (up to 3 inches) to



Tom Hoffmann—Washington State Department of Agriculture

be able to apply high volumes of liquids. Smaller diameter pipes and fittings (approximately 1 to 1-½ inch) work for low-volume applications. Smaller piping is compatible with rotary-wing aircraft because their slower speed makes it possible to use lower flow volumes. Whatever the size, piping must be able to handle the maximum pump volume.

Hoses used in the dispersal system need to be large enough to carry the desired flow and must resist corrosion. Hoses are less likely to blow off if ends of the connecting tubes are beaded or flared. Using double clamps on hose connections also helps to keep them secure. Position hoses in such a way as to avoid sharp bends. Replace hoses if they swell, develop surface cracks, or otherwise show wear. Sometimes, hoses may not show external signs of wear or fatigue but they become brittle and hard after extended exposure to sunlight, high temperatures, vibration, and the various pesticides and other chemicals used in the system. Even when they look serviceable, hoses used beyond their life expectancy may fail without warning. Therefore, regularly replace hoses even if they look intact and free of defects or wear.

A positive shut-off valve, installed in the hose or line that delivers spray material to the nozzles, eliminates dripping when you shut off the spray. The most effective positive shut-off valve is one that incorporates a suck-back feature so that the pump applies a slight negative pressure to the liquid in the boom. The negative pressure aids the nozzle check valves in preventing any dripping. The system pressure gauge will register this slight negative pressure. If nozzles are not equipped with check valves, you may need to increase the negative pressure. Keep the negative pressure low enough so that it does not remove all the liquid from the spray boom, otherwise there will be too long of a delay as the boom refills when starting a new spray pass.

Spray Booms

The spray boom is the structure that supports nozzles along the wingspan or rotor span of the aircraft and usually carries liquid spray to the nozzles. It may be round, airfoil shaped, or streamlined. Streamlined booms create the least amount of turbulence, followed by airfoil booms and then round booms. To place nozzles in cleaner airflow on fixed wing aircraft, position the booms behind and below the trailing edge of the wings. For some configurations, use drop pipes from the boom to keep nozzles in clean air. Research shows that this lower position is likely to give a better deposition pattern. Securely attach spray booms to the aircraft to prevent bouncing. Make sure booms are durable enough to

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handle the output pressure of the pump. Some booms have separate right and left sections. Using a control valve, you can direct spray to either or both of these sections, making it easier to regulate spray placement in sensitive areas.

Operators of rotary-wing aircraft sometimes use special boom and nozzle combinations because of their ability to produce large, uniformly sized droplets at slower speeds. Operators use this type of boom most often for applying herbicides to rights-of-ways. Droplets form as the spray exits multiple needlelike nozzle tubes on the boom. The airstream pulls droplets into the air behind the boom.

Effective spray booms are approximately 75 percent as long as the wingspan for fixed-wing aircraft or the diameter of the main rotor blade of rotary-wing aircraft. If booms are longer than this, wing tip or main rotor vortices capture a large amount of the output from nozzles at the boom tips, causing distortions in the spray pattern and contributing to drift.

Position the boom and nozzles so that the spray will not strike any part of the aircraft or boom attachments. If the spray does strike structural parts of the aircraft, it will likely:

- Collect and fall off in large drops.
- Distort the spray pattern.
- Waste material.
- Corrode aircraft surfaces.

Having removable caps on the ends of a boom is useful for periodic flushing of sediment buildup inside the boom. However, a boom with end caps prevents positioning nozzles at or near the boom ends. Trapped pressurized air in this space between the boom ends and the outermost nozzles causes the spray to continue flowing for a short while even after you close the spray valve. To eliminate this problem, install air bleed lines to each end of the boom. Attach the other ends of these bleed lines to one of the nozzles near the ends of the boom, making sure these nozzles only receive spray fluid from the bleed lines.

Flow Meters, Valves, and Pressure Gauges

The spraying system should include the following components to improve application ability.

Flow Meters

An accurate flow meter monitors the discharge volume of liquid from the pump through the nozzles. The flow meter alerts you to changes in the spraying system such as clogged nozzles, leaks, and pump malfunction.

Valves

Valves in the system start, stop, prevent dripping, and direct and regulate the flow of the liquid. Some valves have control levers that you manually move to turn on or shut off the spray.

Check valves are spring loaded and have a diaphragm, a ball, or needle and seat that starts or stops the liquid flow depending on whether the pressure in the system exceeds a preset minimum pressure. Electronic flow volume controllers employ motorized ball valves to regulate the amount of flow.

Inspect valves in the dispersal system frequently to confirm they are working correctly and are not leaking. Sediments or debris in the plumbing of the system may prevent some valves from shutting off completely or may restrict the flow of liquid passing through them. Make sure all nozzle check valves have the same size outlet diameter to provide uniform flow volumes along the length of the boom.

Pressure Gauges

Use a pressure gauge as another tool to monitor the spraying system. A pressure gauge helps you determine the correct pump speed or spray valve opening in order to achieve the proper nozzle output, droplet size, and spray pattern. You can use the pressure gauge to monitor and maintain system pressure during application should the electronic flow control system in the aircraft stop working. A pressure change in the system during spraying indicates potential problems. For instance, clogged nozzles or filter screens could increase pressure. A drop in pressure might indicate a broken nozzle, a disconnected line, another type of leak, or pump malfunction. When a pressure change occurs, inspect the system to determine the cause and make necessary repairs. To assure precise readings of pressure at the nozzles, connect the pressure gauge sensor line to the spray boom.

The pressure gauge in the aircraft needs periodic checking. When connected to the same pressure source, compare readings from the aircraft's gauge to another gauge known to be accurate.

Nozzles

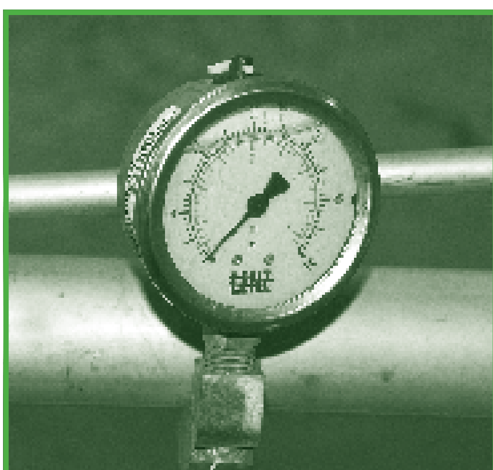
Nozzles provide the primary means of controlling three factors that affect any application and possible off-target movement of the pesticide: the application volume, droplet size, and spray pattern. It is important for nozzles to operate within the range of pressures and flow volumes prescribed by their manufacturers. Therefore, be sure that the spraying system is compatible with the specified pressure and flow volume ranges for the nozzles you use and the aircraft's speed. Manufacturers produce many types of nozzles for various liquid pesticide application situations.

The application volume influences the type of nozzle used in an aerial application. Aerial application volumes fall into three categories:

- Conventional (5 to 15 or more gallons per acre).
- Low volume (LV) (0.5 to 5 gallons per acre).
- Ultra low volume (ULV) (less than 0.5 gallons per acre).

Traditionally, amounts less than 8 gallons per acre were the norm for conventional volume aerial applications. Pilots made these types of applications with cone pattern nozzles. However, aerial spray drift studies indicate that spray output from cone pattern nozzles are likely to emit drift-prone droplets unless configured to produce coarser droplets. Many pilots now make conventional applications using straight stream nozzles, variable orifice flood nozzles, or flat fan nozzles.

Application volumes in the low volume (LV) range are often suitable



BOOM-MOUNTED PRESSURE GAUGE

M. J. Weaver—Virginia Tech

for certain situations, such as applying particular fungicides. You may use flat fan or variable orifice flood nozzles set to a suitable deflection angle, based on orifice size, pressure, and aircraft speed, for LV applications. Drift studies show that properly installed straight-stream or variable orifice flood nozzles reduce the amount of small droplets that are prone to drift.

When using vegetable oil carriers, or when you apply concentrates in forest or public health pest control, such as mosquito abatement spraying, ULV application volumes may be around one to a few ounces per acre. Rotary atomizers work well for ULV applications as well as LV applications.

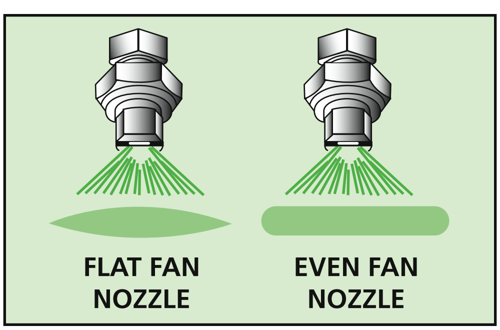
Straight Stream Nozzles

Straight stream nozzles oriented straight back often produce the largest droplets and the lowest drift compared to other nozzle types. These nozzles provide a way to produce large droplets at higher airspeeds when you match the flow volume of the stream from the nozzle with the airspeed. However, at very high speeds the large droplets produced by straight stream nozzles can shatter and create driftable fines.

Fan-Pattern Nozzles

Spray drift studies indicate that nozzles that emit fan-shaped spray patterns typically produce fewer small, drift-prone spray droplets than do cone-pattern nozzles.

Flat fan and even flat fan nozzle tips produce flat, fan-shaped spray patterns. Flat fan patterns have the highest deposition in the center of the pattern and deposition tapers off towards the edges. Even flat fan nozzle patterns are uniform across the whole width of the nozzle pattern. The exact angle of the fan-shaped pattern produced by these nozzle tips depends on nozzle design, spray pressure, and characteristics of the pesticide spray mix. Nozzle tips designed to produce fan-shaped patterns have angles of 25, 40, 65, 80, or 110 degrees. In general, fan nozzle tips that produce wide angles generate more drift-prone spray droplets. For this reason, fan nozzle tips designed to emit no more than an 80-degree spray pattern are better suited for aerial spray applications. Typically, 40-degree flat fans are recommended for the higher speeds associated with fixed winged aircraft and 80 degree flat fans are recommended for slower speeds associated with rotary wing aircraft. Compared to standard flat fan nozzles, even flat fan nozzles have little effect on the spray distribution applied by an aircraft. The more critical consideration when using flat fan nozzles on an aerial boom is that the nozzle tip produces a narrow spray angle.



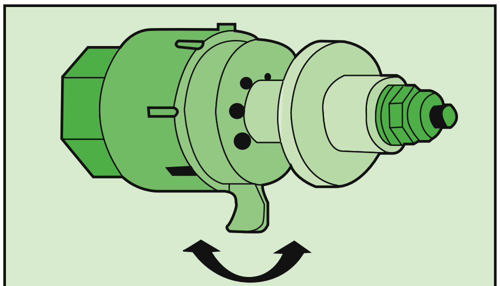
Variable Flow Rate Flat Fan Nozzles

Typically, nozzle orifice sizes are fixed and the only way to increase or decrease nozzle flow volume and maintain a desired spray droplet size range at a certain spray pressure is to change the size of the nozzle orifice. With standard nozzles, slightly increasing or decreasing the spray pressure allows minor adjustments in nozzle flow volume, but this adversely affects the optimum spray pattern. Variable flow rate nozzles overcome this problem because the nozzle orifice size is flexible and enlarges or gets smaller as the system pressure increases or decreases. This maintains greater integrity of the droplet size spectrum and spray pattern as system pressure changes. The advantages of variable flow rate nozzles include:

- The ability to change application volume on the fly by increasing or decreasing system pressure instead of replacing nozzle orifices.
- Better spray droplet uniformity that is less affected by system pressure changes.
- A more uniform application volume and spray pattern even when application airspeed varies.

Variable Orifice Flood Nozzles

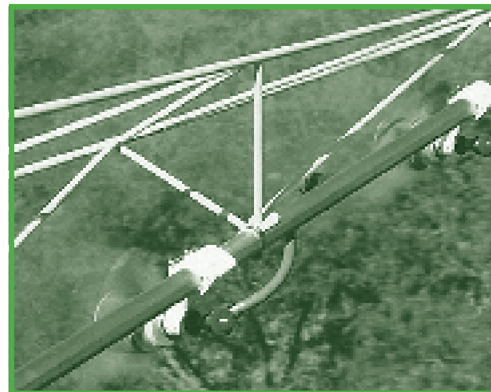
A variable orifice flood nozzle disperses liquid in a flood type wide-angle



flat fan pattern or a straight stream. The nozzle body has two manual adjustments, one for orifice size and the other for deflection angle. Four orifices can be selected, plus an "off" position. The orifice size and pressure determine the nozzle flow volume. Spray from the selected orifice hits an adjustable deflector that you adjust to produce fine, medium, or coarse spray droplets. There are two common types of variable orifice flood nozzles. One has deflection angles of 30, 55, and 90 degrees and the other has a straight stream setting and deflection angles of 5 and 30 degrees. Slower aircraft typically require larger deflection angles than faster aircraft.

Rotary Atomizers

A rotary atomizer consists of a screen mesh cylinder that rotates around the nozzle orifice. Its own fan or an electric or hydraulic motor powers this rotating cylinder. The higher airspeed of fixed-wing aircraft favors the use of fan-driven rotary atomizers. Most fan-drive units have adjustable fan blade pitch so you can achieve the optimum cylinder rotation relative to the aircraft's speed. The slower speeds of rotary-wing aircraft require motor driven cylinders.



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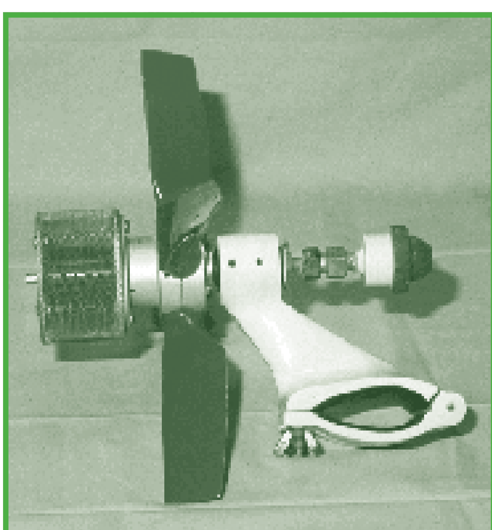

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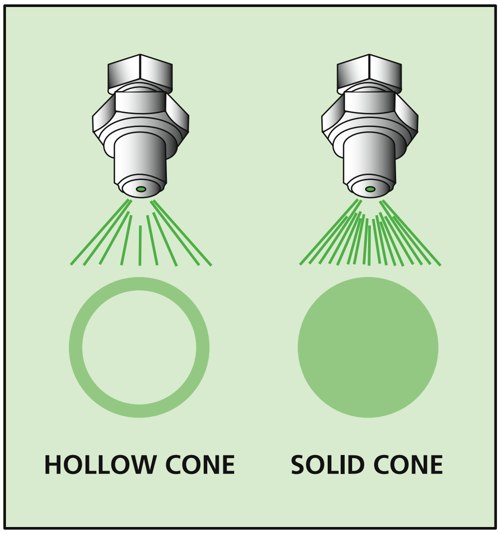
Spray droplets that emerge from the screen mesh cylinder are relatively uniform in size. Rotary atomizer nozzles deliver a wide range of application volumes. Because they have relatively large metering orifices, their nozzles do not clog as easily as conventional nozzles when applying low-volume sprays containing a high concentration of chemicals in suspension. Uniformity also depends on droplet size and nozzle spacing. The number of nozzles you need is based on how wide a swath you intend to cover. Typically, a single rotary atomizer can generate a swath of 10 to 15 feet.

Hollow-Cone Pattern Nozzles

Hollow-cone pattern nozzles include the disc-core type and the whirl-chamber type. Recent spray drift research indicates that using hollow-cone nozzles on an aerial spray boom yields a disproportionate amount of very fine, drift-prone droplets. Because cone nozzles emit spray in a conical pattern, the effect of wind shear is greater than its effect on straight stream or flat fan spray nozzles.

The orifice of a hollow-cone nozzle is located in a disc that fits into the nozzle body. Discs are available in various orifice sizes to accommodate application needs. Located behind the disc is a core, or spinner plate, that puts a high rotational spin on the liquid passing through the orifice. The size of the disc-core combination determines the gallons per minute (gpm) rating of the nozzle at a given pressure.

A whirl chamber nozzle consists of a specialized nozzle body and nozzle cap. When liquid enters the nozzle

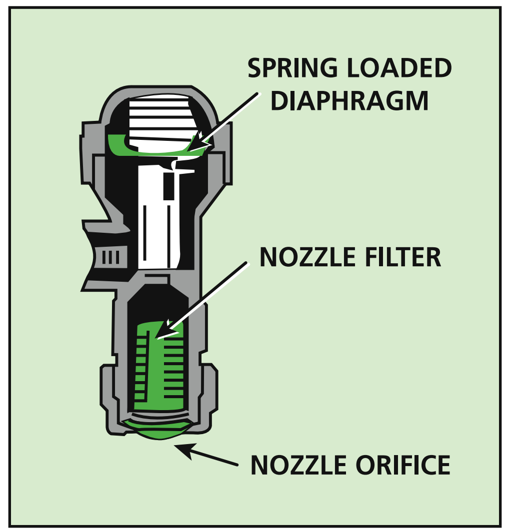


body, the interior structure causes the liquid to whirl rapidly before exiting as a cone-shaped spray pattern. Whirl chamber nozzles are relatively free from clogging problems.

Nozzle Anti-Drip Devices

Equip all the nozzles on the spray boom with check valves to prevent dripping when you shut the spray off. These valves have spring-loaded diaphragms, needles, or steel balls that stop the nozzle flow when spray pressure drops below a certain preset amount, usually about 7 psi. Use anti-drip check valves in combination with shut-off valves that have the suck-back feature. In systems where suck-back is unavailable, use a stronger spring so the nozzles seal shut when pressure drops to about 15 psi. Never switch on and off an electric motor driven pump in a rotary-wing aircraft to start or stop spraying. Using the boom valve to start and stop the spray and leaving the pump running allows the suck-back feature to work properly and provides hydraulic agitation for the spray tank.

Inspect and frequently clean check valves to assure they work properly and are not leaking. Replace diaphragms when they show wear. You can flush needle and seat types of anti-drip check valves without disassembling the nozzle by pulling on the needle, which typically clears the valve of debris and stops the leak.



ELECTRONICS

Electronic equipment such as global positioning systems, flow volume controllers, and mapping systems are important components of aircraft dispersal systems. This equipment increases precision application, reduces error and drift, and prevents waste of pesticide materials. These systems also provide permanent records of various aspects of the application for site mapping, customer billing, and environmental and regulatory reporting.

GPS Systems

Operators choose differential global positioning systems (DGPS) for their aircraft because they provide the high degree of precision needed for aerial application. The amount and kind of navigational information available for aircraft-mounted DGPS equipment depends on the features incorporated into the systems. As with other navigational devices, an FAA-certified aircraft maintenance technician must install, test, and repair DGPS equipment and components. See Appendix 5 for descriptions of types of global positioning systems and how they operate and are managed.

Before purchasing mobile DGPS hardware and software for an appli-

M. J. Weaver—Virginia Tech

cation aircraft, find out if the equipment processes signals for the type of DGPS service that is available in the area where the aircraft operates. In addition, learn what kinds of DGPS peripheral devices, such as light bars and flow controllers, the equipment accommodates.

An aircraft fitted with basic DGPS components provides you with the ability to perform DGPS-aided precision aerial swathing. A basic DGPS includes a:

- DGPS mobile receiver.
- GPS antenna.
- Light bar.
- Computer processor (CPU)—in some units, the CPU and light bar are combined into one unit.

Using the GPS Light Bar

The GPS light bar is a linear array of light emitting diodes (LEDs) that produce a visual representation of the position of the aircraft in relation to the swath you are spraying. It allows you to easily visualize off-track errors and quickly make flight path corrections.

The onboard DGPS receiver continuously sends about 5 updated signals per second to the light bar. These signals activate specific LEDs, with the center of the light bar indicating the aircraft is lined up with the swath centerline. The other LEDs on the left and right of center represent a certain distance away from the swath centerline. This distance is usually 2 feet per LED, but can be set to as little as 6 inches per LED.

After completing a pass, advance the GPS setting to the next swath. When the aircraft is exactly over the centerline of that swath, the center-most LEDs of the light bar illuminate. If the path of the aircraft shifts to the left of the swath centerline, the illuminated sector of the light bar shifts towards the right. You correct the flight course by steering toward the illuminated LEDs. You restore the correct flight path when only the center most LEDs glow.

Once you line up the aircraft with the next swath centerline, use traditional landmark navigation to begin and perform the spray pass by selecting a distant visual object and flying toward it. Occasionally check the light bar during the spray pass to fine-tune your course.

Computers

The advantages of DGPS computer systems include mapping, waypoint navigation, and spray operation record keeping. The computer provides options for you to select a desired application pattern, such as racetrack. The computer then uses the GPS positioning data to continuously calculate and display the aircraft's location with respect to the target site and application pattern. This eliminates the need for flagging or marking devices or human flaggers.

The computer system records the precise in-field location of each spray swath. For jobs requiring multiple spray loads, its mapping system guides you to where to begin applying the next load. Throughout the spray operation, the computer system collects data and constructs records.

Flow Volume Controllers

Manufacturers of DGPS computer systems offer software programs and computer hardware interfaces that provide precision spray boom operations. The aircraft DGPS computer combines continuously updated ground speed data with the spray swath width and sends correction signals to the flow volume controller. The controller regulates boom output by increasing or decreasing pressure and/or flow volume so that it maintains a preset application volume per acre. More sophisticated units even control output on individual nozzles. Flow volume controller systems include means for measuring, computing, and recording:

- Total liquid volume.
- Liquid pressure.
- Liquid flow volume.
- Total spray time.
- Relative humidity.

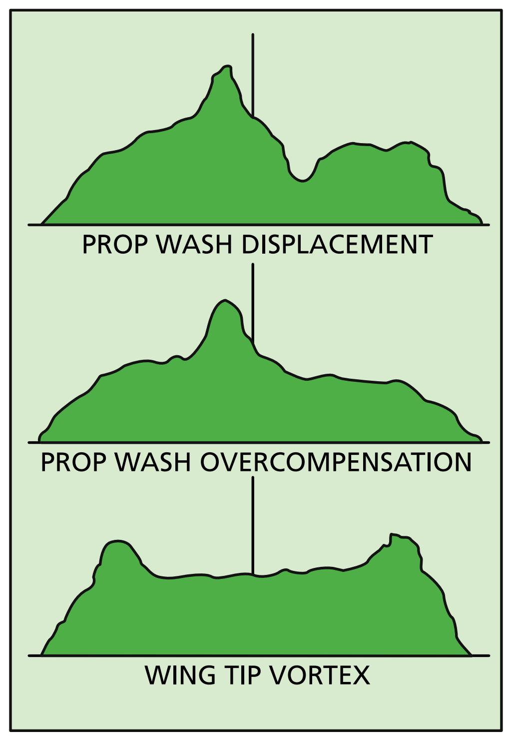
With this equipment, you can deliver the spray uniformly for the duration of the job in progress even when travel speed of the aircraft varies. You use feedback data from the flow volume controller to construct an on-site record of the output performance of the spray boom.

Mapping Systems

Producing maps of the targeted area is one of the features of the global positioning systems in many aircraft. These systems enable you to define boundaries, mark hazards, and produce as-applied maps that document your work. These maps are useful references for future applications. In addition, during an application, the on-screen map in the aircraft shows you where you turned the spray on and off. This gives you the accuracy to separate an area of the same field and fly it in a different direction to help you protect sensitive areas.

