Pacific Rivers Council .org

SUBMITTED VIA EMAIL

Environmental Health Assessment Program
800 NE Oregon St., Suite 640
Portland, OR 97232

RE: COMMENTS ON HIGHWAY 36 CORRIDOR EXPOSURE INVESTIGATION

Dear Investigation Team,

Pacific Rivers Council (PRC) would like to thank you for the opportunity to provide comments on the Oregon Health Authority's (OHA) Highway 36 Corridor Exposure Investigation (EI), issued May 9, 2013.

PRC's mission is to protect and restore rivers, their watersheds and the native species that depend on them. We do this for the benefits that healthy watersheds provide to present and future generations, and for the intrinsic virtues of rivers themselves. The use of pesticides on private forestland has potential adverse effects on water quality, which directly influences both the health of communities that rely on surface water for drinking and recreational activities, and native aquatic species, including Endangered Species Act (ESA)-listed Coho salmon. For these reasons, PRC offers the following comments on the OHA's EI to ensure that these issues are further addressed by the Investigation Team.

In addition to these comments, PRC is including a conceptual environmental monitoring plan (EMP) for the Highway 36 area as a supplement to this comment letter. The EMP is designed to provide a starting point for discussion about monitoring the presence of pesticides in the environment. Further discussion and refinement of the EMP is expected and welcomed, and PRC requests to be consulted in the development of any monitoring program.

We have organized our comments into "General Comments" and "Specific Comments" sections. The general comments address our overall concerns about the completeness of the investigation, and the need for a whole watershed assessment. Our specific comments address the OHA's Conclusion 9-13 regarding the EI inability to identify source(s) or potential pathway(s) of pesticide exposure.

Again, we thank you for the opportunity to provide comments on this important investigation. If you have any questions, please do not hesitate to contact me.

Sincerely,

Greg Haller
Conservation Director

Cc: CAPT Richard Kauffman, Regional Director, Agency for Toxic Substances and Disease Registry

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Synopsis of Comments

General Comments:

- The OHA, and all other involved agencies, have not provided a satisfactory assessment of the risk to public health from exposure to pesticides used on private forestlands.
- Insufficient environmental data is the cause for the OHA's inability to determine with certainty the source of pesticides or exposure pathways.
- Detection of pesticides in residents' urine samples indicates the probability that pesticide applications are in violation of registered product labels and presents an increased risk of drift.
- The presence of pesticides in the surrounding environment jeopardizes the overall health of the region's ecosystems, especially because the region contains a vast network of streams and critical habitat for ESA-listed Coho Salmon.

Specific Comments:

- The source of pesticide exposure is crucial information that is needed to adequately address public health risk. (Issue 1)
- Active and passive air monitoring are necessary because of the high probability of pesticide drift. (Issue 2)
- The OHA did not considered all reasonable and plausible route of pesticide exposure when it concluded that drinking water, soil, and homegrown food are not potential exposure pathways. (Issue 3)

General Comments

The stated purpose of the EI is "to fill important data gaps by collecting and analyzing environmental, human biological and other data" to answer questions regarding public exposure to pesticides. While the EI is a step in the right direction, PRC believes that the OHA, and all other involved agencies, have not provided a satisfactory assessment of public health risks resulting from pesticide applications in the Highway 36 investigation area. This EI concluded that Highway 36 residents were exposed to 2,4-Dichlorophenoxyacetic acid (2,4-D) and atrazine in spring 2011, and 2,4-D in fall 2011. However, data collected by the investigation team was not adequate to determine the source(s) or exposure pathway(s) of these pesticides. As public health is the concern, identification of source(s) and pathway(s) of exposure constitute important information needed to guide appropriate actions, ensuring that the public's health is protected for present and future generations.

First, the inability of this EI to identify a source or exposure pathway indicates that important information is missing. PRC recognizes that this inability to determine the source(s) and pathway(s) through which residents are exposed to pesticides arises as a result of insufficient environmental data. The investigation team did not collect a representative set of environmental data to characterize the region's watersheds, which is an important component of a thorough public health assessment. The value of a watershed has been recognized in the U.S. Environmental Protection Agency (EPA)

Healthy Watersheds Initiative. The initiative states that a healthy watershed provides many benefits to a community, such as "sufficient amounts of clean water required for healthy aquatic ecosystems; habitat for fish and wildlife; safe drinking water; and recreation as well as mental and physical health benefits; and help reduce vulnerability to climate and land use change impacts and costs for adaptation."[1] We strongly urge the investigation team to take a whole watershed approach to protect the integrity of the ecosystems in this region.