POSITIONING BOOMS AND NOZZLES

Improper positioning of nozzles along the spray boom negates the advantages derived from pilot skill, advanced electronics, other application aids, and modern nozzle engineering and manufacturing technology. Determining the proper position for each spray nozzle helps achieve uniform spray deposition. Be sure nozzles are in the aircraft's laminar airflow where there is undisturbed air. Adjust the spacing of the nozzles along the boom to compensate for uneven spray deposition caused by air movement over aircraft surfaces. After positioning the nozzles according to accepted application industry standards, evaluate the setup by conducting pattern testing of the dispersal system. Do this before making any pesticide applications.



Nozzle Adjustments

There are several factors to consider when adjusting nozzle positions.

Prop Wash Displacement

On fixed-wing aircraft, propeller rotation produces a spiral slipstream about the fuselage. This spiral slipstream moves spray particles from right to left under the aircraft. The result is a reduced application volume under the right wing and a higher application volume under the left wing. This problem is most evident on aircraft fitted with spray booms that have a symmetrical nozzle arrangement. The conventional correction for prop wash displacement is to add nozzles to the right side of the boom and remove noz-zles from the left side of the boom. You usually determine the correct number and location of the nozzles by trial and error, preferably

Dale Thomas—Gooding, ID

while conducting pattern testing, not during pesticide application. Generally, the nozzles that need alteration are those positioned within 3 to 6 feet of the fuselage.

Prop Wash Overcompensation

The emphasis on spray pattern distortion due to prop wash has prompted some pilots to overcompensate for propeller-induced effects. You can often correct a pronounced spray peak developing on the left of the fuselage by turning off one or more nozzles mounted within 3 to 6 feet of the right side of the fuselage. Conduct pattern testing to assure you have not overcompensated.

Wing Tip and Rotor Vortex

Wing tip and rotor vortexes usually produce spray patterns with high peaks at its edges. This pattern can occur on either fixed- or rotary-wing aircraft. The vortex captures and propels upward the spray emitted from the outermost nozzles on booms that extend to the full wing or rotor span. Spray droplets so captured do not contribute to the effective swath width, but are a significant source of spray drift. In almost every case, you can overcome a wing tip or rotor vortex induced spray pattern problem by keeping the spray boom length at 75 percent of the wingspan for fixed-wing aircraft or the rotor diameter of rotary-wing aircraft.

Rotor Distortion

Rotary-wing aircraft may display a spray pattern having a low application volume in the middle of the swath and heavier patterns at each end of the spray boom. Normally, you can correct this by adding nozzles under the aircraft between the skids.

Pattern Testing a Spray Boom

When evaluating the spray pattern and determining the effective swath of an aircraft, the application height, power setting, spray pressure, and nozzle location should duplicate field conditions. The best time for spray pattern testing is early in the morning before the sun heats the ground and causes thermal turbulence or convective instability. During testing, fly the aircraft directly into the wind. Conduct pattern test flights only when ambient wind speed is less than 10 mph.

One method for spray pattern testing consists of a detector (fluorometer) that reads the intensity of fluorescent dye deposited onto a string or tape positioned across a test site. A computer converts the fluorescence to data points and displays these in a graphical spray pattern representation.

California Agricultural Aircraft Association

Use this graph to assess nozzle positioning along the boom, determine spray deposition uniformity, and measure the effective swath width. You need to know the effective swath width to program a DGPS guidance system.

If computerized pattern testing equipment is not available, you can determine the spray pattern by other means. The Course Layout figure (next page) depicts a suitable test layout for spray pattern evaluation. Determine the wind direction and place several flags, visible to you from the aircraft, about 100 feet apart along the centerline of the direction of travel. Staple and sequentially number squares of water sensitive paper to small blocks of wood along an 80- to 100-foot line that runs perpendicular to the line of travel. You can substitute plain white cards for the water sensitive paper if you add dye to the spray tank to visualize the droplets.

When flying a spray pattern test, make sure that the nozzle tips, filter screens, and check valves are clean. Put about 30 gallons of water into the spray tank. Before takeoff, operate the pump and briefly engage the boom to check for leaks.

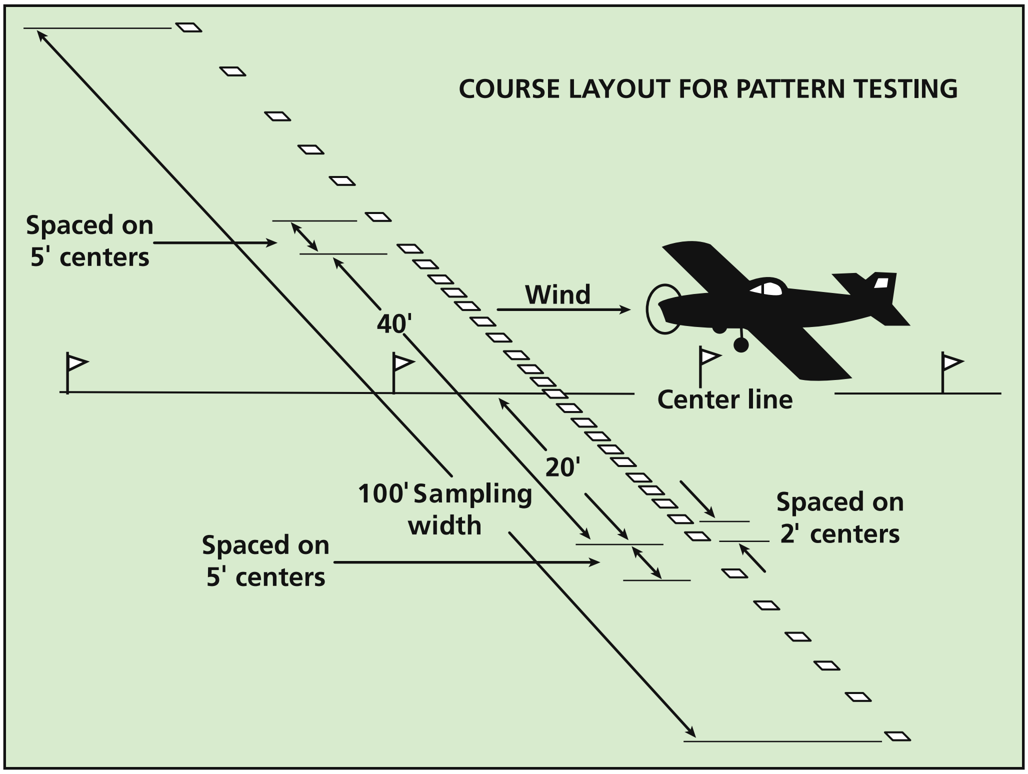
After takeoff, purge the boom and make sure that water from the system reaches the end nozzles. Align the aircraft with the centerline flags on a spray run that duplicates an actual field application. Operate the boom for at least 100 yards both before and after passing over the line of water sensitive paper or cards. To minimize control surface induced air disturbance, maintain straight and level flight during spray boom operation—this will help assure a representative pattern. After the pass, have a ground crew member collect the sprayed cards in the order the ground crew laid them out. Put new cards on the wood blocks and repeat the test to make sure the run was representative of typical spray deposition.

Visual evaluation of treated cards reveals common problems with spray uniformity and swath width. Especially look for:

- A region of light spray droplet density in the vicinity of the flight centerline.
- Uneven spray droplet densities toward the wing tips, indicating prop or rotor distortion (see previous section).
- Light spray droplet density corresponding to boom hangars or other structures that interrupt airflow.

Correct uneven patterns by repositioning nozzles on the spray boom. Conduct a new pattern test to verify that you have improved the pattern.

With a proper nozzle setup, you will notice that the number of spray droplets per card is reasonably constant for some distance on each side of the centerline path and then they gradually diminish until no spray is



evident. The typical pattern forms a trapezoidal shape. The effective swath is the distance between the midpoints on the sloping ends of the pattern. Each midpoint corresponds to a spray deposition that is approximately one-half the average amount of spray deposited in the more uniform portion of the spray pattern. In an actual application, this midpoint is the border between adjacent swaths.

Spraying System Operating Pressure

Drift reduction requires directing nozzles straight back and setting the spraying system operating pressure to match the speed of the aircraft with the exit speed of the pesticide liquid from the nozzles. A pressure of 40 to 60 psi may produce larger droplets due to less wind shear and minimizes the production of droplet sizes prone to drift. Drift prone droplets are those that are smaller than 200 microns in diameter.

When it is necessary to increase the output volume of the nozzles, you can make very small changes by increasing or decreasing the system operating pressure, often by changing the pump speed. Electronic spray volume controllers increase or decrease system pressure to change the output volume of the system when there are slight changes in the aircraft's speed. This produces an application that is more even than if the pressure remains constant as the aircraft's speed varies. However, this adjustment has limitations because, in order to double the spray output, you must quadruple the spray pressure. This will have a major impact on droplet size. In most cases, the best way to make significant changes in boom output volume is by changing nozzle tip size, nozzle orifice size, or by changing the number of nozzles in use. Typically, you should change the spray system pressure only to make minor changes (alterations of 10 percent or less) in boom output.

DRY MATERIAL SPREADERS

On fixed-wing aircraft, ram-air spreaders disperse dry formulations, such as granules or pellets. You would use these spreaders also for applications of fertilizers and seeds. On rotary-wing aircraft, you typically use a centrifugal spreader to apply dry formulations.

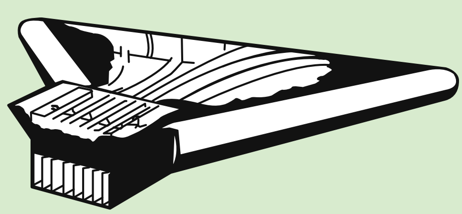
Ram-Air Spreader

A fixed-wing aircraft fitted with a properly configured ram-air spreader can apply dry formulation pesticides very uniformly. However, setup and operation may be more complex than that required for applying liquid pesticide products. General limitations imposed by ram-air spreaders include higher engine power requirements and high aerodynamic drag, which affect aircraft performance and maneuverability.

Ram-air spreaders are comparatively simple, versatile, and reasonably priced. You would typically attach a ram-air spreader beneath the fuselage in such a way that you can remove it easily to restore the liquid spraying capability of the aircraft. The hopper is the same one used to hold liquid pesticide sprays.

An unsatisfactory distribution pattern of dry materials results from most ram-air devices if you attempt to apply more than 250 pounds per acre of material or increase the feed rate to more than 35 pounds per second.

RAM-AIR SPREADER



Feed Rate

In a ram-air spreader, the dry pesticide product drops from the hopper into a ducted airstream, where the airflow ejects it rearward and laterally. A metering gate situated between the hopper floor and the spreader throat governs the feed rate of pesticide granules or pellets. The spreader has either a hinged metering gate or a sliding hatch between the hopper and the spreader.

When using a spreader equipped with a hinged metering gate, you use a cable or rod to rotate the trailing margin of the gate downward to open it to whatever setting you want. Material escapes from the hopper by flowing over the lowered edge of the gate. Usually, hinged metering gates require more frequent calibration adjustment than do sliding hatch types. Some hinged metering gate units are capable of dispensing liquid materials.

Sliding hatch styles of hopper metering gates generally are easier to adjust, especially for low application rates. However, these units tend to be more prone to wear than hinged metering gates.

The hopper metering gate must provide even feed of the pellets or granules across its opening; otherwise, the aircraft will produce an uneven swath pattern. It is unreasonable to expect any combination of ram-air spreader adjustments to compensate entirely for swath pattern problems caused by improper gate adjustment.

Substantially increasing the hopper-to-spreader feed rate beyond its design maximum is a poor strategy for increasing application rate. If you meter too much dry pesticide product into the spreader, ducting becomes choked and less air is able to flow through the unit. Increasing the amount of dry pesticide entering the spreader requires more air to propel the material through the spreader.

Spreader Vanes

The air channel of a typical ram-air spreader consists of from 5 to 13 laterally adjacent, curved ducts. The partitions that form the walls of these ducts are the spreader vanes. Each spreader vane typically has adjustable sections located at its front and rear. These adjustable sections allow for lateral repositioning of the inlet and exit portions of a given vane within the spreader body. Vane adjustment allows you to fine tune a ram-air spreader to a particular aircraft's airflow and slipstream characteristics.

In a ram-air spreader, the material metered from the hopper flows through the ducts as a thin, sheet-like layer of particles. Air entering the spreader inlet forces the product rearward, where it flows along the internal upper surface (ceiling) of the spreader. Spreading of this particle layer is the main job of the spreader vanes. When functioning correctly, the vanes prevent air and particles from moving from one duct to another.

The top of each vane, including the movable sections, must be in close contact with the top of the internal surface of the spreader. If any air gap occurs between vane and duct ceiling, both air and particles can move from one duct to another during spreader operation. This will seriously affect the even distribution of the pesticide.

Adjusting the inlet vane positions helps to make the swath uniform. Airframe-induced influences are known to affect ram-air spreader performance, but that can often be compensated for by spreader inlet vane adjustment.

- Aircraft oil-cooler-induced turbulence.
- Speed ring effects.
- Propwash effects.
- Turbulence caused by a flagging device air deflector.

The propwash effect displaces material released near the right of the fuselage towards the left side of the fuselage. This results in a non-uniform swath where distribution of granules or pellets on the right side is sparse and it is too heavy on the left side. To correct a propwash-induced problem, configure a ram-air spreader to discharge more material from its right side than from its left. Do this by moving the spreader's inlet vanes toward the left, making the left discharge ports smaller than the right side discharge ports.

Shifting inlet vanes too far laterally causes problems, however. As you shift an inlet vane laterally, the airstream attack angle (angle of incidence) of the duct wall increases. When the duct wall angle of incidence becomes too great, static air pressure increases inside the duct and impairs the hopper-to-duct flow rate. This causes an undesired reduction of spreader output. Lateral repositioning of an inlet vane should never exceed a 15-degree angle of incidence as measured in relation to the path of forward flight.

Altering the spreader's exit configuration requires repositioning the adjustable rear portion of one or more spreader vanes if the equipment is set up for this type of adjustment. Rear vane section adjustments provide a way to fine-tune overall swath pattern uniformity. This is because the position of the rear section of a vane mainly influences the exit direction of the particles passing through that duct.

Alignment of the rear section of a vane should, as much as possible, smoothly follow the arc formed by the vane's rigid internal curvature. For rear vane adjustment, the key concepts are smooth, non-obstructive, non-impeding, exit airflow changes. Generally, you only need to make small adjustments. Over-adjustment usually causes particles moving through the duct to slow down, resulting in too much material in one part of the swath.

Spreader Mounting

The best possible mounting configuration of a ram-air spreader is the one that causes the least turbulence. Having the smoothest airflow into, around, and out of the spreader improves spreader performance and provides good application results.

Relative to an aircraft's roll axis, a correctly mounted spreader hangs beneath the fuselage and is level with the fuselage from side-to-side and parallel to the long axis of the fuselage. Spreader mounting differs from airframe orientation only in pitch. The attack angle of a ram-air spreader directly influences the amount of airflow entering the spreader inlet. Set the spreader attack angle by establishing the pitch of the spreader body during mounting.

The forward mounting points of ram-air spreaders are usually nonadjustable. Therefore, change the attack angle by changing the distance between the aircraft fuselage and the rear part of the spreader. In general, the lower skin of the spreader is the reference surface for measuring spreader attack angle. The attack angle of the lower surface should be approximately 1 to 3 degrees less than the attack angle of the lower surface of the aircraft wing. When a spreader attack angle is either too great or too small, the likely result is:

- Increased turbulence and drag.
- Increased deposition of the pesticide material on the tail gear of the aircraft.
- A non-uniform swath pattern.
- Swath narrowing due to lowered exit speeds of particles.

Application Rate and Swath

Up to the point of its maximum material handling capability, changing the application rate of a spreader automatically changes its effective swath width. Increasing hopper feed to the spreader will cause a decrease in swath width because the particle stream exiting a spreader duct becomes heavier and less prone to being broken apart. For high application rates such as jobs requiring more than 250 pounds of pesticide product per acre, the best strategy is to reduce the per-pass application rate, configure the spreader for a reduced swath width, and fly more passes per site.

Centrifugal Spreader

The centrifugal spreader used by rotary-wing aircraft is a self-contained unit having its own hopper. The rotary-wing aircraft carries the entire unit beneath the aircraft, suspended on a cable. The unit meters material from the hopper onto a spinning disc that distributes the pesticide, seed, or fertilizer. A hydraulic motor or gasoline engine usually drives the spinner. You control the motor via a hydraulic control cable or by an electrically activated solenoid. Typically, an operation would have two self-contained units so you can spread with one while the ground crew fills the other. Another method involves using a bag suspended from a boom that the ground crew fills while the pilot makes an application to the field with the spreader. When the hopper needs refilling, the pilot positions the unit under the bag and a ground crew member releases the contents of the bag into the hopper. The refilling operation takes only a matter of seconds while the helicopter hovers above.

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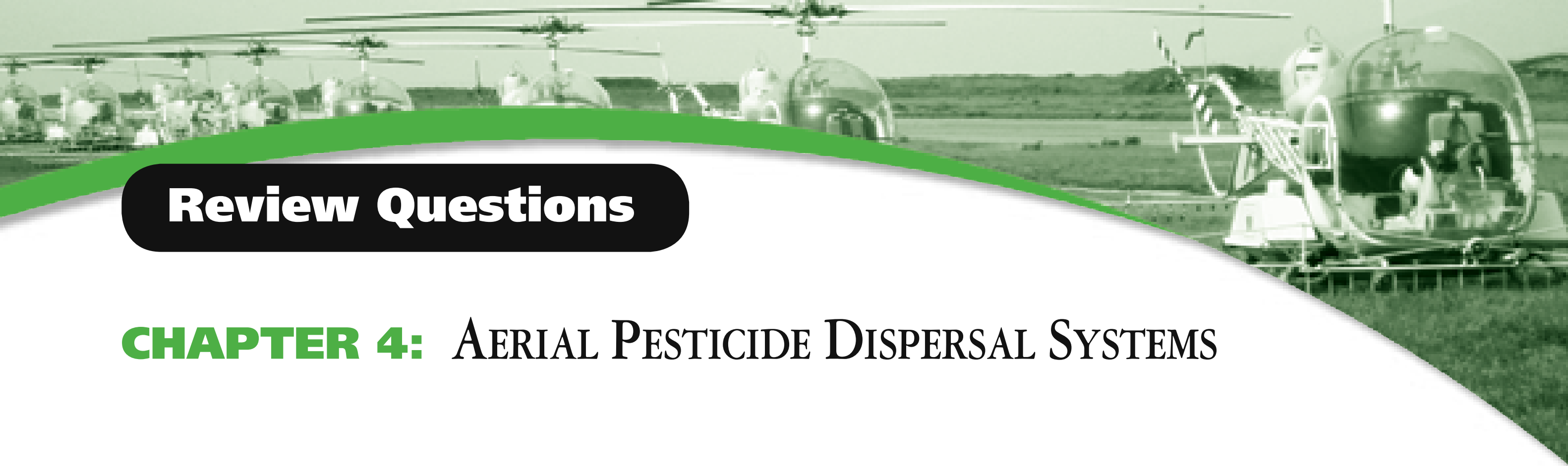

Review Questions

CHAPTER 4: AERIAL PESTICIDE DISPERSAL SYSTEMS

1. **Aircraft suitable for aerial application of pesticides must be:**
   - **A.** Registered with the U.S. EPA.
   - **B.** Constructed entirely of corrosion resistant materials.
   - **C.** Equipped with DGPS navigational equipment.
   - **D.** Able to lift, transport, and disperse pesticides safely.

2. **One of the reasons for an adequate vent in the aircraft pesticide tank is to:**
   - **A.** Release excess pressure.
   - **B.** Allow the pump to function efficiently.
   - **C.** Prevent a vacuum from altering the normal flow of liquid.
   - **D.** Keep the pesticide mixture uniform.

3. **The purpose of baffles inside a liquid spray tank is to:**
   - **A.** Assure even mixing of the spray material.
   - **B.** Prevent extreme pressure changes in the system.
   - **C.** Reduce sloshing of the liquid during flight.
   - **D.** Eliminate foaming of the spray mixture.

4. **Hydraulic agitation of the mixture in the aircraft spray tank requires:**
   - **A.** An external power source.
   - **B.** Sufficient pump output capacity.
   - **C.** Baffles mounted inside the tank.
   - **D.** Proper tank ventilation.

5. **A proper functioning positive cutoff valve with a suck-back feature will supply ________________ pressure to the boom and nozzles when the spray flow is stopped.**
   - **A.** High negative.
   - **B.** Low negative.
   - **C.** High positive.
   - **D.** Low positive.

6. **The purpose of bleed valves at the ends of the spray boom is to:**
   - **A.** Prevent spray from continuing to flow from nozzles after the spray valve is closed.
   - **B.** Prevent pressure from building up from trapped air when the spray valve is opened.
   - **C.** Make cleaning the inside of the spray boom easier.
   - **D.** Reduce internal corrosion of the spray boom.

7. **To accommodate for the influence of prop wash on spray pattern, it is necessary to:**
   - **A.** Regulate the output flow to the nozzles.
   - **B.** Adjust the speed of the aircraft.
   - **C.** Reposition the nozzles on the spray boom.
   - **D.** Decrease the pump speed.

8. The advantage of an electronic sprayer volume controller is that it:

- **A.** Maintains the same spray output as airspeed changes.
- **B.** Reduces or increases the spray output as airspeed changes.
- **C.** Maintains the same spray output as altitude changes.
- **D.** Reduces or increases the spray output as altitude changes.

9. Ram-air spreaders can:

- **A.** Compromise fixed wing aircraft performance.
- **B.** Improve fixed wing aircraft performance.
- **C.** Reduce aerodynamic drag on the aircraft.
- **D.** Reduce the aircraft's power requirements.

10. The purpose of adjusting ram-air spreader vanes is to:

- **A.** Improve the performance of the aircraft.
- **B.** Reduce the aerodynamic drag on the aircraft.
- **C.** Improve the granule distribution pattern.
- **D.** Change the swath width of the granule application.

REVIEW QUESTION ANSWERS ON PAGE 97

CHAPTER 5

CALIBRATING AERIAL APPLICATION EQUIPMENT

LEARNING OBJECTIVES

Reading this chapter will help you understand:

- Why you need to calibrate dispersal equipment.
- How to calibrate liquid and dry dispersal equipment.
- How to make adjustments to the application equipment's dispersal volume or rate.

Pesticide registrants, manufacturers, and regulatory agencies use extensive research to establish proper application volumes and to develop safety precautions that you must legally follow when making a pesticide application. Registrants place this mandatory information on the pesticide labeling. On occasion, regulatory agencies identify a reason to evaluate a product's existing labeling directions, usually because of human safety concerns. As a result, they may impose regulations that supersede the product's current labeling. This may involve changing application volumes or imposing additional safety requirements.

In order to make a legal, safe, and effective aerial application, you are responsible for applying pesticide products uniformly and at the proper volume per unit of area. Pesticide product labels or local regulations prescribe maximum volumes, so exceeding these volumes violates federal and state laws.

The success of each aerial pesticide application depends on accurate calibration. The term calibration refers to setting up and adjusting the application equipment to ensure that you dilute and apply the pesticide active ingredient

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according to regulations. This chapter discusses the steps to take to calibrate, test, and adjust a fixed- or rotary-wing aircraft's pesticide dispersal system. Sidebar graphics are included to detail useful calculations.

Once you calibrate the aircraft's dispersal system, check and test the equipment periodically to be sure the calibration remains accurate. Heavy workloads as well as applying abrasive pesticide formulations contribute to nozzles and other equipment becoming maladjusted or worn.

Technological advances such as DGPS systems and electronic controllers make aerial pesticide application more precise. These tools reduce calibration errors and automatically adjust the spraying system to accommodate for changes in pump output, nozzle wear, and variations in application speed. The best resources for setting up and adjusting these systems are their operation manuals. Therefore, this chapter does not cover calibrating or adjusting electronic devices.

WHY YOU NEED TO CALIBRATE EQUIPMENT

The main reason for calibration is to figure out how much pesticide to put into the tank or hopper of the aircraft so you can apply the work order recommended volume to the target site when you operate the aircraft at a determined speed and altitude. Accurate calibration is necessary for:

- Assuring compliance with the requirements in labeling, law, or regulation.
- Effective pest control.
- Protecting human health, the environment, and treated crops or surfaces.
- Preventing waste of resources.
- Controlling the volume of water (for liquid applications) applied to a given area.

Improper Application Rate

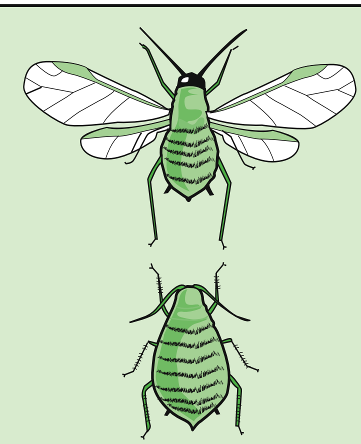
Applicators are legally liable for injuries or damage caused by improper pesticide application. Several problems are associated with applying a pesticide at a volume higher than the maximum legal rate.

Illegal Residues

Applying higher than legal volumes of a pesticide may result in residues on crop plants that exceed the legal tolerance level. If over-application results in illegal residues on plant surfaces, regulators have the authority to confiscate and destroy an entire crop to protect consumers.

Impact on Effective Pest Control

Pesticide registrants and/or manufacturers of pesticides spend millions of dollars researching ways to use their products correctly and effectively. This research includes determining the right amount of pesticide to apply to control target pests. Using less than the labeled rate is legal, but may result in inadequate control, wasting time and money. Application volumes that are too low also may lead to problems such as pest resistance and resurgence. Higher than label rates are illegal and waste pesticides. Using too much pesticide may adversely affect natural enemies of the pest being controlled.



APHID PEST

Human Health Concerns

Pesticides applied at higher than label rates could endanger the health of pesticide handlers, field workers, yourself, and other people working in or visiting an area where you applied them.

Environmental Concerns

Pesticide concentrations higher than label directions may cause serious environmental problems. Calibrating equipment to maintain application volumes within label requirements reduces the potential for contaminating surface water, ground water, and the air.

Impact on Treated Plant Surfaces

Certain pesticides are phytotoxic (injurious to plants) and damage treated plant surfaces when used at higher than label-prescribed rates. Manufacturers evaluate these potential problems while testing their products so they can determine safe concentrations.

Soil Contamination

Using too much pesticide increases the chance of building up excessive residues in the soil. A buildup of certain pesticides sometimes seriously limits the types of future crops that farmers can grow in the treated area.

Wasting Resources

Using the improper amount of pesticide wastes time and adds unnecessary costs to the application.

EQUIPMENT CALIBRATION METHODS

Pesticide materials are expensive, and the fuel, labor, and equipment wear and tear required to make extra applications are costly.

If you apply pesticides improperly, you are subject to criminal and civil enforcement actions that may result in loss of your pilot certificate, paying fines and penalties, serving imprisonment time, and the costs and lost time dealing with lawsuits.

Properly calibrating aerial application equipment is necessary to ensure uniform distribution of the pesticide materials and it helps prevent pesticide related problems. The following sections discuss different calibration techniques for liquid application equipment and granular application equipment.

Calibrating Liquid Sprayers

Calibrating liquid sprayers involves determining how much area each tank of spray covers when the aircraft travels at a known speed and the system operates at a known pressure. You begin by matching the desired application volume and droplet size category with the number of nozzles, nozzle orifice size, application airspeed, and swath width. Use nozzle specifications from the manufacturer to select nozzles that, as closely as possible, produce the desired spray output and droplet size for the product you intend to apply. Arrange nozzles on the boom in such a way as to produce the desired deposition pattern when applying the material from the application height selected. Keep the application height constant during each swath run to obtain uniform coverage. Avoid adjusting application height to either change the swath width or spray pattern uniformity. Instead, replace nozzles to correct swath width and pattern uniformity.

Once the aircraft is properly set up, measure the following four factors:

- Tank capacity.
- Application airspeed.
- Flow volume.
- Effective spray swath width.

Spray pressure is a component of the flow volume because as the pressure increases or decreases the flow volume increases or decreases as well. Spray pressure must never exceed the recommendations of the nozzle manufacturer.

Check liquid spraying equipment frequently when applying abrasive pesticides, such as wettable powders, because these materials cause wear in pumps and nozzles. Pump wear decreases the amount and pressure of fluid output, while nozzle wear increases the volume of output. Alone or in combination, these two occurrences usually lower the output pressure and may produce a poor spray pattern.

Tank Capacity

You need to know exactly how much liquid you can put into the aircraft's spray tank in order to determine how much area you can spray with each load. This requires measuring the capacity of the spray tanks, usually one time only. If you modify the tank, or remove or add components inside the tank, you will have to re-measure its capacity. Never rely on tank size ratings provided by the manufacturer because these may be approximate volumes, they may not take into account fittings installed inside the tank, and they do not account for the attitude of the aircraft while it is on the ground.

Position the fixed- or rotary-wing aircraft on a level surface and make sure there is no liquid in the system. Drain the system if necessary, then close any open valves to prevent water leaks. Start adding measured amounts of clean water. Keep the pump running to circulate the liquid. Using a flow meter, bring the water level to the maximum operating fill point. This is the level to which you will always fill the tank whenever applying a full load. Once you determine the actual capacity of the tank or tanks, paint or engrave this amount onto a prominent place near the tank for permanent reference.

While filling the tank, also calibrate the tank sight gauge, or make marks on the tank as you add measured volumes of water. Once you calibrate the sight gauge or tank, it is easy to see how much liquid is in the tank when it is not entirely full. Always return the aircraft to a level surface when reading the sight gauge or tank marks. The sight gauge readings while the aircraft is in flight will differ from readings taken when the aircraft is on the ground due to flight attitude.

Application Airspeed

Measure airspeed under actual working conditions, with the aircraft spray tank about half full of water (to get the best average for weight considerations), and flying at the same altitude as an actual spray application. If the aircraft spraying system is equipped with a flow volume controller, the controller will calculate the proper flow volume and make adjustments if airspeed changes. For it to make these adjustments, you must enter the application volume and the size of the effective swath width into the unit.

Flow Volume

If the aircraft is not equipped with a flow volume controller, measure the actual output of the system when nozzles are new, then periodically thereafter to accommodate for nozzle wear. Manufacturers provide charts showing the estimated output of given nozzle sizes at specified spray pressures. Manufacturer charts are most accurate when using new nozzles—used nozzles may have different output volumes because of wear. Even new nozzles may have slight variations in actual output. Additionally, the pressure gauge in the aircraft may not be accurate, which further adds error to the output estimate determined from manufacturer charts. These charts express flow volume in gallons per minute, which you can then convert to gallons per linear mile at the prescribed swath width.

Rotary-wing Aircraft. Rotary-wing aircraft usually have electric or hydraulic powered pumps, so the aircraft does not need to be in flight to measure nozzle output. To find out the combined flow volume for all nozzles on a helicopter spray boom, collect liquid from each nozzle over a known time (such as 30 seconds) and add together these amounts. Use a calibrated container that measures liquid ounces. Once you determine the total amount of output, convert the ounce measurement into gallons and then determine the gallons per minute and mile outputs (see *Sidebar 1*).

Fixed-wing Aircraft. Most fixed-wing aircraft use fan driven spray pumps, so the aircraft must be airborne or have the engine running at high speed while on the ground. Due to the air blast from the propeller, you cannot collect spray from the nozzles. Therefore, find

SIDEBAR 1

CALCULATING SPRAYER FLOW VOLUME PER MILE

(Rotary-Wing Aircraft)

A helicopter spray boom is equipped with 30 nozzles. Liquid has been collected from each nozzle for 30 seconds. When combined, the total amount of liquid collected is 600 ounces.

Convert the 600 ounces per 30 seconds into gallons per minute.

$$\frac{\text{total ounces collected} \times 60 \text{ seconds/minute}}{\text{seconds of collection time}} = \text{ounces/minute}$$

$$\frac{600 \text{ ounces collected} \times 60 \text{ seconds/minute}}{30 \text{ seconds}} = 1200 \text{ ounces/minute}$$

Next, convert the total ounces per minute into gallons per minute.

$$\frac{1200 \text{ ounces/minute}}{128 \text{ ounces/gallon}} = 9.375 \text{ gallons/minute}$$

In this example, the helicopter discharges 9.375 gallons of liquid per minute. This result can be converted to gallons per mile by dividing the airspeed in miles per hour by 60 minutes per hour and then dividing the result into the gallons per minute.

Assume the helicopter is traveling at 50 miles per hour.

$$\frac{50 \text{ MPH}}{60 \text{ minutes/hour}} = 0.833 \text{ miles/minute}$$

$$\frac{9.375 \text{ gallons/minute}}{0.833 \text{ miles/minute}} = 11.25 \text{ gallons/mile}$$

the output of the sprayer over time by measuring how much water you use during several test flights. Each time you fill the tank, make a run operating the sprayer for a timed period.

Start by moving the aircraft to a level surface and fill the tank to a known amount with clean water. Fill the tank to a level that you can duplicate when refilling. Check for leaks around tank seals, hoses, and hose fittings. Be sure all nozzles are clean and operating properly or the results will be inaccurate.

Take off and fly to an area where you can release the spray water. Operate the sprayer at its normal operating speed and pressure. Open the valve to the spray boom, starting a stopwatch at the same time. Continue to run the sprayer for several minutes, and then close the valve. Record the elapsed time, return to the ground, and park the aircraft at the same spot where you originally filled the tank.

Attach a flow meter to a low-pressure filling hose and refill the tank to the original level. Record the gallons of water used; this volume is the amount of liquid sprayed during the timed run. Determine the gallons per minute output of the sprayer and convert the result to gallons per mile as shown in *Sidebar 2*. For more accuracy, repeat this process two more times to get an average of sprayer output.

Swath Width

A crucial step in the calibration of an aircraft liquid dispersal system involves determining the effective

SIDEBAR 2

CALCULATING SPRAYER FLOW VOLUME PER MILE

(Fixed-Wing Aircraft)

For this example, the aircraft's spray tank is filled with water to its top mark. After takeoff and leveling off, the pilot made four runs at 120 MPH and opened the spray valve for 30 seconds for each run. After landing, the aircraft was returned to the same location where the tank was originally filled. Using a flow meter attached to a water hose, the tank was refilled to the top mark. It took 36 gallons of water to refill the tank.

Calculate the gallons per minute output of the sprayer.

$$\frac{\text{36 gallons}}{\text{2 minutes}} = \text{18 gallons/minute}$$

Convert the gallons per minute into gallons per mile.

$$\frac{\text{120 miles/hour}}{\text{60 minutes/hour}} = \text{2 miles/minute}$$

$$\frac{\text{18 gallons/minute}}{\text{2 miles/minute}} = \text{9 gallons/mile}$$

swath width. Although the actual swath width may be wider, the effective swath width includes overlaps made with each pass to achieve a more even application. Measure the amount of overlap leading to the effective swath width produced by an aircraft by pattern testing. Whenever you alter the spray boom in any way or change application height, you must repeat this pattern test and recalculate the effective swath width. Application height affects the effective spray swath, so the application height used during pattern testing must be the same as the height flown during an actual application.

Application Height

Application height describes the distance between the nozzle tips and the target, be it the plant canopy or open ground at the target site. The effective swath width usually increases as the application height increases due to air movement. However, there are limits to how high you can go and get a wider swath. Spray drift management studies indicate that application height can affect the amount of off-target drift of the spray, depending on the spray droplet size. Therefore, minimizing off-target drift risk requires lower application heights. The greater the application height, the more time it takes for spray droplets to reach the target and so they are subjected to evaporation and other forces that create off-target drift. High temperatures and low humidity will increase the evaporation rate.

An application height of 8 to 10 feet is usually the maximum suitable for applying spray droplets that have less tendency to drift. For application heights greater than 8 to 10 feet, you need larger spray droplets to reduce drift. The pesticide label usually provides application height limits or a range of application heights for a particular product. Flying too low can cause additional drift issues because of air turbulence hitting the ground (ground effect).

Determining the Acres per Minute Treated

To calculate the number of acres treated in one minute, use the airspeed

SIDEBAR 3

CALCULATING ACRES TREATED PER MINUTE

Convert the airspeed from miles per hour to feet per minute using this formula.

$$\frac{\text{MPH} \times 5{,}280 \text{ feet/mile}}{60 \text{ minutes/hour}} = \text{feet/minute}$$

Assume for this example that the aircraft travels at 120 miles per hour. Convert this speed to feet per minute.

$$120 \text{ MPH} \times 5{,}280 \text{ feet/mile} = 633{,}600 \text{ feet/hour}$$

$$\frac{633{,}600 \text{ feet/hour}}{60 \text{ minutes/hour}} = 10{,}560 \text{ feet/minute}$$

Next, multiply the effective spray swath width by the feet per minute airspeed to determine the area, in square feet, covered in one minute. The effective swath width has been determined to be 50 feet and the travel speed is 10,560 feet per minute.

$$\text{feet/minute} \times \text{effective swath width} = \text{square feet/minute}$$

$$10{,}560 \text{ feet/minute} \times 50 \text{ feet} = 528{,}000 \text{ square feet/minute}$$

Convert this area into acres by dividing the square feet/minute by 43,560 square feet/acre.

$$\frac{528{,}000 \text{ square feet/minute}}{43{,}560 \text{ square feet/acre}} = 12.1 \text{ acres/minute}$$

and the effective swath width measurements in the calculations shown in *Sidebar 3*.

Determining the Application Volume per Acre

In the “Flow Volume” section, the fixed-wing aircraft example calculation (*Sidebar 2*) showed that a boom with 50 nozzles was discharging 18 gallons per minute. At 120 miles per hour, this amounts to 9 gallons per mile. *Sidebars 3 and 4* illustrate how to convert the gallons per mile to gallons per acre.

Determining the Amount of Pesticide to Put into the Tank

The label or job order prescribes how much pesticide to apply per acre. Be sure to confirm that the job order does not exceed the legal rate given on the label. You may have to adjust nozzle output or modify the application pattern to achieve this desired volume. For example, you may have to make more than one pass over a swath to apply the total number of gallons of spray or pounds of granules per acre as required by the label or job order application rate.

To prevent waste of pesticide material, you must accurately know the size of the area to be treated. Then, mix only the amount of pesticide needed. Multiply the total acres in the application site by the application volume to find out how much pesticide will be required for the complete job.

Use tank volume and the gallons per minute figure to calculate how much time it will take for you to spray out all the liquid in the tank. Once you know this time, you can calculate the total area covered with each tank of material. The result will be the actual acres of treatment site that you can spray with

SIDEBAR 4

DETERMINING GALLONS PER ACRE

A spray boom having 50 nozzles discharges 18 gallons of spray per minute. Using the calculations from *Sidebar 3*, this aircraft covers 12.1 acres per minute.

Divide the gallons per minute by the acres per minute to get gallons per acre.

$$\frac{\textbf{18 gallons/minute}}{\textbf{12.1 acres/minute}} = \textbf{1.49 gallons/acre}$$

Therefore, the aircraft in this example will be spraying 1.49 gallons of liquid per acre when traveling at 120 miles per hour and spraying a 50 foot effective swath width.

SIDEBAR 5

DETERMINING THE AMOUNT OF PESTICIDE TO PUT INTO THE TANK

A fixed wing aircraft is equipped a with spray tank with a total measured capacity of 300 gallons. The aircraft spraying system will discharge 18 gallons per minute when flown at 120 miles per hour.

Divide the tank capacity by the gallons per minute to determine how many minutes it will take to spray 300 gallons, the tank's capacity.

$$\frac{\textbf{300 gallons/tank}}{\textbf{18 gallons/minute}} = \textbf{16.7 minutes/tank}$$

Next, calculate the number of acres that can be sprayed with one tankful of liquid. To do this, multiply the minutes per tank figure by the acres per minute figure computed in Sidebar 3.

$$\textbf{16.7 minutes/tank} \times \textbf{12.1 acres/minute} = \textbf{202 acres/tank}$$

In this example, the aircraft can treat 201.7 acres with one tank of spray mixture. Assume the job order prescribes 2 pints of pesticide per acre. Knowing that one tank can cover 201.7 acres, the total amount of pesticide to put into the tank can be calculated.

Multiply the pints per acre by the acres per tank and divide this by 8 pints per gallon to determine the gallons of pesticide to put into the tank.

$$\frac{\textbf{2 pints/acre} \times \textbf{202 acres/tank}}{\textbf{8 pints/gallon}} = \textbf{50.5 gallons/tank}$$

These calculations show that 50.5 gallons of pesticide must be mixed with 249.5 gallons of water to fill the tank with 300 gallons of spray mixture.

one tank of pesticide mixture. Knowing this value and the recommended rate of application (units of pesticide per acre of treatment area) makes it possible to determine how much pesticide to mix with water in the aircraft's tank. See the calculations for this in *Sidebar 5*. You also need to calculate the area to be treated (*Sidebars 6-9*).

Changing Sprayer Output

Once calibrated, you have determined the output volume of the aircraft's spraying system for a specific speed, altitude, and pump pressure. However, there may be times during an operation when you may need to change the output volume slightly. These include:

- Accommodating variations in foliage density.
- Different plant spacing within the same field.
- Special requirements of the treatment area such as obstacles or sensitive areas.
- Compensating for nozzle or pump wear.

You can make the adjustments discussed below, either alone or in combination, to effectively increase or decrease sprayer output, but only within a limited range.

Changing Speed. Typically, you should not adjust application speed in a fixed-wing aircraft to change the application volume. However, the simplest way to adjust the volume of spray (and amount of pesticide) you are applying in a

SIDEBAR 6

CALCULATING THE AREA OF A RECTANGULAR OR SQUARE APPLICATION SITE

To calculate the area of a rectangular (or square) site, you must know the:

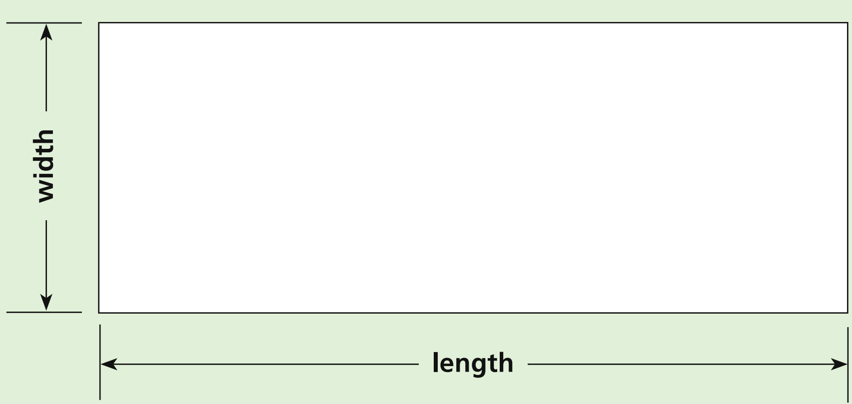
- Length of the longest side (in feet)
- Width of one adjacent side (in feet)

A rectangular field is 800 feet long and 250 feet wide. To find the area of the field (in square feet), multiply the length times the width.

$$\textbf{800 feet} \times \textbf{250 feet} = \textbf{200,000 square feet}$$

Convert the 200,000 square feet to acres by dividing by the number of square feet in one acre (43,560 square feet).

$$\frac{\textbf{200,000 square feet}}{\textbf{43,560 square feet per acre}} = \textbf{4.59 acres}$$



SIDEBAR 7

CALCULATING THE AREA OF A TRIANGULAR APPLICATION SITE

To calculate the area of a triangular site, you must know two dimensions, making sure both of these dimensions are in feet.

- The length of the longest side of the triangle (its **base**).
- The width of the triangle at its widest point (its **height**).

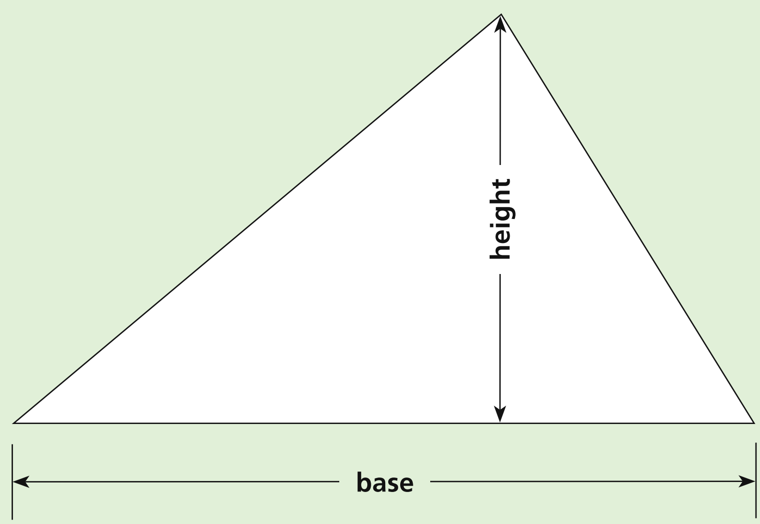
$$\text{area of a triangle} = \frac{(\text{base} \times \text{height})}{2}$$

The longest side (base) of a triangular field measures 650 feet. The distance between this side and the point where the two other sides meet (height) is 300 feet.

$$\frac{650 \text{ feet} \times 300 \text{ feet}}{2} = 97{,}500 \text{ square feet}$$

Divide the 97,500 square feet by 43,560 square feet per acre to find the number of acres in this triangular site.

$$\frac{97{,}500 \text{ square feet}}{43{,}560 \text{ square feet per acre}} = 2.24 \text{ acres}$$



SIDEBAR 8

CALCULATING THE AREA OF A CIRCULAR APPLICATION SITE

To calculate the area of a circular site, you must know two values.

- The radius of the circle in feet (see diagram below)
- The value of the constant pi (often indicated by the Greek letter π) which is approximately 3.14

The radius is the length of the straight-line distance from the center of a circle to any given place on the circle's edge. The radius is equal to one half of the diameter. A diameter is the length of the longest possible straight-line distance across a circle, passing through the center of the circle. Pi is a ratio of the circumference of a circle to its diameter. It is used to determine areas or volumes that involve circles, spheres, and other curved objects.

The area of any circle is determined by multiplying pi (π) times the square of the radius of the circle, where the square of the radius means multiplying the length of the radius by itself. Use this formula.

$$\text{area} = \pi \times r^2$$

where r is the radius and π = 3.14

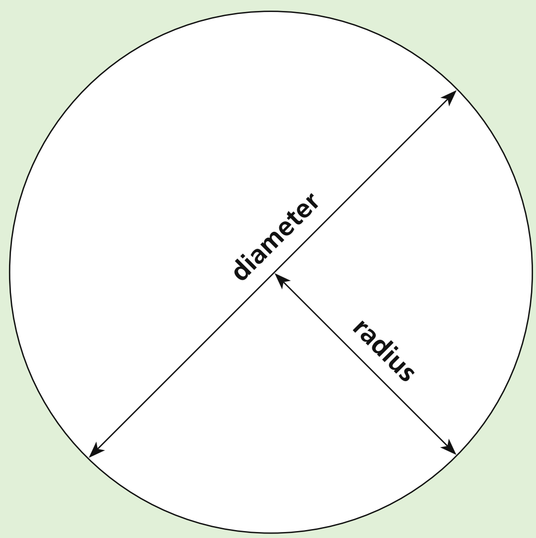
Before making any calculations, make sure the length of the radius (or the diameter) is known in feet. If only the diameter is known, divide this by 2 to get the radius.

The diameter of the circular field is 400 feet. This means that the radius is 200 feet. To calculate the area, multiply π (3.14) times the square of the radius (200 feet × 200 feet).

$$\text{area} = 3.14 \times (200 \text{ feet} \times 200 \text{ feet}) = 125{,}600 \text{ square feet}$$

To convert this area to acres, divide the 125,600 square feet by 43,560 square feet per acre.

$$\frac{125{,}600 \text{ square feet}}{43{,}560 \text{ square feet per acre}} = 2.88 \text{ acres}$$



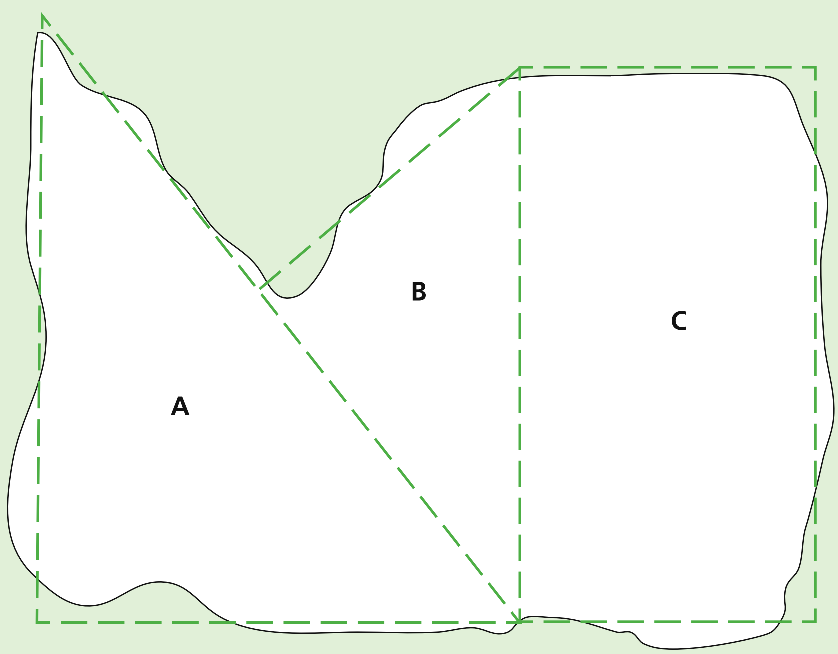
SIDEBAR 9

CALCULATING THE AREA OF AN IRREGULARLY-SHAPED APPLICATION SITE

Many sites are not perfect circles, rectangles, or triangles. Often, agricultural sites have curved corners, have a bulge along one or more sides, or, have a notched area because an obstacle does not allow cultivation or spraying. This can make an accurate area calculation difficult. Here are some guidelines on how to proceed.

- *First, sketch a general map of the site. This is a key step, yet, in most cases, you do not need many measurements to make a good general map. The main purpose of the map is to let you clearly identify the number and kinds of shapes that together make up the site.*
- *Next, identify the kinds and number of shapes such as triangles, circles, and rectangles that together form the irregular shape. Return to the field and place marker stakes to identify the boundaries of each identified shape or subsection. Record the location of each marker stake on a map.*
- *Take in-field measurements to determine the dimensions of each regularly shaped subsection. Record these measurements on the map.*
- *Calculate the area (in square feet) of each regularly-shaped subsection, following the procedures for calculating the areas of a rectangles, circles, and triangles.*
- *Finally, add together the square feet calculations from all the subsections. This will give you the total size, in square feet, of the irregularly shaped site. This square foot measurement can then be converted to acres.*

In the example shown here, based on the general map of the site, three regularly shaped subsections (Triangle A, Triangle B, and Rectangle C) can be identified and measured. Then add together the three areas.



rotary-wing aircraft is to change the speed. A slower speed results in more material applied, while increasing the speed reduces the application volume. Changing the travel speed eliminates the need for altering the concentration of chemicals in the spray tank if there is a valid reason for increasing or decreasing the application volume. However, there are limits to the amount of speed change that you can make. Increasing speed too much is a problem because it increases the wind shear effect on spray droplet sizes, producing smaller spray droplets. In addition, faster speeds may reduce the application volume so much that it results in poor coverage and ineffective pest control. Flying too slow may possibly result in over-application by exceeding the maximum label rate. At the very least, it would increase the amount of pesticide applied, causing runoff and waste, and increasing application time and cost.

Changing Output Pressure. As nozzles begin to wear, the spray volume will increase from the orifice getting larger. However, when a pump begins to wear, it becomes less efficient as it moves less volume of spray because of the increase in space between the moving parts that normally force the liquid through the system. As a result, the nozzle output drops off. Adjusting the pump speed to increase or decrease output pressure will change the spray volume slightly. Increasing pressure increases the output, while decreasing pressure lowers it. In order to double the output volume, you must increase the pressure by a factor of four. This is usually beyond the capabilities of the spraying system and a pressure increase negatively affects the droplet size spectrum. The working pressure range of the sprayer pump also limits this adjustment.

Changing Nozzle Orifice Size. The most effective way to change the output volume of the aircraft spraying system is to install different sized orifices on nozzles. Larger orifice sizes increase volume, while smaller ones reduce spray output. Changing orifice sizes usually alters the pressure of the system and requires an adjustment of the pressure regulator or pump speed. Be aware that changes in orifice size will also change the droplet size and spray pattern and will affect drift potential. A major factor in reducing drift is to reduce the amount of small fines prone to off-target drift. Considerations must include the effect of airspeed on droplet atomization as well as the effect of air shear across the nozzle face. Use tables from nozzle manufacturer web sites or manufacturer literature as guides for estimating output of different nozzle and orifice size combinations. When you change nozzle orifices, remeasure the output volume.

Calibrating Granule Applicators

The techniques for calibrating granule applicators are similar in many ways to those used for liquids. However, granules vary in size and shape from one pesticide to the next, influencing their flow rate from the applicator hopper and spreader. Temperature and humidity may also influence granule flow. Due to their lower drift potentials, you generally can apply pesticides formulated as granules from greater application heights than what is suitable for liquids. Usually, higher granule application heights produce more uniform deposition patterns.

Before beginning to calibrate a granule applicator, be sure that it is clean and all parts are working properly. Measure three variables when calibrating a granule applicator:

- Application airspeed.
- Output rate.
- Swath width.

Application Airspeed

Always measure airspeed under actual working conditions with the aircraft loaded to normal operational weight and flying at the altitude that you will use when making a granule application.

Output Rate

To determine the rate of output, follow the manufacturer's guidelines

SIDEBAR 10

COMPUTING GRANULE APPLICATION RATE PER ACRE

The weight of the granules collected in all 13 pans totals 2 ounces.

Compute the pounds of granules being applied per acre as follows:

$$\frac{\text{43,560 square feet/acre} \times \text{2 ounces}}{\text{13 square feet}} = \text{6,701.54 ounces/acre}$$

Convert ounces per acre to pounds per acre by dividing by 16 ounces per pound:

$$\frac{\text{6,701.54 ounces/acre}}{\text{16 ounces/pound}} = \text{418.85 pounds/acre}$$

and set the ram-air spreader gate or centrifugal spreader gate to the desired rate per acre. Place a series of at least 13 collection pans at 5-feet intervals in a straight line on the ground. Set these out perpendicular to the flight line. The footprint shape of the collection pans is unimportant, but the pans should be approximately 4 inches deep and have an area of at least 1 square foot. All of the collection pans must be exactly the same size. Pad the bottom of each pan with a thin foam layer to help prevent any granules from bouncing out.

Swath Width

Fly a swath test along a centerline oriented at a right angle to the line of collection pans. If ambient wind speed is greater than a sustained 8 mph, orient the line of pans at a right angle to the prevailing wind and fly directly into the wind.

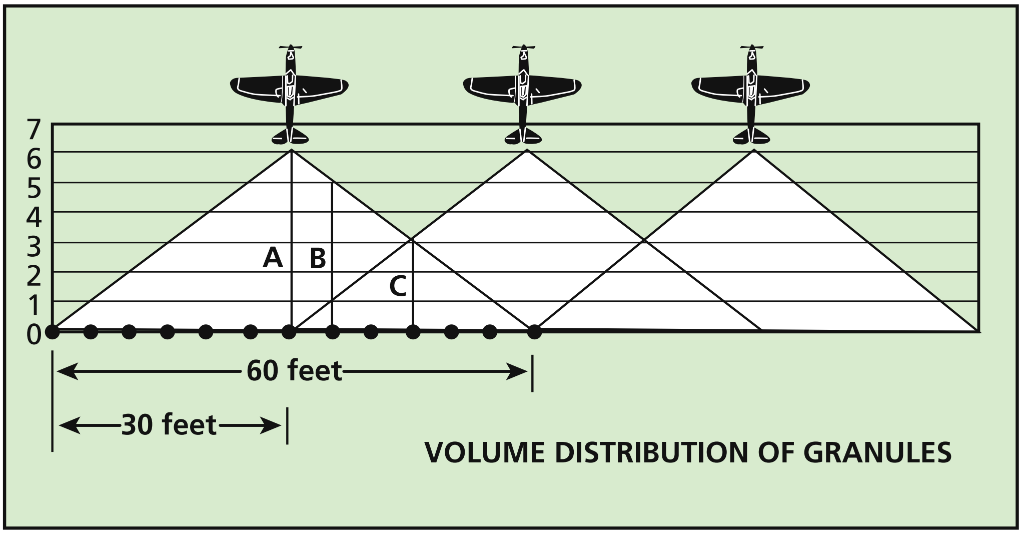
After the swath test flight, use a small graduated cylinder to collect and measure granule volume in each individual pan, progressing from left to right. Record each pan's volume on a graph in the exact order of collection. Plotting these volumes as a graph lets you visualize the distribution of your granule application across the swath. Finally, combine the granules from all the pans into another container, then weigh and record this weight. Calculate the total area of the 13 pans. For example, if each pan is exactly one square foot, the total area would be 13 square feet. *Sidebar 10* shows how to calculate the granule application rate per acre.

The distribution shown in the figure on the next page is an idealized plotting of the amounts caught in 13 pans laid out 5-feet apart across a 60-foot swath. Another pass centered 30 feet to the right of the first pass produces a 50% overlap of the swaths and results in an even distribution of granules. This represents an effective swath width of 30 feet.

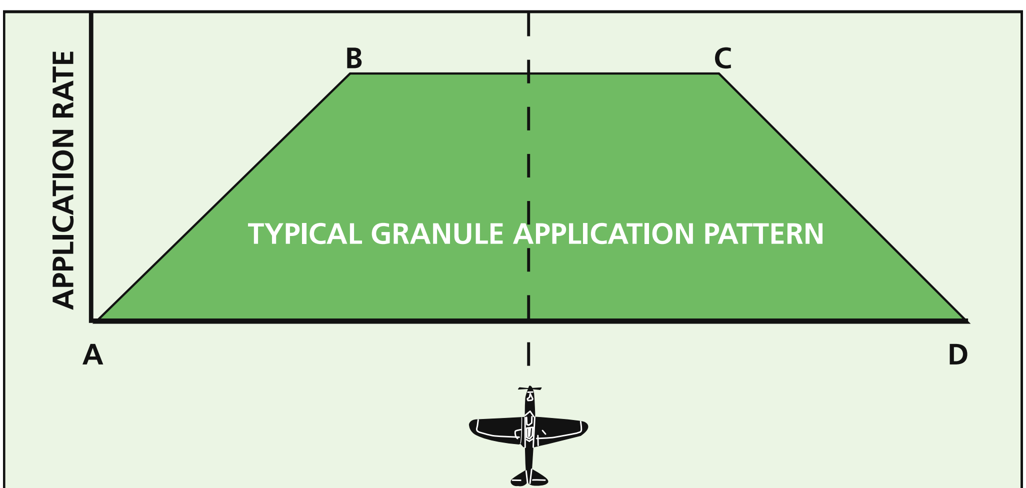
Examination of this figure shows that at point A, six units (these could be pounds, ounces, or any other unit of weight) were collected in the pan. At point B, the first swath applied five units in the pan and the second swath added one more for a total of six. At point C, each swath applied three units for six units in the pan.

The pattern shown at the bottom of the next page is a more typical trapezoidal pattern generated by granular spreaders. The effective swath width of a pattern having this shape is determined by adding the distances AD and BC together and dividing by 2, as shown on the next page.

Once you determine the effective swath width, you can estimate the



amount of granules, in pounds per acre. The example above is not an ideal method of calibrating a granule applicator because of the large difference in weight between the granules caught in the pans and those deposited onto the actual application swath. Unfortunately, it is often impossible to calibrate dry materials accurately unless you are using the actual materials. Spreading pesticide granules onto an area not designated for the application of a pesticide is dangerous and irresponsible. If possible, obtain blank granules (granules of the same size, shape, and weight as the pesticide product, but without the pesticide active ingredient) from the manufacturer to use for calibration. If this is not possible, the only alternative is to rely on the equipment manufacturer recommendations for setting and adjusting the ram-air spreader gate or



If distance AD (the distance between the two end pans containing zero granules) is 60 feet, and distance BC (the distance where granule catch per pan is relatively constant) is 30 feet, calculate the effective swath width.

$$\text{effective swath width} = \frac{60 \text{ feet} + 30 \text{ feet}}{2} = 45 \text{ feet}$$

In this situation, application passes should be made 45 feet apart.

centrifugal spreader gate to the desired rate per acre. This setting should result in accurate initial application rates. You can fine-tune this rate to be even more precise by calculating the amount of pesticide that you applied to a known area and comparing that to the desired rate.

Review Questions

CHAPTER 5: CALIBRATING AERIAL APPLICATION EQUIPMENT

1. The purpose of calibration is to:

- **A.** Determine the capacity of the spray tank(s).
- **B.** Prevent off-target pesticide drift.
- **C.** Apply the correct amount of pesticide.
- **D.** Protect the environment.

2. Applying a pesticide at a rate that is higher than the pesticide label rate is:

- **A.** Necessary.
- **B.** Careless.
- **C.** Illegal.
- **D.** Useful.

3. Increasing airspeed without changing the spray output will result in:

- **A.** More pesticide active ingredient applied per acre.
- **B.** Less pesticide active ingredient applied per acre.
- **C.** An increase in the pesticide flow volume.
- **D.** A decrease in the pesticide flow volume.

4. If 1700 ounces of material is collected from nozzles on a helicopter spray boom in 90 seconds, what is the total flow volume in gallons per minute?

- **A.** 4.42
- **B.** 8.85
- **C.** 13.28
- **D.** 17.70

5. An aircraft spraying system has an output volume of 8 gallons per minute. How many gallons are sprayed per mile when the aircraft travels at 130 miles per hour?

- **A.** 3.7
- **B.** 4.5
- **C.** 5.8
- **D.** 6.5

6. An effective swath width is the:

- **A.** Total swath made by two passes.
- **B.** Total swath made by a single pass.
- **C.** Width of a single pass that includes portions of overlaps from other passes.
- **D.** Distance between the outermost or widest points of application across the entire swath.

7. An aircraft sprays 20.2 gallons per minute. How many minutes of spraying time are needed to spray out 147 gallons of spray mixture?

- **A.** 6.8
- **B.** 7.3
- **C.** 8.5
- **D.** 9.0

8. Given an application rate of 11.3 gallons per acre, how many acres can be sprayed with 147 gallons of spray mixture?

- **A.** 11
- **B.** 12
- **C.** 13
- **D.** 14

9. If an aircraft treats 14 acres per tank of spray mixture, how many pints of pesticide liquid should be put into the spray tank to apply at a volume of 1.5 pints per acre?

A. 11

B. 15

C. 21

D. 24

10. How many acres are in a rectangular field that measures 620 feet by 1280 feet?

A. 16.1

B. 18.2

C. 22.8

D. 28.8

REVIEW QUESTION ANSWERS ON PAGE 97

CHAPTER 6

Making an Aerial Pesticide Application

LEARNING OBJECTIVES

Reading this chapter will help you understand:

- Safe ferrying techniques.
- What to check when arriving at the application site.
- How to recognize and work with weather at the application site.
- Different types of application patterns.
- Special considerations when applying granules.

The reasons for following proper aerial pesticide application methods are to make precise, safe, and legal aerial applications consistently and to minimize the off-target movement of pesticide droplets. Proper application methods include knowing how to:

- Recognize the factors and conditions that contribute to off-target pesticide drift and other offsite movement, and know how to minimize off-target pesticide drift and other offsite movement.
- Safely ferry the aircraft between home base, the loading site, and the application site.
- Inspect the application site and surrounding areas for hazards before beginning the application.
- Watch for hazards throughout the application operation.
- Fly an effective application pattern and make safe and efficient turns and passes.
- Recognize the atmospheric factors that influence the stability and maneuverability of the aircraft.
- Use DGPS or other guidance systems.

Agricultural aircraft are highly visible and noisy, and as a result, some people view aerial pesticide applications as nuisances or hazards. The sight of an aircraft flying low over fields is a serious and sometimes anxiety producing concern for some. When you make aerial applications, be aware of these concerns and, when necessary, be sure to acknowledge them by taking steps to foster better communication with the public. Notify people in the area about a planned application and make efforts to mitigate noise in areas where people live and work during ferrying or application operations.

Preflight, departure, and application **checklists** are useful tools for you, ground crew members, and others involved in an aerial application operation (see Pages 85 and 86 for pilot and ground crew checklists). These checklists help anyone involved in the operation to organize and manage their responsibilities and they help to assure that the operation is safe and effective.

For you and the ground crew, the first and last runs of the day often call for extra attention. The first flight of the day requires that you and ground crew members be alert and mentally prepared immediately for the complexities of the operation—with no time to bring the operation up to maximum performance gradually. Likewise, the last flight of the day must not be rushed or compromised in any way in order to finish quickly—it requires the same attention, care, and time as every other flight during that day. However, the first flight of the day is the best time to schedule jobs that are more difficult since you and the ground crew are more rested.

FERRYING

When traveling with an empty or full aircraft between the loading area and the application site, fly at an altitude of at least 500 feet above the surface and keep at least 500 feet away from people or personal property. Make every effort to avoid flying over buildings, residential areas, parks or playgrounds, penned animals, and other areas where people or livestock may be present. If the operation requires many trips back into an area, avoid taking the same route each time. Instead, vary the flight route by one-eighth to one-fourth mile during each trip to avoid repeated passes over the same surroundings. This tactic tends to minimize the audio and visual impact of the flights, as opposed to repeatedly flying the same route and subjecting the same people to the same level of distraction.


Tom Hoffmann—Washington State Department of Agriculture

CHECKING THE APPLICATION SITE

Upon arrival at an application site, fly an initial inspection pass to verify that:

- Local weather conditions are suitable for the prescribed aerial application work.
- Agricultural workers, spectators, trespassers, and others, including their vehicles and equipment, are not within or immediately adjacent to the application area, especially down-wind of the site.
- Livestock are not in the application area or adjacent areas where they may come in contact with the spray.
- Crops adjacent to the application site match those identified on the work order—if in doubt, verify the type of crop with the grower before beginning an application.
- All members of the ground crew assigned to this operation are present and ready to begin their duties.
- The communication link between you, the ground crew, and the base location is functioning correctly and that you have a working backup communication plan in case of equipment failure.

- The aircraft DGPS system, if equipped, is properly functioning.

If you note any conditions in the application site or adjacent areas that the pesticide label does not permit or that you consider unsafe, and these conditions cannot be resolved quickly, abort the operation and return to your home base. If the area is clear and conditions favor an application, circle the field at a very low altitude, but high enough to clear all obstructions by at least 50 feet. Look for utility poles, guy wires, high tension power lines and other types of utility lines, and other obstructions such as trees, buildings, windmills, radio antennas, road signs, pipeline markers, and fences that are in or near the treatment area. Carefully check around trees that may conceal power lines or other obstacles. Look for breaks in the normal cultivation or planting pattern that may indicate the presence of power lines or other hazards. Poles, high fences, or other obstructions may prevent cultivation of weeds or other vegetative growth in these areas, so look for vegetative clues indicating the presence of obstructions that may otherwise blend into the background.

After circling the field and noting obvious hazards, fly just above and to one side along power lines and telephone wires and check each pole. Look for branch wires, guy wires, and transformers. Transformers usually have branch wires leading to a house, shop, well, or other structure. A guy wire will normally be placed on the opposite side of a pole from a branch wire or at the pole where a main line makes a turn. Branch wires may be obscured or difficult to see, so look for a cross arm going in a different direction from the main wires. If any structures are near the treatment area, look for wires that provide electrical power and telephone service to them.

Consider the possibility that conditions may have changed since someone made previous inspections or aerial applications to this particular field. For instance, crops in fields adjacent to the application site may be different from those noted on the work order. If this is the case, confirm the application site location. Also, new buildings or wells may have necessitated new power poles, or the utility company may have relocated some power lines. Sometimes the height of the planted crop or trees may have changed since a previous application. For example, it may have been possible to fly under certain wires in the spring when a crop was first planted, but not possible later in the year when the crop is taller. In addition, heat causes wires to expand and therefore hang lower to the ground during hot summer days.

WHAT TO WATCH FOR DURING AN APPLICATION

Conditions at an application site or surrounding areas may change during the course of an application. For this reason, be constantly alert and keep in contact with someone on the ground at the site.

Monitor Changes

Changes that may affect the safety or effectiveness of the opeation include the following:

Weather

Wind speed may increase or decrease or the wind direction may change, creating hazards of drift or

John Mateski—Newberg, OR

Carol Ramsay—Washington State University

contamination of sensitive areas. Alternatively, wind may stop altogether, increasing the chances of a temperature inversion condition. The weather may worsen and turn to rain, requiring postponement or cancellation of the application. Some pesticides are restricted to applications at times when temperatures remain below a certain level—if the temperature at ground level rises above this point, plants may suffer damage (phytotoxicity) from the spray material. Certain pesticide labels may have humidity restrictions for application.

Hazards

Previously unidentified hazards may become apparent to either you or the ground crew, requiring that you stop or modify the application at that site. This might include the discovery of livestock in the area or a work crew arriving to work in an adjacent field or nearby. There may also be communication from the property manager or others with concerns about hazards.

Field Workers

Field workers may inadvertently walk or drive into an area being sprayed or people working in adjacent fields unaware of the application operation could pass through or walk into the field under treatment. In both cases, the operation is required to stop until everyone is safely out of the area. This emphasizes the importance and usefulness of ground crew members in spotting people in the area and helping them to leave quickly.

Service People and Others

Various people occasionally have reasons to enter fields or pass through them as part of their job responsibilities. This includes electric meter readers, delivery services, people called to make repairs on equipment, irrigation district personnel, mosquito control district personnel, and others. In addition, some people enjoy walking or running through rural property, often without the permission of the landowner, and may be unaware of the hazards. The ground crew can assist in spotting and warning anyone attempting to enter the application site and escort them out of the area for their own safety.

Importance of Onsite Ground Crew During an Application

Each on-site ground crew member needs to be able to communicate directly with you, providing site-specific details of current weather conditions, topographical features, location and dimensions of ground-based hazards, buffer zone locations, and other information about hazards or sensitive areas. Duties of an on-site ground crew member typically include:

- Acting as a liaison between you and the property manager to ensure aerial application obligations are met.

PILOT CHECKLIST

Things to consider before, during, and after any application.

- Inspect the aircraft and all of its safety equipment and your personal safety equipment for proper operation and usable condition.
- Be sure the aircraft's onboard fire extinguisher is in working condition and has a readable inspection tag.
- Confirm that the correct pesticide material is mixed with the proper amount of water and put into the aircraft's spray tank by the ground crew by rechecking the pesticide label and counting the number of empty containers.
- Wear an approved safety helmet, long-sleeved shirt, long pants, shoes, socks, and, when out of the cockpit, the other required personal protective equipment specified on the pesticide label or in regulation.
- If possible, avoid mixing and loading activities to reduce chances of bringing pesticide residue into the aircraft's cockpit.
- Check the field and surrounding area before applying pesticides to be sure there are no animals, humans, crops, waterways, streams, or ponds that might be injured or contaminated either by direct application or drift.
- Whenever possible, avoid flying through the suspended spray of a previous pass.
- Stop the application and return at another time if winds rise or other adverse weather conditions develop and create a drift hazard; also stop the application if the wind is too calm, usually less than 2 mph.
- Never turn on dispersal equipment or check the flow volume except while over the area you are treating.
- Refuse to fly if the customer requires having any pesticide applied in a manner and at a time that may create a hazard to crops, humans, animals, and the surrounding environment.
- Make sure every application of a pesticide follows a valid label for a listed crop or site and that the label has no prohibition for application by air.
- Read the label and know the hazardous characteristics of the pesticides.
- Using a smoke generator or other device, estimate how far and in what direction some of the chemical may move away from the application site.
- Never spray over a flagger, other handlers, or anyone else working in the area.
- After making an application, if you notice any equipment malfunction or problems, securely fasten a note in the cockpit to alert other pilots and the maintenance crew.
- Prepare and keep accurate application records.

GROUND CREW CHECKLIST

Instruct members of the ground crew to take several precautions before, during, and after any application.

- Using extreme care when handling pesticides or cleaning the aircraft or other contaminated equipment.
- Reading the labels of all pesticides being mixed and wearing label- or regulation-required work clothing and personal protective equipment.
- Insuring that the correct pesticides are properly diluted and mixed before loading into the aircraft's spray tank.
- Tightly securing tanks and hoppers so the pesticides will not blow back over the pilot or the cockpit.
- Closing and securing the hopper and covering it as soon as loading is completed.
- Removing any pesticide spilled around the aircraft tank fill opening.
- Not standing in runoff water and avoiding splashes.
- Changing out of work clothing and washing thoroughly at the end of the work day after handling pesticides, washing the aircraft, or cleaning contaminated equipment.
- Assisting in preparing and keeping application records.

The ground crew should also be familiar with the pilot's checklist.

- Preventing individuals from entering the site, both immediately prior to and during the application operation.
- Immediately reporting the presence of unauthorized individuals in the treatment site to you and the on-site field crew supervisor or leader.
- Assisting you in pretreatment target area inspection.
- Acting as an in-field reference point for you to identify swath boundaries.
- Providing emergency response and summoning emergency services in case of a crash incident.

APPLICATION METHODS

Use safe flying procedures during all phases of the application operation. Never take risks for the thrills at the expense of good judgment or safety. To ensure that the pesticide application will be effective, follow label use directions and requirements in the label and regulations. Avoid off-target pesticide drift or other off-target movement of the pesticide material. Adhere to the methods discussed in this manual to avoid off-target pesticide drift. Visually check the spray or granule discharge while making applications to spot application problems.

Straight, parallel passes produce the most uniform spray pattern. Use a reliable method, such as DGPS, to mark each swath to ensure uniform coverage and to avoid excessive overlap or gaps. Whenever possible, make passes perpendicular or at a 45 degree angle to the wind direction to assist in overlap and coverage uniformity. Begin treatments on the downwind side of the treatment site to minimize flying through spray suspended in the air from previous swaths. Also, try to make application passes parallel to the longest dimension of the treated area to reduce the number of turnarounds.

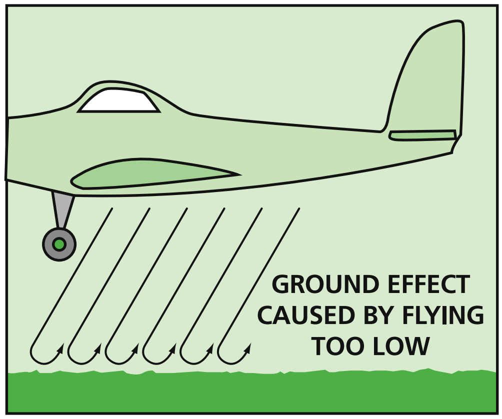
To prevent spray from contacting sensitive areas, or to avoid flying or turning over residences and other sensitive areas, you may need to wait for more favorable conditions or alter the application pattern in relation to prevailing wind direction and even contrary to logical field layout. For instance, consider a rectangular field having its longest width running east and west. Because the wind is from the north, it would appear logical to make east-west passes. However, on the eastern border of the field is a road with houses on the other side of this road. East-west passes require making turns over the road and houses. In this situation, make shorter, north-south passes over the field—even though this requires making more turns.

Application Speed

Maintain constant airspeed, consistent with the calibration of the aircraft, during each pass of an application. Variations in speed during an application may result in uneven coverage unless you are using an electronic flow volume controller to compensate for speed changes. Flying crosswind or 45 degrees to the crosswind during an application avoids the adverse effects of head- and tailwinds on the application volume.

Altitude

Notwithstanding legal requirements in the label, in law, or in regulation, the type of pesticide you apply usually determines application altitude. For example, liquid pesticides are most effective and off-target drift is less of a problem when you make applications 8 to 12 feet above the crop or tree canopy. Flying lower will reduce



off target drift because the droplets are closer to the ground, however flying too low may cause uneven streaking due to not allowing enough time for the spray pattern to fill in. Flying too low over bare ground or over short crops may produce a ground effect that forces air displaced by the aircraft to move upward from the ground. Ground effect occurs when the aircraft is less than ¾ the wing or rotor span from the ground. This upward moving air entraps and lifts some of the spray and contributes to off-target pesticide movement. Trees and other plants with dense foliage may lower the ground effect risk.

Application altitude also depends on atmospheric conditions. It is common for an aircraft to fly higher in calm conditions and lower when the wind is higher. As the aircraft gets lower, the induced drag decreases, reducing drift. Wing tip vortices, which will increase drift, are dependent on aircraft configuration, speed, and weight. Slower and heavier aircraft will have larger wing tip vortices due to increased induced drag.

Keep the application height constant during each application pass to maintain the effective swath width that you determined during calibration of the dispersal equipment. Failure to do so will result in difficulty obtaining uniform coverage.

Obstructions

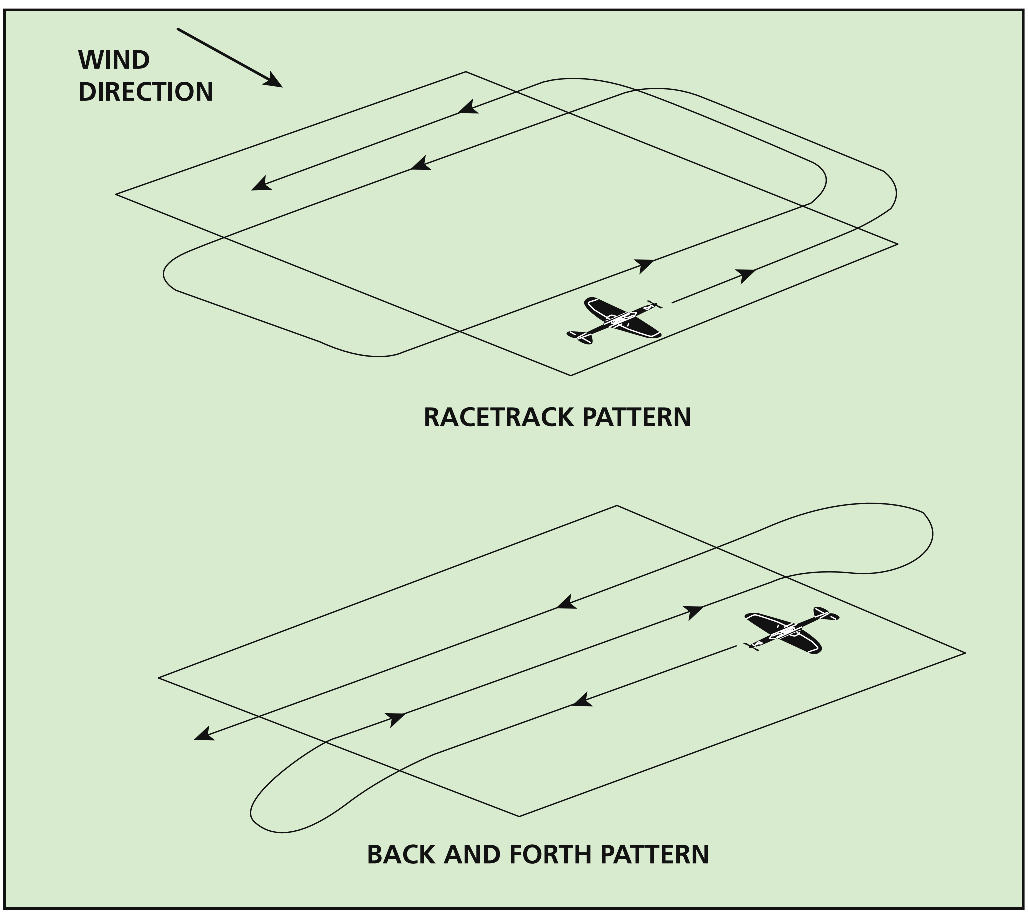
If you encounter obstructions at the beginning or end of a swath run, turn the spray on or shut it off one or two swath-widths from the beginning or end of the field. Then, when you finish all parallel swaths, fly one or two swaths crosswise to the rest of the application direction to finish out the field. Never disperse materials while dropping in or pulling out of a field because this distorts the deposition pattern. Should this happen, the pesticide will be more likely to drift or concentrate in a small area. If there are obstructions along the sides of a field, fly parallel and as close to the obstruction as is safe. For safety, leave an untreated buffer strip adjacent to buildings, residences, livestock areas, bodies of water, and other sensitive areas.

There are two methods for working around trees, poles, or other obstructions in the middle of a field. One is to treat them in the same manner as if they were at the end of the field: stop spraying one or two swath widths before reaching the obstruction. Pull up and fly over the obstruction. Then, make a 180-degree turn before dropping in to spray, approaching the obstacle from the other direction. This will allow better control of the aircraft's speed and will avoid overshooting the other side. Complete the application by spraying one or two swath widths on each side of the obstacle, perpendicular to the previous swaths. The second method is to stop spraying and pull up as you approach the obstacle, make a 360° turn, fly over the obstacle, drop down, and continue spraying.

When a high enough wire crosses a swath that has trees at one end, fly under the wire if possible, and then pull up and fly over the trees. This is safer than entering the field over trees and then passing under the wire.

FLIGHT PATTERNS

One flight pattern for aerial application is the adjacent swath or back and forth pattern, applying swaths over the target in straight, parallel lines. In areas that



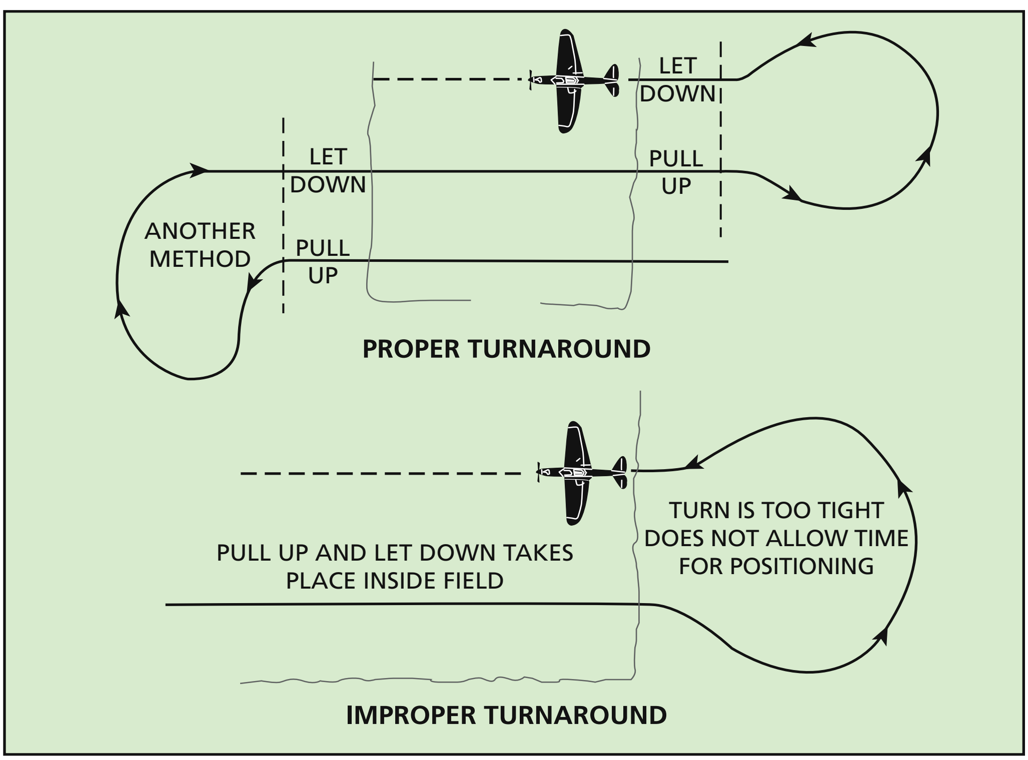
are too rugged for uniform altitude and speed, follow the contours of the slopes during application passes. In hilly terrain, or where hills or mountains confine the application area and do not permit contour flying, make all passes in one direction, down slope. Upslope spraying can be dangerous.

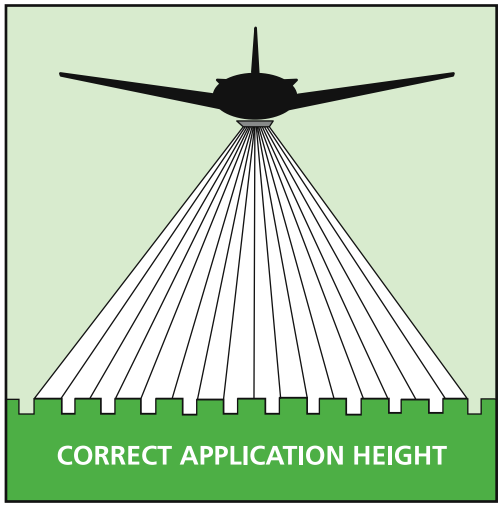
Usually, the racetrack pattern is the most energy-efficient. This pattern maximizes application time and lessens the time required for turns. It also allows time for the spray to settle, reducing the chance of flying through it. This pattern often minimizes pilot fatigue. Whether flying a racetrack or back and forth pattern, it is important to start and stop spraying at the right time when entering or leaving the field. Starting too soon or stopping too late causes spray to be applied to off target areas. Starting too late or stopping too soon may result in improper coverage to field ends.

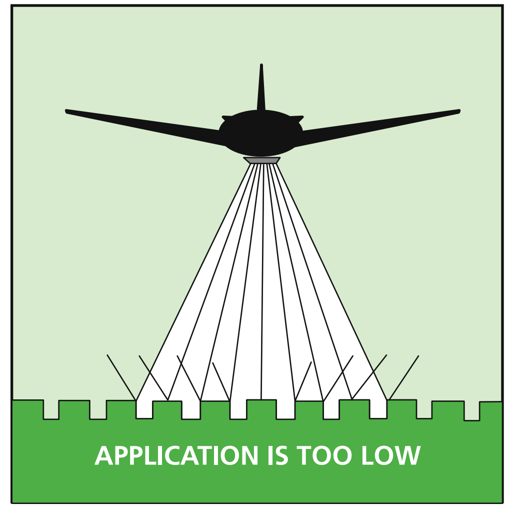
The Turnaround

When flying back and forth or racetrack swaths in a fixed-wing aircraft, be careful when executing turnarounds. This is because a pull up followed by a turn renders a low-speed, high-drag condition that could lead to a stall. Poorly executed turnarounds cause a considerable number of aerial application accidents. In addition, poorly executed turnarounds do not allow time for proper positioning for the next swath and may result in uneven applications.

When completing a swath run, pull up, clear any obstructions, and level off before starting a turnaround. After pull up, make a wide enough initial turn downwind that will provide sufficient room for a smooth turn around. Then level off for several seconds before completing the turn back into the treatment area. This provides ample time for the turn, prevents crowding the turn, and reduces the chance of a stall spin. Many factors affect the number of seconds needed in level flight before completing the turn, including swath spacing, speed and direction of the wind, air density, altitude, and the load weight, power, and maneuverability of the aircraft. Attentiveness to these factors and careful timing during this final stage of the turnaround are the keys to avoiding the hazards associated with fast or intricate maneuvering. Always complete the turnaround before dropping in over any obstructions on the next swath run approach.







Avoid snapping reversal or wing over turns. When making a turn by going upwind first requires more space and time to complete the turn. Any turning while dispensing a spray or granules distorts the distribution pattern resulting in uneven application of the pesticide. Whenever possible, avoid making turnarounds over residences and other buildings, penned poultry or livestock, livestock watering places, ponds, reservoirs, or other bodies of water. Avoiding these areas mitigates or minimizes nuisance from noise or sight of the aircraft.

Applying Granules

Airspeeds of 100 to 120 mph or faster (depending on the type of aircraft) for some fixed-wing aircraft, but slower for rotary-wing aircraft, are recommended when applying granules. These speeds maintain good airflow through the spreader and obtain proper distribution and maximum swath width.

Application Height

The maximum swath width at a certain height above the crop varies with the density, size, and grading of the granule particles. For most materials and aircraft, this is in the range of 45 to 70 feet. Effective height is determined by the lateral distance the spreader throws the heavier particles. Flying below this height allows particles to hit the ground while still traveling in the lateral direction. Flying above this height achieves no increase in swath width because particles fall vertically after the lateral energy dissipates. Do not fly any higher than necessary because this increases problems with swath displacement.

Maintain the flying height, airspeed, and correct ground track as constant as possible to obtain uniform results. Crosswinds have considerable effect on offsetting the dispersal pattern from the ground track centerline because of the higher-flying height required for granules. Head- or tailwinds affect ground speed, therefore, making adjustments in flow volume and/or airspeed can improve uniform distribution on alternating upwind-downwind passes. An onboard DGPS unit linked to a flow controller simplifies this process by providing automatic in-flight regulation of the dispersal system output as airspeed changes.

FACTORS INFLUENCING THE AIRCRAFT

Density altitude as well as local weather conditions and load weight can affect the stability and maneuverability of an aircraft during an application operation. Weather conditions such as wind can affect the stability and handling of the aircraft and contribute to uneven swaths and off-target pesticide drift.

ESTIMATING DENSITY ALTITUDE

The following is a fairly accurate and easy-to-remember general rule for determining the density altitude at locations above sea level:

- Standard temperature at sea level is 59°F. For elevations above sea level, subtract 3.5 degrees per thousand feet of elevation from the sea level temperature of 59°F.
- For each 10°F above standard temperature at any particular elevation, add 600 feet to the field elevation. For each 10°F below standard temperature, subtract 600 feet.

Here is an example. The elevation at the application site is 2,342 feet.

1. Divide the elevation by 1,000.

$$\frac{2{,}342}{1{,}000} = 2.342$$

2. Multiply 2.342 by 3.5.

$$2.342 \times 3.5 = 8.197$$

3. Subtract 8.197 from the sea level standard temperature of 59°F.

$$59 - 8.197 = 50.803$$

4. The standard temperature at the application site is 50.8°F. In this example, assume that the current temperature at the application site is 97°F. Subtract the standard temperature at the application site from this.

$$97 - 50.8 = 46.2$$

5. Divide this difference by 10 degrees (for each 10°F above standard).

$$\frac{46.2}{10} = 4.62$$

6. Multiply 4.62 by 600 (600 feet per 10 degrees).

$$4.62 \times 600 = 2{,}772$$

7. Add this correction factor of 2,772 feet to the field elevation of 2,342 feet at the application site.

$$2{,}772 + 2{,}342 = 5{,}114$$

The density altitude for the application site when the temperature is 97°F is 5,114 feet. This means that you should handle the aircraft at the application site as you would on a standard day at 5,114 feet elevation.

Humidity also affects available engine power and aircraft performance because higher humidity is an increase in water content of air, displacing oxygen that is vital for optimum engine internal combustion. For example, at 96°F, the water vapor content of the air can be as much as eight times greater than it is at 42°F. High humidity can reduce the available engine power needed for takeoff and climbs as well as maneuvers needed for pull-ups and turnarounds during applications.

Density Altitude

Density altitude is a condition where air molecules spread or thin out, becoming less dense, changing aircraft flight characteristics such as lift and maneuverability. In addition, thinner air means that less oxygen is available for optimum engine performance and this reduces horsepower unless the aircraft has a turbocharged engine. Factors that influence the density of air molecules include pressure (the effect of altitude) and temperature. The higher the altitude, the less dense air becomes because the air molecules are further apart, leaving fewer molecules to provide lift for the aircraft. Warmer air temperature also causes air molecules to move further apart, making the air less dense as well.

Density altitude, as well as high air temperatures, affects the stability and maneuverability of the aircraft for making applications, takeoffs, and landings. It also changes stall thresholds and influences the ability to perform maneuvers such as turns and rolls. The effects of density altitude can even appear in low altitude areas, such as near sea level, when the air temperature goes above standard (59°F). Takeoff distance, available engine horsepower, and climb rate are all adversely affected. For an aircraft loaded with spray material or granules, an increase in density altitude results in:

- Increased takeoff distance.
- Reduced rate of climb.
- Increased true airspeed on approach and landing.
- Increased landing roll distance.
- Limited service ceiling of the aircraft while en route.

Density altitude limits the performance capabilities of the aircraft, but is not a height reference and should not be confused with pressure altitude, indicated altitude, true altitude, or absolute altitude.

In high elevation areas, usually between mid-morning and mid-afternoon, high temperatures sometimes have such an effect on density altitude that normally safe aerial application operations become extremely hazardous. Very high temperatures at lower elevations can also affect aircraft performance, making it necessary to reduce the weight of the pesticide load for safer flight. During periods of high temperatures, it may be safer to make applications during early mornings, when temperatures generally are lower. However, early mornings are typical times for temperature inversion conditions in many areas.

OPERATION S.A.F.E.

(Self Regulating Application and Flight Efficiency)

One U.S. Department of Agriculture scientist characterized the growing public concern over possible effects of spray drift by stating: "Drift control is the key to survival of aerial application in agriculture."

In response to this concern, members of the National Agricultural Aviation Association (NAAA), the organization of professional aerial applicators and pilots, developed Operation S.A.F.E. The word S.A.F.E., important in any pilot's vocabulary, is an acronym for Self-Regulating Application and Flight Efficiency.

The intent of Operation S.A.F.E. is to clearly demonstrate that ag aviation recognizes its responsibility to minimize the potential for adverse health and environmental effects of agricultural chemical application. The program was approved by the NAAA Board of Directors in 1981.

Because the performance of one aerial applicator reflects on all others, participation in Operation S.A.F.E. is not limited to NAAA members. Any licensed operator or agricultural aviator is welcome to participate in Operation S.A.F.E. In order to qualify for the S.A.F.E. emblem, the participant must be a current member of the NAAA.

Operation S.A.F.E. is a comprehensive program of education, professional analysis of application, and commitment to the principles outlined by the NAAA Board of Directors. NAAA is convinced that full implementation of Operation S.A.F.E. offers substantial advantages to the operator, customers, and the producers of chemicals applied by air. These advantages are found in economy of operation and application, as well as in increased safety and reduced health and environmental concerns.

The backbone of Operation S.A.F.E. is the Professional Application Analysis Clinic—the Operation S.A.F.E. Fly-In. Professional application analysis clinics are a key part of Operation S.A.F.E. Participation in an NAAA-approved swath analysis equipment, under the direction of an authorized analyst, is essential to qualify for the Operation S.A.F.E. emblem. The emblem is affixed to an individual aircraft only when the aircraft, its pilot, and the operator have each met Operation S.A.F.E. guidelines.

Fly-ins have long been a popular activity among pilots. Their objectives traditionally range from getting together to swap experience and stories to socializing. However, among ag pilots, fly-ins have long been seen as a learning experience, an opportunity to improve their own performance and increase their professionalism.

The key to the effectiveness—and acceptance—of aerial application is the spray pattern of the aircraft itself and the dedication of operators to its accuracy. Swath study and analysis have been a part of aerial application since the first plane dusted an Ohio catalpa grove in 1921. Since that time, scientists from land grant universities and private corporations, and aerial applicators have been active in improving the state-of-the-art of aerial application. Chemical manufacturers have worked on chemical

(continued on next page)

Paul Newby—Bozeman, MT

formulations and additives to improve the pilot's ability to put the product on the target.

Today, equipment is available to provide the operator a precise picture of swath characteristics, and to provide it quickly. Thus, the Operation S.A.F.E. fly-in becomes a professional application analysis clinic. The Operation S.A.F.E. clinic gives the operator and pilot the opportunity to test equipment with a trained analyst to help interpret the information and to recommend changes to improve performance. A follow-up test is immediately available, so the operator can be certain improvement does exist.

NAAA expects all applicators to remain informed of and comply with all pertinent legal requirements. In addition, participating applicators agree to submit voluntarily to an inspection of their equipment and operating procedures to determine:

- Compliance with manufacturers' mixing rates, application recommendations, and label requirements of agricultural chemicals.
- Adequacy of safety procedures in storing and handling agricultural chemicals.
- Compliance with flight safety procedures.

The NAAA urges every operator and pilot to participate in an Operation S.A.F.E. clinic yearly. Check with your state ag aviation association to see when a clinic will be offered in the area. Display the Operation S.A.F.E. sticker and yearly decals on the aircraft with pride. Let customers know that you have taken advantage of this opportunity to check equipment and refresh your skills prior to taking on their job.

Review Questions

CHAPTER 6: MAKING AN AERIAL PESTICIDE APPLICATION

1. The last application flight of the day:

- **A.** Is more relaxed and requires less attention.
- **B.** Is not as important as other flights of the day.
- **C.** Requires the same attention as every other flight.
- **D.** Should be to the most challenging field of that day's operation.

2. Varying the application speed without changing flow volume during an application will:

- **A.** Provide a more even application.
- **B.** Accommodate for wind direction changes.
- **C.** Result in uneven coverage.
- **D.** Increase off-target drift potential.

3. The application pattern that helps to avoid flying through spray from a previous swath is the:

- **A.** Race track pattern.
- **B.** Back and forth pattern.
- **C.** Alternate swath pattern.
- **D.** Upslope pattern.

4. Ferrying flights must be made at an altitude of at least:

- **A.** 8 to 10 feet.
- **B.** 100 feet.
- **C.** 500 feet.
- **D.** 1500 feet.

5. Ferrying flights that pass over areas where people live or work should:

- **A.** Follow the same route in each direction for all trips.
- **B.** Be varied by 1/8 to 1/4 mile for each trip.
- **C.** Follow the same route each time to the field, but vary the route when returning to base.
- **D.** Follow a different route each time to the field, but use the same route for each return to base.

6. Breaks seen in the normal cultivation patterns of a field may alert the pilot to:

- **A.** Changes in soil type.
- **B.** Problems with field cultivation equipment.
- **C.** Hidden hazards.
- **D.** Changes in the needed application volume.

7. Too wide or too narrow overlapping of spray passes will result in:

- **A.** Flight hazards.
- **B.** Increased chances of off-target drift.
- **C.** Uneven application patterns.
- **D.** Disabling of the DGPS system.

8. To avoid the adverse effect of headwinds or tailwinds on an application volume, you should fly:

- **A.** Into the wind.
- **B.** Against the wind at all times.
- **C.** Back and forth, alternating between into the wind and against the wind.
- **D.** Crosswind or 45 degrees to the crosswind.

9. Which of the following would have little effect on the safety and effectiveness of an application if changes occur during the operation?

- **A.** Moving the operation to a different mixing-loading location.
- **B.** Wind intensity increases.
- **C.** Delaying the application until field workers leave the area.
- **D.** Leaving a buffer area adjacent to a sensitive area.

10. The problem with flying too low when making a granule application is that:

- **A.** Granules are still moving vertically at lower heights.
- **B.** Granules are still moving horizontally at lower heights.
- **C.** Even granule dispersal is affected by the ground effect at lower heights.
- **D.** Propwash has a greater effect on granules at lower heights.

REVIEW QUESTION ANSWERS ON PAGE 97

Review Question Answers

CHAPTER 1

1. B
2. D
3. B
4. A
5. D
6. A
7. C
8. A
9. B
10. C

CHAPTER 2

1. A
2. B
3. D
4. C
5. A
6. A
7. C
8. D
9. D
10. C

CHAPTER 3

1. C
2. B
3. C
4. A
5. C
6. D
7. B
8. C
9. D
10. C

CHAPTER 4

1. D
2. C
3. C
4. B
5. C
6. B
7. C
8. B
9. A
10. C

CHAPTER 5

1. C
2. C
3. B
4. B
5. A
6. C
7. B
8. C
9. C
10. B

CHAPTER 6

1. C
2. C
3. A
4. C
5. B
6. C
7. C
8. D
9. A
10. B

APPENDIX 1

PESTICIDE REGULATORY AGENCY CONTACT INFORMATION

Alabama
Plant Protection and Pesticide Management Section
Alabama Department of Agriculture and Industries
P.O. Box 3336
Montgomery, AL 36109-0336
(334) 240-7236

Alaska
Environmental Health
Alaska Department of Environmental Conservation
555 Cordova
Anchorage, AK 99501-2617
(907) 269-1099

Arizona
Environmental Services Division
Arizona Department of Agriculture
1688 West Adams Street
Phoenix, AZ 85007-2617
(602) 542-3575

Arkansas
Arkansas State Plant Board
P.O. Box 1069
Little Rock, AR 72203-1069
(501) 225-1598

California
California Department of Pesticide Regulation
1001 I Street
P.O. Box 4015
Sacramento, CA 95812-4015
(916) 445-4000

Canada
Pest Management Regulatory Agency
Health Canada
2720 Riverside Drive D765
Ottawa, ON K1A 0K9
Canada
(613) 736-3662

Colorado
Division of Plant Industry
Colorado Department of Agriculture
700 Kipling Street, Suite 4000
Lakewood, CO 80215-8000
(303) 239-4138

Connecticut
Waste Engineering and Enforcement Division
Department of Environmental Protection
79 Elm Street
Hartford, CT 06106-5127
(860) 424-3264

Delaware
Delaware Department of Agriculture
2320 South Dupont Highway
Dover, DE 19901-5515
(302) 698-4570

District of Columbia
Department of Health
Environmental Health Administration
Toxic Substance Division
Pesticide Program
51 N Street NE, 3rd Floor, Room 3003
Washington, DC 20002
(202) 535-2280

Florida
Department of Agricultural Environmental Services
Florida Department of Agriculture and
Consumer Services
3125 Conner Blvd - Suite F, Room 130 - C16
Tallahassee, FL 32399-1650
(850) 488-3731

Georgia
Plant Industry Division
Georgia Department of Agriculture
Capitol Square
Atlanta, GA 30334-4201
(404) 656-1265

Hawaii
Plant Industry Division
Hawaii Department of Agriculture
1428 South King Street
Honolulu, HI 96814-2512
(808) 973-9535

Idaho
Division of Agricultural Resources
Idaho Department of Agriculture
P.O. Box 790
Boise, ID 83701-0790
(208) 332-8531

Illinois
Bureau of Environmental Programs
Illinois Department of Agriculture
P.O. Box 19281
Springfield, IL 62794-9281
(217) 785-2427

Indiana
Indiana State Chemist Office
175 South University Street
Purdue University
West Lafayette, IN 47907-2063
(765) 494-1492

Iowa
Consumer Protection and Industry Services Division
Iowa Department of Agriculture and
Land Stewardship
Wallace Building, 502 East 9th Street
Des Moines, IA 50319-0051
(515) 281-8610

Kansas
Kansas Department of Agriculture
901 South Kansas Avenue
Topeka, KS 66612-1281
(785) 296-3556

Kentucky
Division of Consumer and Environmental Protection
Kentucky Department of Agriculture
107 Corporate Drive
Frankfort, KY 40601-1108
(502) 573-0282

Louisiana
Pesticide and Environmental Programs
Louisiana Department of Agriculture and Forestry
P.O. Box 3596
Baton Rouge, LA 70821-3596
(225) 925-3763

Maine
Board of Pesticides Control
Maine Department of Agriculture
28 State House Station
Augusta, ME 04333-0028
(207) 287-2731

Maryland
Office of Plant Industries and Pest Management
50 Harry S. Truman Parkway
Annapolis, MD 21401-7080
(410) 841-5870

Massachusetts
Division of Regulatory Services
Massachusetts Department of Agricultural Resources
251 Causeway Street, Suite 500
Boston, MA 02114-0009
(617) 626-1771

Michigan
Pesticide and Plant Pest Management Division
Michigan Department of Agriculture
P.O. Box 30017
Lansing, MI 48909-7517
(517) 373-4087

Minnesota
Pesticide and Fertilizer Management Division
Minnesota Department of Agriculture
625 Robert Street North
St. Paul, MN 55155-2538
(651) 201-6615

Mississippi
Bureau of Plant Industry
Mississippi Department of Agriculture and Commerce
P.O. Box 5207
Mississippi State, MS 39762-5207
(662) 325-8789

Missouri
Plant Industries Division
Missouri Department of Agriculture
P.O. Box 630
Jefferson City, MO 65102-0630
(573) 751-2462

Montana
Agricultural Sciences Division
Montana Department of Agriculture
P.O. Box 200201
Helena, MT 59620-0201
(406) 444-2944

Nebraska
Nebraska Department of Agriculture
Bureau of Plant Industry
301 Centennial Mall
P.O. Box 94756
Lincoln, NE 68509-4756
(402) 471-2394

Nevada
Division of Plant Industry
Nevada Department of Agriculture
350 Capital Hill Avenue
Reno, NV 89502-2923
(775) 688-1182

New Hampshire
Division of Pesticide Control
New Hampshire Department of Agriculture, Markets, and Food
P.O. Box 2042
Concord, NH 03302-2042
(603) 271-3640

New Jersey
Pesticide Control
Coastal and Land Use Enforcement
New Jersey Department of Environmental Protection
P.O. Box 411
Trenton, NJ 08625-0411
(609) 984-2011

New Mexico
Division of Agricultural and Environmental Services
New Mexico Department of Agriculture
P.O. Box 30005, Department 3AQ
Las Cruces, NM 88003-8005
(505) 646-2133

New York
Division of Solid and Hazardous Materials
New York State Department of Environmental Conservation
625 Broadway, 9th Floor
Albany, NY 122337250
(518) 402-8651

North Carolina
Structural Pest Control and Pesticides Division
North Carolina Department of Agriculture and Consumer Services
1090 Mail Service Center
Raleigh, NC 27699-1090
(919) 733-3556

North Dakota
Plant Industries
North Dakota Department of Agriculture
600 East Boulevard, 6th Floor
Bismarck, ND 58505-0020
(701) 328-4756

Ohio
Division of Plant Industry
Ohio Department of Agriculture
8995 East Main Street
Reynoldsburg, OH 43068-3399
(614) 728-6383

Oklahoma
Consumer Protection Services Division
Oklahoma Department of Agriculture, Food, and Forestry
P.O. Box 528804
Oklahoma City, OK 73152-8804
(405) 522-5879

Oregon
Pesticides Division
Oregon Department of Agriculture
635 Capitol Street, NE
Salem, OR 97301-2532
(503) 986-4635

Pennsylvania
Bureau of Plant Industry
Pennsylvania Department of Agriculture
2301 North Cameron Street
Harrisburg, PA 17110-9408
(717) 772-5217

Puerto Rico
Analysis and Registration of Agricultural Materials
Puerto Rico Department of Agriculture
P.O. Box 10163
Santurce, PR 00908-1163
(787) 796-1710

Rhode Island
Division of Agriculture and Resource Marketing
Rhode Island Department of Environmental Management
235 Promenade Street
Providence, RI 02908-5767
(401) 222-2782

South Carolina
Regulatory and Public Service Programs
Clemson University
109 B Barre Hall
Clemson, SC 29634
(864) 656-1234

South Dakota
Office of Agronomy
Division of Agricultural Services
South Dakota Department of Agriculture
Foss Building, 523 East Capitol
Pierre, SD 57501-3182
(605) 773-4432

Tennessee
Tennessee Department of Agriculture
Division of Regulatory Services
P.O. Box 40627, Melrose Station
Nashville, TN 37204-0627
(615) 837-5152

Texas
Texas Department of Agriculture
Pesticide Programs Division
P.O. Box 12847
Austin, TX 78711-2847
(512) 463-7504

Utah
Utah Department of Agriculture and Food
350 North Redwood Road
P.O. Box 146500
Salt Lake City, UT 84114-6500
(801) 538-7180

Vermont
Vermont Agency of Agriculture, Food, and Markets
116 State Street, Drawer 20
Montpelier, VT 05620-2901
(802) 828-2431

Virgin Islands
Division of Environmental Protection
Department of Planning and Natural Resources
Cyril E. King Airport
St. Thomas, VI 00802
(340) 774-3320

Virginia
Office of Pesticide Services
Virginia Department of Agriculture and Consumer Services
P.O. Box 1163, 102 Governor Street, Room 149
Richmond, VA 23218-1163
(804) 371-6561

Washington
Pesticide Management Division
Washington Department of Agriculture
P.O. Box 42589
Olympia, WA 98504-2589
(360) 902-2011

West Virginia
Regulatory and Environmental Affairs Division
West Virginia Department of Agriculture
1900 Kanawha Boulevard East
Charleston, WV 25305-0190
(304) 558-2208

Wisconsin
Agriculture Resource Management Division
Wisconsin Department of Agriculture
Trade and Consumer Protection
P.O. Box 8911
Madison, WI 53708-8911
(608) 224-4567

Wyoming
Technical Services
Wyoming Department of Agriculture
2219 Carey Avenue
Cheyenne, WY 82002-0100
(307) 777-6574

APPENDIX 2

FAA REQUIREMENTS FOR AGRICULTURAL AIRCRAFT OPERATORS

The FAA's approach for evaluating and determining your ability to comply with Part 137 and other applicable regulations focuses on three categories: the pilot, the aircraft, and the operation. You must successfully satisfy each of the following five phases in the evaluation process to become a certified agricultural aircraft operator:

- Pre-application.
- Formal application.
- Document compliance.
- Demonstration and inspection.
- Certification.

For complete and helpful information on the process to follow to obtain an FAA pilot certification for agricultural operations, refer to FAA Advisory Circular 137-1A—Certification Process for Agricultural Aircraft Operators. You may obtain this document and application forms from the local Flight Standards District Office (FSDO). For the nearest FSDO office, check the FAA listing in the United States Government section of the local telephone directory.

The Pre-Application Process

Pre-application involves an informal meeting to provide you with an overview of the certification process and identify the necessary resources helpful to you as you go through the certification process. If you are familiar with all of the requirements of the agricultural aircraft operation's certification process and the required documentation (e.g., if you have previous experience as an agricultural aircraft operator), you may not need a pre-application meeting.

During the meeting, an official from the FSDO will determine if you meet the eligibility requirements for obtaining an operator certificate by asking you about the following:

- Your area of operation.
- Location of your home base of operations.
- Location of probable satellite sites for your operation.
- Type of operation—private or commercial.
- Your experience with dispensing pesticides or other agricultural materials.
- Whether you are operating as an individual, a corporation, or a partnership.
- Your previous experience as an agricultural aircraft operator.
- Category and class of aircraft you are operating (rotary- or fixed-wing).
- Qualifications and experience of your chief supervisor.
- Applicability of parts 91 and 137 to the proposed type of work.
- Any previous or pending enforcement action pertaining to you, your management personnel, or chief supervisor.

Depending on the size and scope of your proposed operation, you may need to prepare a letter of intent as part of the required documentation for your application. When required, the letter of intent must include:

- The specific type of agricultural aircraft operator certificate for which you are applying (commercial or private).
- The legal company name of your company and any "doing business as…" names.
- Address of your home base of operations.
- Primary airport address, mailing address, and telephone numbers.

- Type of aircraft proposed for the operation.
- The estimated date when operations or services will begin.
- The names and addresses of all management personnel or chief supervisor.
- Names of three people you designate to provide certificate letters, in order of preference.
- A copy of the articles of incorporation if the operation is a corporation.

Formal Application

The next step is to fill out and submit three copies of FAA Form 8710-3—Agricultural Aircraft Operator Certificate Application, along with your Letter of Intent (if applicable) and other requested documents to the appropriate FAA Flight Standards District Office. You may obtain this form from the local FSDO or download it from the FAA web site (http://www.faa.gov) by typing in “FAA Form 8710-3” in the search box.

Document Compliance

A certification team assigned to you will review your application and associated documents within 30 business days of receiving it. They will notify you in writing whether the formal application is accepted or rejected. If the application is inaccurate, not completed properly, or does not include all the required documentation, the team returns the application to you with a letter outlining unsatisfactory items. You must correct these items before your certification process continues.

Demonstration and Inspection

This phase includes inspection of your facilities and aircraft. The team inspects your home base of operations for compliance with applicable operating procedures. The size and complexity of your operation determines the extent of the inspection required at your base. You must demonstrate to inspectors that you can conduct operations to the highest degree of safety.

You must provide for inspection at least one certificated and airworthy aircraft that is equipped for aerial agricultural work that you will use in your or your employer’s pest control operation. An Airworthiness Inspector verifies that the aircraft is properly certificated and airworthy, its inspection status is current, and it is safe for operation.

Inspectors look at five areas during this inspection:

- The commercial applicator record keeping system being used.
- Methods used for informing personnel of their duties and responsibilities.
- Aircraft condition and airworthiness.
- Facilities (if applicable).
- Your knowledge and skills.

If you work as a pilot-in-command for an agricultural operator, then the operator or a person designated by that operator determines your knowledge and skills. Once you successfully demonstrate that you have the necessary knowledge and skills, the operator provides you with an endorsement letter.

Application Record Keeping

You must show examples of a record keeping system you have in place for your aerial application operation. The law requires you to keep these operation records for at least 12 months or longer. Since record keeping requirements vary by state, check the requirements in the state where you are conducting business. These records should include the:

- Name and address of each person for whom agricultural aircraft services were provided.
- Date of the service.
- Name and quantity of the pesticides and other agricultural material dispensed for each operation conducted.
- Name, address, and certificate number of each pilot used in agricultural aircraft operations and the

date that pilot met the knowledge and skills requirements of 14 CFR § 137.19(e).

- Additional information depending on state requirements.

Informing Personnel of Their Duties and Responsibilities

You must provide inspectors with documentation that shows how you have informed each person employed in your agricultural aircraft operation of their duties and responsibilities for the operation. The EPA Worker Protection Standard mandate for documenting pesticide handler training in agricultural operations satisfies some of these requirements.

Aircraft

An Airworthiness Inspector inspects the aircraft, aircraft records, and dispensing equipment. The inspector verifies the following to determine the aircraft is safe to conduct the proposed operation:

- You have up-to-date and complete aircraft maintenance records.
- The aircraft complies with all applicable airworthiness directives.
- The aircraft meets certification and airworthiness requirements.
- The aircraft inspection is up-to-date.
- The aircraft has approved and properly labeled seat belts and shoulder harnesses installed for each pilot station.
- The aircraft is appropriately equipped for agricultural operations.
- If the aircraft is equipped to release the tank or hopper as a unit, it is equipped to prevent inadvertent release by the pilot or other crewmember.
- The aircraft is in a condition for safe operation.

Should questions arise concerning the load jettisoning capability of the aircraft used in congested-area operations, you must present jettisoning test data that show the aircraft is equipped with a device capable of jettisoning at least one-half of the aircraft's maximum authorized load of agricultural materials within 45 seconds. Jettisoning does not apply to rotary-wing aircraft.

Facilities

FAA regulations do not specify the type of facilities you must have as an agricultural operator. State and local regulations and, to some extent, EPA regulations address requirements for facilities. The FAA facilities inspection verifies that the practices and procedures at the base of operations conform to FAA regulations.

Knowledge Test

The Operations Inspector conducts a knowledge and skills test during initial certification. As required by § 137.19(e), you or your designated chief supervisor will be the testing candidate. This requirement applies to applicants who seek either a private or a commercial operating certificate.

The objective of the knowledge and skills test is to evaluate the pilots in an operation and to assure that they are qualified to act as pilot-in-command of an agricultural aircraft. A pilot who was previously qualified under part 137 may not have to take the knowledge and skills test if proper documentation is available.

The pilot must have adequate knowledge of the aircraft's operating limitations to be used under the applicable requirements contained in 14 CFR part 91, § 91.9. Weight and balance information receives special emphasis. Knowledge of the aircraft's performance capability is required and includes:

- Stall speeds at maximum certificated gross weight, straight ahead, power off, and flaps up.
- Best rate and best angle of climb speed.
- Maneuvering speeds.
- Density altitude and its effect on performance.

- Performance capabilities and operating limitations of the aircraft to be used.
- Takeoff distance required to clear a 50-foot obstacle at maximum certificated gross weight with zero wind.

In addition, you must demonstrate your knowledge of the following limitations and restrictions applicable to agricultural aircraft operations:

- Passenger carrying.
- Weight and balance.
- Operating without position lights.
- Dispensing in congested areas.
- Not observing standard airport traffic patterns.
- Altitude during ferrying to and from dispensing sites.

Before an applicator credential is awarded for dispensing pesticides, you must demonstrate a thorough knowledge of methods to protect a pilot against contamination and methods of safe pesticide use and handling. The knowledge test may be written or given orally, and consists of the following subject areas:

- Steps to take before starting operations, including surveying the area to be treated.
- Handling pesticides and proper disposal of used containers.
- Pesticide hazards and precautions when handling and applying pesticides.
- Recognizing symptoms of pesticide exposure, appropriate first aid, and how to contact a poison control center.
- Safe flight and application procedures.
- State-specific laws and regulations.

Skills Test

You perform the skills test with the aircraft's tanks or hoppers loaded, using a suitable inert material such as water, lime, or sand. The examiner evaluates your piloting skills and operational judgment in the following areas:

- Ground crew coordination and loading procedures.
- Engine start, warm-up, and taxi procedures.
- Fixed-wing aircraft short-field and soft-field takeoffs, directional control, liftoff, and climb.
- Approaches to the working area.
- Flareout.
- Swath runs.
- Pull ups and turnarounds.
- Clean-up swath or trim passes.
- Jettisoning of remainder of load after swath runs in the event of in-flight emergency.
- Rotary-wing aircraft rapid deceleration or quick stops.
- Approach, touchdown, and directional control on landing.
- Taxi, engine shutdown, and securing of aircraft.

Certification

The FAA awards you the Agricultural Aircraft Operator's Certificate after the FSDO certification team concludes that you meet the qualifications listed above and you demonstrated that you have the necessary knowledge and skills or have a knowledge and skills endorsement from the operator of the firm for whom you are working.

APPENDIX 3

HEAT STRESS

Heat stress occurs when the body is subjected to a level of heat with which it cannot cope. With heat stress, the heat, not pesticide exposure, causes certain symptoms. Wearing personal protective equipment—clothing and devices that protect the body from contact with pesticides—can increase the risk of heat stress by limiting the body's ability to cool down.

Avoiding Heat Stress

Several factors work together to cause heat stress. Before beginning a pesticide-handling task, think about whether any of the following conditions are likely to be a problem that might lead to heat stress:

- Heat factors—temperature, humidity, air movement, and sunlight.
- Workload—the amount of effort a task takes.
- Personal protective equipment (PPE).
- Drinking water intake.
- Scheduling.

Heat and Workload

High temperatures, high humidity, and sunlight increase the likelihood of heat stress, although air movement from wind or from fans may provide cooling. Because hard work causes the body to produce heat, a person is more likely to develop heat stress while working on foot than while driving a vehicle. Lifting or carrying heavy containers or equipment also increases the likelihood of overheating.

Signs and Symptoms of Heat Stress

Heat stress, even in mild forms, makes a person feel ill and impairs his or her ability to do a good job. They may get tired quickly, feel weak, be less alert, and be less able to use good judgment. Severe heat stress (heat stroke) is a serious illness. Unless you cool a heat stress victim quickly, he or she can die. Severe heat stress is fatal to more than 10 percent of its victims, even young, healthy adults. Victims may remain sensitive to heat for months and be unable to return to the same type of work.

Learn the signs and symptoms of heat stress and take immediate action to cool yourself or another person down if these symptoms appear. Signs and symptoms may include:

- Fatigue (exhaustion, muscle weakness).
- Headache, nausea, and chills.
- Dizziness and fainting.
- Loss of coordination.
- Severe thirst and dry mouth.
- Altered behavior (confusion, slurred speech, quarrelsome or irrational attitude).

Heat cramps are another type of heat stress. These are painful muscle spasms in the legs, arms, or stomach caused by loss of body salts through heavy sweating. To relieve cramps, drink cool water. Stretching or kneading the muscles may temporarily relieve the cramps. If there is a chance that stomach cramps are pesticide-related rather than caused from salt loss, get medical help right away.

First Aid for Heat Stress

It is not always easy to tell the difference between heat stress illness and pesticide poisoning because many signs and symptoms are similar. Get medical help right away rather than wasting time trying to decide what is causing the illness. First aid for heat stress includes:

- Get the victim into a shaded or cool area.

- Cool the victim as rapidly as possible by sponging or splashing the skin, especially around the face, neck, hands, and forearms, with cool water or, when possible, immersing in cool water.
- Carefully remove all PPE and any other clothing that may be making the victim hot.
- If conscious, have the victim drink as much cool water as possible.
- Keep the victim quiet until help arrives.

Severe heat stress (heat stroke) is a medical emergency. Unless you cool the victim immediately, brain damage and death may result.

APPENDIX 4

STEPS TO FOLLOW IN CLEANING UP A PESTICIDE SPILL

The following steps should be taken whenever a pesticide spill takes place. For large spills, contact local authorities for assistance in management, prevention of injuries, and protection of the environment.

- Refer to the pesticide label to determine the PPE required for cleaning up a spill.
- Clear the area and keep unprotected people from coming near the spill.
- Administer first aid and obtain medical care for anyone who received, or possibly received, a pesticide exposure.
- Prevent fires by extinguishing sources of ignition and providing adequate ventilation.
- Control the release. Use any strtegy available to stop the flow of the spill.
- Contain the release. Use sand or other absorbent to keep the pesticide confined. Patch the leaking container or transfer its contents to a sound container.
- Clean up the spilled pesticide and absorbent and any contaminated objects. Place these materials into a sealable and suitable holding container.
- Clearly label containers holding spilled pesticide and contaminated soil and other objects. Include the pesticide name, signal word, and name of responsible party.
- Manage the contaminated area. Consult the product label and Material Safety Data Sheet (MSDS) for the particular product. Consult with the state regulatory agency on how to properly manage the release and how to properly dispose of recovered product and other items such as contaminated soil and absorbents.

APPENDIX 5

GLOBAL POSITIONING SYSTEMS

A global positioning system (GPS) provides one of the most accurate meth-ods of navigation for aerial pesticide applications. A receiver installed in the aircraft picks up satellite signals that let you know the speed of the aircraft, direction of travel, and its altitude and location. Because of the usefulness of this information, GPS equipment, in most cases, is an essential tool for precision aerial application. Recent studies indicate that at least 92 percent of agricultural pilots in the U.S. use GPS equipment.

A GPS receiver uses satellite-transmitted data to calculate its own current location. In order to find its exact location, the receiver must simultaneously detect identification signals from four different GPS satellites. The time it takes signals to travel from three of the GPS satellites form the basis for the calculations performed by the GPS receiver to determine its three-dimensional spatial location. Signals from the fourth satellite verify time signals from the three other satellites.

The U.S. Department of Defense created the Global Positioning System program in 1973. The original intent of this program was to provide a satellite-based navigational system for military purposes. Although various aspects of GPS technology are now readily accessible to the public, the U.S. Department of Defense continues to fund and manage the GPS program.

The Global Positioning System can rapidly reference any specific location on Earth. Functionally, the GPS system consists of three major components or segments:

- Space Segment—a constellation of 24 Earth-orbiting satellites.
- Control Segment—five Earth-based satellite monitoring stations.
- User Segment—individual GPS signal receivers owned and operated by users.

Space Segment

The Department of Defense began launching Earth-orbiting GPS satellites in February 1989 and completed this task in June 1993 with 24 satellites in orbit. Each satellite completes one orbit around the Earth every 12 hours, remaining in one of six orbital paths. Relative to the Earth's surface, the six orbital paths are equidistantly spaced at 60-degree intervals and each orbital path is inclined approximately 55 degrees relative to the Earth's equatorial plane. This satellite arrangement enables a GPS user to access between five and eight satellites at any one time.

Control Segment

The control segment consists of five Earth-based tracking stations. Stations are located in Hawaii, on Ascension Island in the middle of the South Atlantic Ocean, on the island of Diego Garcia in the middle of the Indian Ocean, on Kwajalein Atoll (2,100 miles southwest of Hawaii and 1,400 miles east of Guam) in the Pacific Ocean, and in Colorado Springs, Colorado.

The Colorado Springs location is the master station. All the tracking stations monitor the satellites and determine precise orbit location data. The Colorado Springs master station sends corrections for orbital location and clock data to all satellites in the system. This information enables a satellite to send an up-to-date subset of satellite location and time data to a user's GPS receiver.

User Segment

The user segment is the worldwide total of all GPS receivers currently in service. This includes government, military, and civilian users. Seagoing vessels, trains, trucks, mass transit busses, cars, farm equipment, motorcycles, commercial airliners, general aviation aircraft, and agricultural aircraft use GPS signals for navigation. In addition, GPS units provide useful data for many purposes other than navigation, such as:

- A universal and instantly available global time reference having atomic clock accuracy.
- A basis for precision map construction.
- A way to precisely measure movements of geological formations.
- The ability to track all of the individual vehicles within an entire fleet, such as with taxicabs or fire trucks.
- The guidance needed for an aircraft to execute an accurate and safe landing under local zero visibility conditions.
- The ability to provide aircraft speed and location in real time for agricultural aircraft to automatically and continuously regulate spray output as a function of the actual travel speed and position of the aircraft.

Differential GPS

Each GPS satellite broadcasts signals over two microwave frequency channels. One channel carries a strong signal that only the military uses. The signal of the second channel, known as the coarse acquisition (C/A) signal, is less robust. This signal is available for nonmilitary GPS use, although calculations based on it do not provide pinpoint precision of the GPS receiver location. C/A signals typically provide location precision in a range of ± 100 feet horizontal accuracy. This level of precision is not accurate enough for aerial pesticide application.

To improve accuracy of the C/A signal, a technology known as Differential GPS (DGPS) provides greater precision. DGPS technology with a strong differential correction signal reduces the horizontal error range down to between less than three feet and rarely more than ten feet. Aerial applicators use DGPS systems.

Regular GPS relies on a single receiver, but DGPS technology requires two. One receiver remains fixed at an accurately surveyed location, and serves as a reference point. Aircraft have the second receivers installed in them. Both of these receivers detect the same C/A-signals from orbiting satellites, but the stationary receiver transmits data to refine the mobile receiver's positioning information. Although the stationary receiver cannot determine which particular GPS satellites a mobile receiver uses, it detects all accessible satellites, computes the timing signal correction factor for each, and transmits the correction data to the aircraft's mobile receiver, which sorts out the satellite data.

DGPS providers transmit the correction signals from stationary GPS receivers to mobile receivers over a wide-range communication network. Two transmission methods predominate:

- FM radio tower beacon (e.g., U.S. Coast Guard Differential GPS Navigation Service; Nationwide Differential GPS Service).
- Communication satellite relay (e.g., Wide Area Augmentation System (WAAS) and various commercial DGPS services).

Wide Area Augmentation System

Because GPS alone did not meet navigation requirements of the Federal Aviation Administration for accuracy, integrity, and availability, the FAA and the Department of Transportation (DOT) developed the Wide Area Augmentation System (WAAS) for use in precision flight approaches. WAAS corrects for GPS signal errors caused by ionospheric disturbances, timing, and satellite orbit errors, and it provides vital integrity information regarding the status of each GPS satellite.

WAAS consists of approximately 25 ground reference stations positioned across the United States, covering a very large service area. These stations link together and form the U.S. WAAS network. Two master stations, one located on the East Coast and the other on the West Coast, collect data from the reference stations and create a correction message that they transmit to a geostationary communication satellite (GEO). The satellite broadcasts the message on the same GPS frequency to receivers onboard aircraft that are within the broadcast coverage area of the WAAS.

The WAAS improves basic GPS accuracy to approximately 28 feet vertically and horizontally, improves the availability of the signals using geostationary communication satellites, and provides necessary integrity information about the entire GPS system.

For some users in the U.S., the position of the geostationary satellites over the equator makes it difficult to receive their signals if trees or mountains obstruct the view of the southern horizon. WAAS signal reception is ideal for open land areas and for marine applications.

U.S. Coast Guard Maritime Differential GPS Navigation Service

The U.S. Coast Guard provides a Maritime DGPS service for the Harbor and Harbor Approach phase of marine navigation. The Maritime DGPS service coverage area includes the coastal United States, Great Lakes, Puerto Rico, and most of Alaska and Hawaii. It consists of two DGPS control centers and about 65 DGPS reference stations. The reference stations transmit correction signals on U.S. Coast Guard radio beacon frequencies, and this service is available to the public.

Many GPS receivers are equipped with built-in radio receivers that accept and process GPS-satellite correction signal data. The position accuracy of the Maritime DGPS Service is within approximately 33 feet. If an aircraft is equipped with suitable DGPS receiving equipment, and is less than 100 miles from a reference station, its pilot may typically expect positioning accuracy of about 2.5 feet. For aircraft operating more than 100 miles away from the Maritime DGPS reference station, positioning accuracy decays at a rate of approximately 3 feet per 90 miles. Because of this distance-related decay in accuracy, you should obtain GPS satellite signal corrections from the closest Maritime DGPS reference station for the most accurate positioning data. The Nationwide DGPS program is incorporating the Maritime DGPS program into its system.

Nationwide DGPS Service

A 1997 federal law directed the U.S. Department of Transportation to work with several other government entities to develop and operate a standardized Nationwide DGPS Service. The goal of this service is to provide reliable local-area GPS-satellite signal correction data to the public without charge. This program involves the U.S. Air Force, U.S. Coast Guard, U.S. Army Corps of Engineers, the National Oceanic and Atmospheric Administration, the Federal Highway Administration, and the Federal Railroad Administration. When completed, the Nationwide DGPS Service expects to have approximately 80 DGPS radio beacon sites in place throughout the continental United States. The plan will provide every area in the continental United States with double coverage DGPS correction data from two land-based radio beacon towers. The program will ultimately include all U.S. Coast Guard-operated DGPS reference stations. Each Nationwide DGPS System radio beacon site has a 300-foot tower antenna that substantially increases the effective range available for mobile DGPS user reception. The signal from each site covers a range of 250 miles with enough signal strength to provide positional accuracy of about 3 feet or less.

Commercial DGPS Services

Commercial DGPS services provide additional options for pilots making aerial applications in remote locations. These services fill in areas missed by the government systems. Most mobile DGPS equipment is compatible with the commercial DGPS services. Subscribing to one of these services provides pilots with a high degree of location accuracy suitable for precise aerial pesticide application.

GLOSSARY

adjuvant. A material added to a pesticide mixture to improve or alter the deposition, toxic effects, mixing ability, persistence, or other qualities of the active ingredient.

agitation device (agitator). A mechanical or hydraulic device that stirs the liquid in a spray tank to prevent the mixture from separating or settling.

agricultural aircraft operations. The Federal Aviation Administration Regulation Part 137 of the Code of Federal Regulations Title 14 (14 CFR 137) prescribes rules governing agricultural aircraft operations within the United States and the requirements for commercial and private Agricultural Aircraft Operator certificates for those operations.

agricultural aircraft operator certificate. Certificate issued by the Federal Aviation Administration under provision of 14 CFR 137 to pilots who meet specific requirements as provided in Part 137.

anti-drip device. A spring-loaded mechanism built into an aircraft spray nozzle that closes off the nozzle when the fluid pressure drops below a certain level. This prevents nozzles from dripping when the spray is shut off.

application pattern. The course the pilot follows above the area being treated with a pesticide. *See also* **back and forth application pattern** and **racetrack application pattern**.

application swath. *See* **swath** and **swath width**.

area of a circle.
Area = 3.14 × radius × radius ($A = \pi r^2$)

area of a square or rectangle.
Area = length × width

area of a triangle.
Area = base × height divided by 2

back and forth application pattern. Also known as a back and forth flight pattern. Making application swaths in a sequential manner by flying a swath in one direction and the adjacent swath in the opposite direction.

baffle. A structure built into an aircraft-mounted spray tank that suppresses the sloshing of liquid in the tank, reducing the effect of load shift on the aircraft.

boom. A structure attached to an aircraft to which spray nozzles are attached.

buffer area (or zone). A part of a pest-infested area that is not treated with a pesticide to protect adjoining areas from pesticide hazards.

buffer strip. An area of a field left unsprayed for protecting nearby structures or sensitive areas from drift. The minimum buffer strip is usually one swath width.

carrier. The liquid or powdered inert substance that is combined with the active ingredient in a pesticide formulation. May also apply to the water, oil, or other substance that a pesticide is mixed with prior to application.

Code of Federal Regulations (CFR). Regulations used to enforce federal laws. The CFR contain sections that address aerial application of pesticides as well as training and certification of pesticide handlers.

co-distillation. A phenomenon where pesticide molecules are picked up in water vapor and can move off site.

Commercial Agricultural Aircraft Operator. A category of the FAA certification process applying to pilots for hire who make pesticide applications by air.

commercial applicator. A person who, for hire, uses or supervises the use of a restricted-use pesticide and this definition varies among states.

conflict with labeling. Any deviation from instructions, requirements, or prohibitions of pesticide product labeling concerning storage, handling, or use, except: a decrease in dosage rate per unit treated; a decrease in the concentration of the mixture applied; application at a frequency less than specified; use to control a target pest not listed, provided the application is to a commodity/site that is listed and the use of the product against an unnamed pest is not expressly prohibited; employing a method of application not expressly prohibited, provided other directions are followed; mixing with another pesticide or with a fertilizer, unless such mixing is expressly prohibited; and an increase in the concentration of the mixture applied.

congested area. A populated area where personal injury or property damage might occur if an aircraft crashes or if the pesticide load must be dumped.

conventional application volume. For aircraft, the conventional application volume ranges between 5 to 15 or more gallons of spray per acre.

corrosive materials. Certain chemicals that react with metals or other materials. Some pesticides are corrosive, and special handling requirements are needed when using these.

coverage. The degree to which a pesticide is distributed over a target surface.

decontaminate. The most important step in reducing potential injury when someone has been exposed to a pesticide. Decontamination involves thoroughly washing the exposed skin with soap and water or flushing the exposed eye with a gentle stream of running water.

dehydration. The process of a plant or animal losing water or drying up. Dehydration is a major contributor to heat related illnesses in people.

density altitude. A condition where air molecules spread out or become less dense as altitude increases and/or as temperatures rise. Density altitude has an effect on the operational performance of an aircraft.

differential GPS (DGPS). A global positioning navigation system that relies on a mobile receiver mounted in an aircraft and a fixed ground-based receiver, providing a higher degree of positional accuracy than a mobile receiver used alone.

directions for use. The instructions found on pesticide labels indicating the proper procedures for mixing and application.

drift (spray). *(from National Coalition on Drift Minimization)* "The movement of pesticide through the air at the time of pesticide application or soon thereafter from the target site to any non- or off-target site, excluding pesticide movements by erosion, migration, volatility, or windblown soil particles after application."

driftable fine. Spray droplets that are 200 microns in diameter or smaller.

droplet spectra. A classification of spray droplets into eight categories based on the volume median diameters of spray droplets. The eight categories are extra fine, very fine, fine, medium, coarse, very coarse, extra coarse, and ultra coarse.

dynamic surface tension. Variation or changes in the surface tension of a liquid based on the position of molecules of substances within droplets that alter surface tension.

economic poison. (1) Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any insects, rodents, nematodes, fungi, weeds, and other forms of plant or animal life or viruses, except viruses on or in people or other animals, which the Secretary of Agriculture shall declare to be a pest, and (2) any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.

effective swath width. A swath that includes overlaps made with each pass to achieve a more even application.

environmental contamination. Spread of pesticides away from the application site into the environment, usually with the potential for causing harm to organisms.

evaporate. The process of a liquid turning into a gas or vapor.

exposure. The unwanted contact with pesticides or pesticide residues by people, other organisms, or the environment.

extensional viscosity. The amount of stretching or stringiness required for a droplet to break off from a stream or flow of liquid.

Federal Aviation Administration (FAA). The federal agency responsible for enforcing rules affecting aircraft operations.

ferrying. The process of flying an aircraft from its home base to a pesticide application site and returning to its home base or location where the material loading takes place.

field worker. Any person who, for any kind of compensation, performs cultural activities in a field. A field worker does not include individuals performing tasks as a crop advisor, including field checking or scouting, making observations of the well being of the plants, or taking samples, nor does it include local, state, or federal officials performing inspection, sampling, or other similar official duties.

filter screen. Fine screens placed in key locations in a spraying system to catch foreign materials that would otherwise clog the spray nozzles.

fine. A spray droplet that is 200 microns in diameter or smaller.

first aid. The immediate assistance provided to someone who has received an exposure to a pesticide. First aid for pesticide exposure usually involves removal of contaminated clothing and washing the affected area of the body to remove as much of the pesticide material as possible. First aid is not a substitute for competent medical treatment.

flow rate. The amount of pesticide being expelled by a pesticide spray or granule applicator per unit of time.

general-use pesticide. Pesticides that have been designed for use by the general public as well as by licensed or certified applicators. General-use pesticides usually have minimal hazards and do not require a permit for purchase or use.

geostationary communication satellite. A satellite whose orbit speed exactly matches the rotation of the earth, and thus remains stationary in relation to the earth; used for communication and global positioning.

global positioning system. A navigational device that uses signals from satellites to determine the receiver's position.

granule. A dry formulation of pesticide active ingredient and inert materials compressed into small, pebble-like shapes.

handle. Mixing, loading, transferring, applying (including chemigation), or assisting with the application (including flagging) of pesticides; maintaining, servicing, repairing, cleaning, or handling equipment used in these activities that may contain residues; working with opened (including emptied but not rinsed) containers of pesticides; adjusting, repairing, or removing treatment site coverings; incorporating (mechanical or watered-in) pesticides into the soil; entering a treated area during any application or before the inhalation exposure level listed on pesticide product labeling has been reached or greenhouse ventilation criteria have been met; performing the duties of a crop advisor, including field checking or scouting, making observations of the well being of the plants, or taking samples during an application or any restricted entry interval listed on pesticide product labeling. Handle does not include local, state, or federal officials performing inspection, sampling, or other similar official duties.

handler. A person involved with mixing, loading, transferring, applying (including chemigation), or assisting with the application (including flagging) of pesticides; maintaining, servicing, repairing, cleaning, or handling equipment used in these activities that may contain residues; working with opened (including emptied but not rinsed) containers of pesticides; adjusting, repairing, or removing treatment site coverings; incorporating (mechanical or watered-in) pesticides into the soil; entering a treated area during any application or before the inhalation exposure level listed on pesticide product labeling has been reached or greenhouse ventilation criteria have been met; and performing the duties of a crop advisor, including field checking or scouting, making observations of the well being of the plants, or taking samples during an application or any restricted entry interval listed on pesticide product labeling. The handler definition does not include local, state, or federal officials performing inspection, sampling, or other similar official duties.

heat-related illness. Potentially life-threatening overheating of the body under working conditions that lack proper preventive measures, such as drinking plenty of water, taking frequent breaks in the shade to cool down, and removing or loosening personal protective equipment during breaks.

human flagger. An individual who assists in an aerial application by positioning and waving marking flags to indicate to the pilot the location of swaths. Flaggers must receive pesticide handler training.

intentional misapplication. The deliberate improper use of a pesticide, such as exceeding the label rate or applying the material to a site not listed on the label.

inversion. A weather phenomenon in which cool air near the ground is trapped by a layer of warmer air above. Vapors of pesticides applied during an inversion can become trapped and concentrated and move away from the treatment area with the potential to cause damage or injury at some other location.

labeling. The pesticide product label and all other written, printed, or graphic matter accompanying the pesticide. Labeling may not necessarily be attached to or part of the container.

light bar. An accessory to the aircraft mounted global position system that enables the pilot to locate the center of each spray swath through the use of an array of lights.

low volume (LV) application volume. Application of liquid pesticides at the rate of 0.5 to 5 gallons of liquid per acre.

Material Safety Data Sheet (MSDS). An information sheet provided by a pesticide manufacturer describing chemical qualities, hazards, safety precautions, and emergency procedures to be followed in case of a spill, fire, or other emergency.

mesh. The number of wires per inch in a screen, such as a screen used to filter foreign particles out of spray solutions to keep nozzles from becoming clogged. Mesh is also used to describe the size of pesticide granules, pellets, and dusts.

micron. A very small unit of measure: $^1/_{1,000,000}$ of a meter; represented by the greek symbol μ.

MSDS. *See* **material safety data sheet**.

non-target organism. Animals or plants within a pesticide-treated area that are not intended to be controlled by the pesticide application.

off-target pesticide drift. Pesticide drift that moves outside of the application area during or immediately following a pesticide application.

off-target pesticide movement. Any movement of a pesticide from the location where it was applied. Off-target movement occurs through drift, volatilization, percolation, water runoff, crop harvest, blowing dust, and by being carried away on organisms or equipment.

output volume. The amount of a pesticide mixture discharged by an aircraft over a measure period of time. The usual output volume for aircraft liquid sprayers is measure in gallons per minute or gallons per mile.

pattern testing. The process used to determine the spray swath or granule swath pattern by flying test passes and visualizing the droplet array or granule distribution across the swath.

personal protective equipment (PPE). Apparel and devices worn to minimize human body contact with pesticides or pesticide residues. PPE must be provided by an employer and is separate from, or in addition to, work clothing. PPE may include chemical resistant suits, chemical resistant gloves, chemical resistant footwear, respiratory protection devices, chemical resistant aprons, chemical resistant headgear, protective eye wear, or a coverall (one- or two-piece garment).

pesticide drift. Any movement of pesticide material from its intended swath during application. Movement of pesticide material becomes problematic when it moves from the application site.

pesticide handler. *See* **handler**.

phytotoxic. Injurious to plants.

pilot-in-command. The Journeymen Pest Control Aircraft Pilot supervising or conducting a pesticide application.

precautionary statement. The section on pesticide labels where human and environmental hazards are listed; personal protective equipment requirements are listed here as well as first aid instructions and information for physicians.

private agricultural aircraft operator. A category of the FAA certification process applying to pilots who make pesticide applications by air on their own property or property of which they control.

private applicator. An individual who uses or supervises the use of a pesticide for the purpose of producing an agricultural commodity on property owned, leased, or rented by him or her or his or her employer.

prop wash. The displacement of air and spray droplets caused by the propeller of the aircraft. The spray pattern is displaced to the left of the centerline of the aircraft.

racetrack application pattern. The application pattern that involves making successive overlapping loops across a field rather than a back and forth pattern.

regulations. The guidelines or working rules that a regulatory agency uses to carry out and enforce laws.

residual effectiveness. The pesticidal action of material after it has been applied. Most pesticide compounds will remain active several hours to several weeks or even months after being applied.

restricted-entry interval (REI). The period of time after a field is treated with a pesticide during which restrictions on entry are in effect to protect people from potential exposure to hazardous levels of residues.

restricted-use pesticide. Highly hazardous pesticides that can only be possessed or used by certified commercial or private applicators.

rotor distortion. Similar to prop wash of a fixed wing aircraft, but involving the displacement of air and entrapped spray droplets as a result of the rotation of the rotary wing aircraft rotor.

service container. Any container designed to hold concentrate or diluted pesticide mixtures, including the sprayer tank, but not the original pesticide container.

shear viscosity. The resistance of a liquid to flow.

smoke generator. A device mounted on an aircraft that produces smoke by injecting oil into the exhaust system. This smoke trail is used by the pilot to visualize air movement.

statement of practical treatment. A section of the pesticide label that provides information on treating people who have been exposed to the pesticide. This includes emergency first aid information.

supplemental label. Additional instructions and information not found on the pesticide label because the label is too small but legally considered to be part of the pesticide labeling.

swath (or swath width). The area covered by one pass of the pesticide application equipment.

temperature inversion. *See* **inversion**.

ultra low volume (ULV) application volume. Applications of less than 0.5 gallons of spray per acre.

volume median diameter (VMD). Half of the total spray volume of a nozzle consists of spray droplets that are smaller than the VMD numerical value, while the other half is made up of droplets that are larger than the VMD numerical value.

wide area augmentation system (WAAS). A highly accurate GPS navigational system used for precision flight positional determination.

wing tip vortex. The circular or spiral swirling of air caused by the wing tips of an aircraft, and resulting in entrapment of spray droplets affecting the dispersal pattern. Keeping the fixed wing aircraft boom length at approximately 75 percentage of the wingspan eliminates spray droplets becoming entrapped.

Worker Protection Standard. The 1992 amendment to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) that makes significant changes to pesticide labeling and mandates specific training of pesticide handlers and workers in production agriculture, commercial greenhouses and nurseries, and forests.

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ILLINOIS
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Securing Pesticides for Transportation

We are approaching the time of the year when we will start to see more farmers and commercial applicators on the roadways getting fields ready for planting with spray rigs, anhydrous tanks, fertilizer wagons, and such. It is no doubt one of my most favorite seasons as we have left the dull, grey, brown, gloomy months of winter for trees leafing out, grass greening up, flowers blooming, and all these barren fields once again filled with new crops!

As a driver I am reminded of the caution I must use by slowing down and giving applicators the space they need on the road. However, those hauling also need to be mindful of the hazards of moving pesticides. As with the application of pesticides, it is also the end user's responsibility to make sure that the pesticide load is properly and safely secured, even if that end user did not load the pesticides themselves.

There are state and federal protocols in place that allow for the transportation of these materials to be done so that there is minimal risk to all. I have created a list of things that applicators/operators should consider when hauling pesticides.

Loads can become a hazard on the road if not properly secured.

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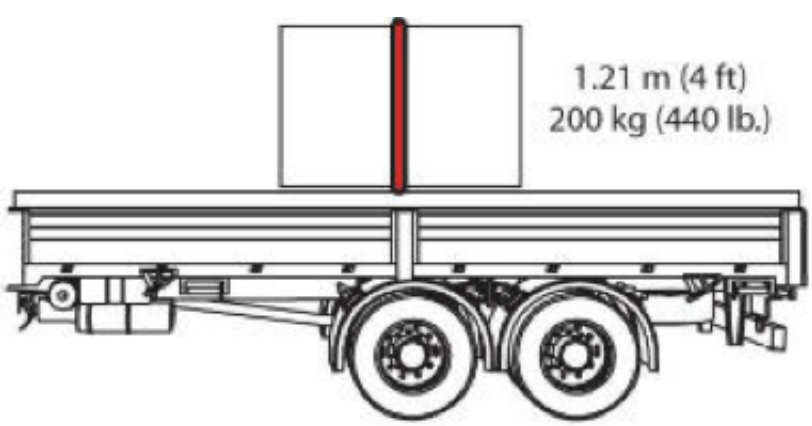
Top 10 Things to Do When Hauling Pesticides

1. Make sure all vehicles and trailers are in good working order. This includes clean and clear lights, windows, and mirrors. Hitches, chains, straps, and pins should be in working order.
2. Never put pesticides inside a cab or vehicle. Make sure they are transported in the bed of a truck, trailer or trunk, but never in a passenger area. Chemicals spilled or fumes inhaled can lead to illness or death.
3. Keep pesticides in original containers. These containers already meet the US DOT regulations and therefore will keep you within compliance when hauling them to your field. Make sure that containers are not leaking or torn. If applicable, make sure that dry pesticides are transported above wet products. That way there is not a risk of cross-contamination should there be a leak.
4. A tie-down is required for loads 5 ft or shorter or less than 1,100 lbs. According to the Federal Motor Carrier Safety Administration you must have a minimum of one tie-down for this load size. Larger loads require more tie-downs. Be sure to check the working load limit (WLL) determined by the manufacturer. This is the maximum load in pounds in which new and used tie-downs in good condition should be applied. Tie-down straps should not have tears greater than 3/8 inch if the strap is less than 2 inches. Chains also need to be checked for any change of shape or cuts, as those render the chain ineffective and it needs to be replaced.
5. Drivers transporting pesticides for commercial use or across state lines are required to follow the Illinois Department of Transportation regulations regarding driver's licenses, placarding, shipping papers, inspections, and fees. Please refer to http://www.idot.illinois.gov or the Illinois Farm Bureau publication on motor vehicle rules for farmers http://www.ilfb.org/media/2800883/-otr-booklet-2017-01.pdf



6. Drive carefully and defensively. Do not let more than three cars pile up behind your rig. Pull over and let them pass. Be sure that a "Slow Moving" sign is displayed on the back of the vehicle/trailer/equipment. Travel during the day and not near dusk or dawn.
7. Stay off heavily travelled roads if at all possible or drive when roads are least travelled.
8. Carry copies of product labels and safety data sheets for each product. These provide information about active ingredients; how to use the product, including personal protective equipment; human, environmental and other hazards; first aid; storage and disposal; information for emergency personnel in case of a spill; and emergency numbers.
9. Haul pesticides in moderate temperatures. If hauling in extreme high or low temperatures there is a risk of the chemical formulations being altered and becoming less stable.
10. Pack an emergency spill kit. Include an absorbent spill pad, litter, broom or brush, dustpan or shovel, plastic bag, and personal protective equipment.

Rules and regulations do change and are complex. It is best to call and ask questions when changing how you transport or secure your load. Be sure to check out resources available at IDOT and the Federal Carrier Motor Safety Administration website. It is important that you stay informed.

The following references can help:

http://www.idot.illinois.gov

https://ppp.purdue.edu/wp-content/uploads/2016/08/PPP-75.pdf

http://pest.ca.uky.edu/PSEP/pdfs/7transportation.pdf

https://www.law.cornell.edu/cfr/text/49/173.5

https://www.fmcsa.dot.gov/regulations/cargo-securement/drivers-handbook-cargo-securement-chapter-2-general-cargo-securement

https://oeh.cals.cornell.edu/sites/oeh.cals.cornell.edu/files/shared/documents/pesticides/transporting%20pesticides%20guide.pdf

https://extension.psu.edu/transporting-pesticides-in-pennsylvania

Maria Turner

WPS Pesticide Safety Training Requirements: Illinois

The Worker Protection Standard (WPS) is a regulation intended to reduce the risks of illness or injury resulting from occupational exposures to pesticides used in the production of agricultural plants.

WPS requires agricultural employers and commercial pesticide handler employers to provide specific information and protections to workers, handlers, and other persons when WPS-labeled pesticide products are used on agricultural establishments in the production of agricultural plants.

In 2015, the USEPA announced a major revision to the WPS. As of January 2, 2018, almost all new requirements within the 2015 Revised Worker Protection Standard are in full enforcement. The only exception is the expansion of worker training topics to 23 items, and handler training expanded to 36 items. The expanded training topics requirement will not become effective until 6 months after a Federal Register Notice announcing the availability of training materials.

Do you need to provide pesticide safety training to your employees?

Not all pesticide operations fall under the WPS. If you are unsure, use The Worker Protection Standard: Does It Apply To You? tool produced by the Pesticide Educational Resources Collaborative (PERC): http://pesticideresources.org/wps/doesitapply.html, or review the How to Comply With the 2015 Revised Worker Protection Standard For Agricultural Pesticides Manual: http://pesticideresources.org/wps/htc/htcmanual.pdf

WPS pesticide safety training frequency and exemptions

If WPS applies to your operation, you must provide training prior to a worker entering a treated area on an agricultural establishment, or prior to a handler conducting any handling task. The revised regulation no longer allows a grace period for this training. The regulation also requires pesticide safety training for all workers and handlers on an annual basis.

Certain employees may be exempt from the annual training requirements. Certified pesticide applicators, certified crop advisors, agricultural workers who never enter treated areas within 30 days of pesticide application or within 30 days of the end of a restricted entry interval (REI), and certain members of the establishment owner's immediate family are not required to complete safety training. Consult the previously referenced "How to Comply" manual for details on each exemption.

WPS training resources for owners and employers in Illinois

Trainers can use any WPS training materials as long as they are EPA-approved. Approved trainings will have an EPA-approval number similar to the following: EPA approval W/H PST 00001. Be sure to select training materials that meet the training requirements for the employee; i.e. worker training, handler training, or training for trainers. In the past, Illinois Pesticide Safety Education Program (PSEP) training clinics qualified for WPS trainings. Unfortunately, we are not able to cover all of the expanded training topics within the short timeframe of our PSEP training clinics. Illinois PSEP currently recommends that trainers utilize training materials published on the Pesticide Educational Resources Collaborative (PERC) website: http://pesticideresources.org.

Who can conduct the safety training?

The person who conducts the training must be a certified applicator or have completed an EPA-approved train-the-trainer program. The Illinois Department of Agriculture also has the authority to designate approved trainers, such as University of Illinois Extension. The trainer must be present at all times during the training to respond to trainees' questions. A translator may be necessary to ensure that the information is presented in a manner that the trainees can understand.

Recordkeeping requirements

Training records for each worker and handler must be kept on the establishment for 2 years from the date of training. Training records must include the following information:

- The worker's or handler's printed name and signature,
- The date of training,
- Trainer's name,
- Evidence of the trainer's qualification to train,
- Employer's name, and
- Information to identify which EPA-approved training materials were used for the training (i.e., the EPA document number or EPA approval number for the materials)

If requested, the employer must provide a copy of the training record to the employee. These records will also be necessary in the event of a WPS compliance inspection.

Sources

Pesticide Educational Resources Collaborative (PERC) http://pesticideresources.org

How to Comply with the 2015 Revised Worker Protection Standard for Agricultural Pesticides: What Owners and Employers Need to Know. http://pesticideresources.org/wps/htc/index.html

Travis Cleveland

Aerial Applications: Fixed-wing or Helicopter

The benefits of aerial application are well known to many growers. One item that sometimes gets confusing when selecting an aerial applicator, however, is which platform does a better job in terms of application efficacy: helicopter or fixed-wing. The truth is that when properly set up, there is no difference in application efficacy between these two platforms.

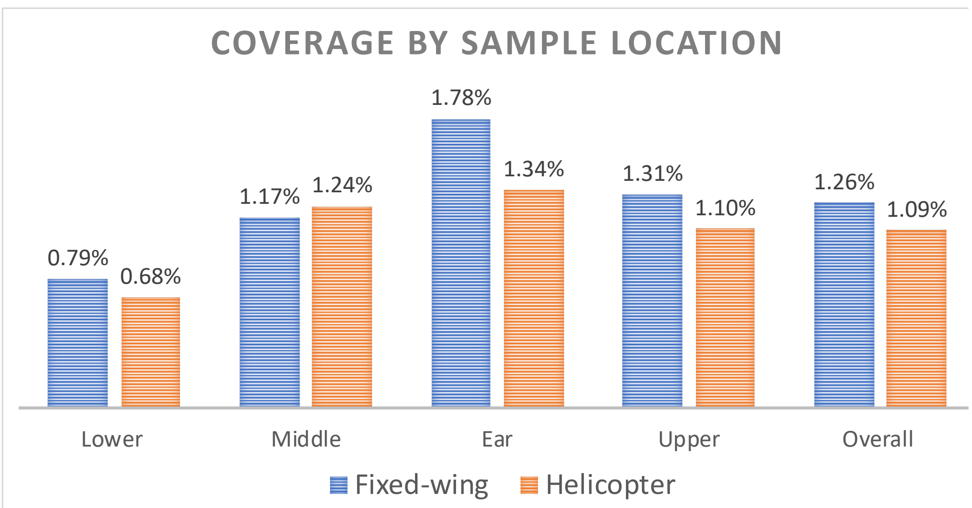
A common misconception is that the downwash of air generated by a helicopter results in more canopy penetration and deposition of spray droplets than a fixed-wing aircraft. In actuality, this effect only happens when the helicopter is at a stationary hover or very slow forward airspeed.

The downwash effect on a given ground area is rapidly reduced as forward airspeed increases. At 50-60 MPH, the downwash resembles that of a similar size (power and weight) fixed-wing aircraft. Further, wake vortices generated at the rotor blade tips will impact the spray pattern in the same way wingtip vortices affect fixed-wing spray patterns, and spray systems should be configured to introduce a minimum amount of spray particles into these vortices.

In terms of downwash, then, there is no effective advantage of using a helicopter or fixed-wing aircraft over the other.

A study conducted in part by the University of Illinois Department of Agricultural and Biological Engineering in 2012 had the opportunity to compare fixed-wing and helicopter performance making fungicide applications to corn.

While the primary purpose of the study was to compare different adjuvants for their performance on corn fungicide applications from a fixed-wing aircraft, we were able to add a helicopter treatment to the study. This was done to address the claim that helicopters provide better coverage.



The fixed-wing aircraft was an Air Tractor AT-402; the helicopter was a Bell 206. Both aircraft were set up to apply 2 gallons of spray per acre. The spray solutions used for the comparison were identical: water, fungicide at a rate of 10 fluid ounces per acre, a drift reduction adjuvant at 4 fluid ounces per acre, and a pink dye to measure coverage mixed at 2 quarts per 100 gallons of spray.

The sampling occurred in a production cornfield. The field was divided up into sections for each treatment. Every treatment received four swaths of application. The center section of each treatment was sampled at two locations within the treatment area. The sampling section was 100 feet wide, and samples were collected from every other row across the 100-foot sampling line. The samples consisted of white kromekote cards attached to leaves in the upper, middle, and lower parts of the plant. In addition, a card was attached to a sampling platform at the ear. The pink dye used in the spray solution stained the cards pink where it deposited. The cards were collected, scanned in a flatbed scanner, and analyzed with a software program that measured the percent area covered. The higher the percent coverage, the more spray deposited on the card.

The figure below shows the average percent coverage for the two treatments in the four canopy locations and overall.

The fixed-wing aircraft had slightly more coverage at three out of the four canopy positions and overall. There was, however, no statistical difference in spray coverage between the two aircraft types at any canopy location or overall.

Proper aircraft setup and operation, including things such as nozzle choice, deflection angle, and application height, have a major impact on the coverage obtained during an aerial application of any pesticide. If properly set up and operated, there should not be a difference in coverage and application efficacy between fixed-wing aircraft and helicopters, as demonstrated by this study.

Matt Gill

Pesticide Misuse Cases for 2017

In 2017, 430 pesticide misuse complaints were filed with the Illinois Department of Agriculture. This was 309 more than in 2016. There were 246 complaints related to dicamba misuse.

Of the 430 complaints, 212 resulted in issuing warning letters. Fourteen of the complaints (7 were applicators without a license) received a monetary penalty between $500-$1,000. A total of 135 cases were closed or withdrawn.

Maria Turner, based on information from an Illinois Department of Agriculture Report.

When properly set up, there is no difference in application efficacy between these two platforms.

End-of-the-Season Licensing Opportunities

We are entering the final stretch of the 2017-2018 pesticide operator and applicator training clinic season. If you have new employees or just haven't had time to attend one of the early training clinics, there are still opportunities to register for a training clinic or attend testing sessions.

Six training and testing clinics remain for the season. Registration for the training clinics is available through the University of Illinois Pesticide Safety Education Program (PSEP) website: http://web.extension.illinois.edu/psep/training/commercial/clinics.php.

Upcoming training and testing clinics:

April 3-4 in Matteson

General Standards, Turfgrass, Ornamental, Rights-of-Way, Mosquito

April 10-11 in Collinsville

General Standards, Rights-of-Way, Mosquito

April 23-24 in Alsip

General Standards, Turfgrass, Ornamental, Rights-of-Way, Mosquito

April 25-26 in Skokie

General Standards, Turfgrass, Ornamental, Aquatics

May 2-3 in Des Plaines

General Standards, Turfgrass, Rights-of-Way, Mosquito

May 9-10 in Springfield

General Standards, Mosquito

During each of these two-day clinics, the morning on the first day will be dedicated to General Standards training. Applicator training sessions are offered in the afternoon on the first day and in the morning on the second day of training. our $50 registration fee includes both days of training so please feel free to register for topics in addition to General Standards and join us for applicator training! Testing sessions on both days run from 12:30 PM - 4:00 PM. On the first day of the clinic, only General Standards tests will be available. On the second day, any test can be taken, including all applicator tests and General Standards.

Day one:

General Standards Training
8:00 AM – 11:30 AM

Testing for General Standards
12:30 PM – 4:00 PM

Applicator Training

2:30 PM – 5:00 PM

Day two:

Applicator Training

8:00 AM* – 11:30 AM

Testing for any topic

12:30 PM – 4:00 PM

* 8:00 AM for Turfgrass; 8:30 AM for Rights-of-Way, Mosquito

Online training

Online training modules are available for Demonstration & Research, Grain Facility, Vegetable Crop, Plant Management and Private Applicators. Registration for online training is $15 and can be found at http://web.extension.illinois.edu/psep/index.php.

Test-only sessions

In addition to the combined training and testing clinics, three test-only sessions are available. To register for test-only sessions visit the University of Illinois PSEP website: http://web.extension.illinois.edu/psep/training/commercial/clinics.php. While registration is required for these sessions, there are no registration fees.

April 12 in Carterville

April 17 in Springfield

May 17 in Streamwood

The Illinois Department of Agriculture (IDA) also offers testing by appointment at their Springfield and Dekalb offices. To register by phone, call the Springfield office at (800) 641-3934 or the Dekalb office at (815) 787-5476

What to bring for the test

When it is time to take your test(s), you will be asked to provide a photo ID, your social security number (card not needed) and, if you have been licensed in the past, a retest or renewal letter sent to you by IDA. For everyone who wishes to use a calculator during the test, please bring a basic function, scientific calculator. Smartphones and graphing calculators cannot be used during the test.

After you have completed and passed your test(s), IDA will bill you for your operator or applicator license(s) by mail. Most people receive their license(s) in the mail in 3 – 4 weeks. If you have any questions about training, testing or licensure, please visit the University of Illinois PSEP website: http://web.extension.illinois.edu/psep/index.php.

Good luck on your tests!

Sarah Hughson

EPA Announces Draft Pesticide Label Revisions on Respirators to Ensure Consistency between EPA and NIOSH

EPA is requesting public comment on revised respirator descriptions for pesticide labels.

EPA is making these revisions, with the encouragement of state regulatory agencies, as part of our efforts to:

- Bring the respirator descriptions on pesticide labels into conformance with the current National Institute for Occupational Safety and Health (NIOSH) respirator language (https://www.cdc.gov/niosh/index.htm);
- Ensure that pesticide handlers and their employers have the information they need to identify and buy the respirator required to provide needed protection;
- Delete outdated statements referring to respirators that no longer exist; and
- Clarify and update language to ensure easy compliance with the guidance.

After considering comments, EPA will update Chapter 10, "Worker Protection Labeling," of the Label Review Manual (LRM). After releasing the revised chapter, EPA will ask registrants submitting labels for other reasons to revise their personal protective equipment (PPE) statements to include the updated descriptions at the same time. Those registrants who wish to revise only the PPE statements to incorporate the new respirator descriptions will be advised to submit a fast-track amendment with the changes. For existing products not otherwise updated, EPA will require the submission of labels with the revised descriptions of respirators during the registration review process.

Please submit comments on the revised respirator section by May 22, 2018, to opprespiratortable@epa.gov. We are requesting comment from regulators, registrants, pesticide users, safety educators and other stakeholders on the revised respirator descriptions for the LRM.

Read the proposed revisions: Label Review Manual Chapter 10; Revised Respirator Descriptions for Public Comment (https://www.epa.gov/sites/production/files/2018-03/documents/lrm-chapter-10-respirator-language-6-mar-2018_0.pdf)

EPA press release, submitted by Michelle Wiesbrook

We're on facebook! Search for the University of Ilinois Extension Pesticide Safety Program (PSEP).

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The *Illinois Pesticide Review* is published six times a year. For more information about pesticide safety or for more issues of this newsletter, please visit us at *www.pesticidesafety.illinois.edu*. You can also reach us at 800-644-2123.

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TESTIMONY

March 26, 2019

House Natural Resources Committee
Chair Brad Witt

RE: Opposition to HB 3044

Submitted by: Terry Harchenko, Owner, Industrial Aviation Services, Inc.

Thank you for the opportunity to testify in opposition of HB 3044. My name is Terry Harchenko. I am the owner-operator and a pilot of Industrial Aviation Services, Inc. Industrial Aviation, for the past 49 years, has provided aerial application services using both airplanes and helicopters in Salem and the surrounding area to a current customer base of 265 family farms.

My first opposition to HB 3044 is in Section 1, Paragraph 2 (a). Some of the information required to be recorded during the application requires what is known as AIMMS equipment (Aircraft Integrated Meteorological Measurement System). In my communication with the manufacturer of the AIMMS equipment, it was determined to be questionable as to the accuracy of the recorded data with regard to the intent of HB 3044. There is also the issue to gain FAA approval for the installation on each individual aircraft and at a great expense.

I would like to give an example of how burdensome it would be to compile the required information required by HB 3044, to format it, and for DEQ to analyze the data. Last Thursday (3/21/2019), I flew an application for a family farm that had 45 separate field locations. Imagine four of our company aircraft working the same day, not counting all the other aerial applicators throughout the state. This would overwhelm the DEQ. The record keeping requirements of the Bill are already required by the Oregon Department of Agriculture.

Industrial Aviation Services, Inc. applies over 100 agricultural products. All of these EPA-registered products have a product label which includes specific information and requirements to the application of the product by aircraft. Many of these requirements are aircraft set-up to help mitigate off-target movement. The label is the law and is already enforced by Oregon Department of Agriculture and Oregon OSHA.

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In closing, those family farms which I have discussed HB 3044 with are highly opposed to posting information of the application to their crops. They consider this to be proprietary information on what products and blends of fertilizers they choose to have applied as well as the timing. They, as well as myself, feel the public posting of this information puts the applicator and land owner at risk for harassment and vandalism. **We respectfully ask you to vote NO on HB 3044.** Any questions regarding this testimony may be directed to myself at 503-510-6489.