Secondly, the use of pesticides in the Highway 36 corridor may be in violation of the EPA approved product labels as evidenced by detection of pesticides in residents' urine samples. There is heavy reliance on pesticide use on private forestlands to control unwanted vegetation. Pesticide applications in this region (and the majority of Oregon's private forestland) are of concern because of the nature of aerial pesticide applications. Forestry pesticide aerial applications are outside the normal operating guidelines of product labels and have an increased risk of drift, especially in Oregon, because of extreme slope angles, variable microclimates (e.g., wind eddies), and downslope winds.[2,3] OHA's findings indicate that residents have been exposed to these pesticides, confirming the presence of pesticides in the environment outside of the targeted application area. Consequently, this finding also increases the probability that applicators are in violation of EPA registered product labels for 2,4-D, atrazine, and other pesticides. Product labels state that it is a violation of federal law to use pesticide(s) in a manner inconsistent with labeling. It is also the responsibility of pesticides applicators to make appropriate adjustments to account for weather conditions and application method to prevent spray drift. The actual weather conditions and methods used by applicators are difficult to evaluate because there is no requirement for applicators to release pesticide use information to the public. However, given the steep terrain in the region, pesticide applicators use helicopters flying at heights reaching 100 feet (ft).[4] This practice exceeds the product label recommended maximum height of ten feet, which is used by the EPA to assess drift risk, and can greatly increase pesticide drift potential. A simple modeling exercise with AgDRIFT Tier III Forestry (Appendix A) verified increased drift occurrence with increasing boom height and wind speed. All modeled boom heights (10, 20, 40, 50, and 100 ft) and wind speed of 4 miles per hour (mph) indicated pesticide drift beyond 60 ft downwind from spray origin. Modeled boom heights of 40 and 50 ft showed >20% of sprayed materials deposited 50 ft downwind. Modeled boom height of 100 ft showed 50% of sprayed materials deposited over 150 ft downwind. Increasing the wind speed to 10 mph (boom height 40 ft) increased overall deposition distance (20% of sprayed material) by approximately 100 ft. Current pesticide practices and regulations for private forestland are far too lenient and, as demonstrated by this EI, do not ensure the containment of harmful chemicals necessary to protect the environment and human health.

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[1] Healthy Watersheds Initiative: National Framework and Action Plan. EPA, August 2011. Publication Number: EPA 841-R-11-005.
[2] Lobet. Ingrid. (2012). In Oregon, Residents Struggle to Solve a Pesticide Mystery. *The Atlantic*. Retrieved from May 3, 2013.
[3] Turner, Stuart. (2011). Potential Off-Target Pesticide Movement: Aerial Application in the Oregon Coastal Range. BOF Meeting Minutes April 29, 2011 Attachment 18
[4] Turner, Stuart. (2011)

Lastly, evidence of pesticides in the surrounding environment is a major concern for the overall health of the region's ecosystems, especially because the region contains a vast network of streams and critical habitat for ESA-listed Coho salmon, as well as cutthroat trout and steelhead.[5] The Highway 36 investigation area contains an expansive network of watersheds that the Oregon Department of Fish and Wildlife (ODFW) has designated as salmon and steelhead habitat. Additionally, ODFW has designated Fish Creek as Core Cold Water Habitat. In spring 2011, the Siuslaw Watershed Guardians (SWG) conducted water quality samplings using a passive technique, Polar Organic Chemical Integrative Samplers (POCIS). The study detected atrazine, atrazine metabolite, and hexazinone in 4 of 5 sample sites in the Fish Creek watershed. Available spray records acquired by Beyond Toxics show significant aerial application of pesticides in the Fish Creek watershed that are adjacent to and crossing over surface water. These data indicate that pesticide contamination may have resulted from direct surface water overspray, runoffs, or drift. A toxicology study by Nieve-Puigdoller et al.[6] in 2007 indicates that atrazine is harmful to smolt development in Atlantic salmon causing ionoregulatory, growth and endocrine disturbance. The study also reported a 9% mortality rate over a 21 days exposure time. While the SWG dataset did not detect 2,4-D, it should be noted that 2,4-D was sprayed in Fish Creek watershed in spring 2011, before POCIS deployment.

The importance of 2,4-D in the discussion of pesticides drift is evidenced by court-ordered buffer zones of 60 feet for ground application and 300 feet for aerial application adjacent to salmon supporting waters. These court-ordered buffer zones resulted from Washington Toxics Coalition, et al. v. EPA (2004). Initial review of 2,4-D EHE (an ester form) toxicology by the EPA indicated "No Effect" findings for Northern California/Southern Oregon Coastal Coho salmon, thus, no buffer zones requirement was enforced. However, the recent Biological Opinion released June 30, 2011 by the National Marine Fisheries Service (NMFS), as a product of EPA consultation request required by ESA Section 7, found that the herbicide 2,4-D is "likely to jeopardize the existence of Pacific salmonids [including Coho salmon], and likely to destroy or adversely modify designated critical habitat for ESA-listed salmonids."[7] NMFS also indicated that the ester form is the most toxic form of 2,4-D. Pesticide spray records acquired through the OHA investigation process showed that two 2,4-D ester formulations, 228-95-71368 and 71368-11, were applied in the Highway 36 investigation region. These pesticides records also revealed that most pesticide applications contain a mixture of two or more pesticides. The significance of exposure to multiple pesticides was studied by Laetz et al. with association to the National Oceanic and Atmospheric Administration (NOAA) Fisheries indicated that a mixture of organophosphate (OP) and N-methyl carbamate (CB) pesticides produced additive or synergistic AChE inhibition in the brains of juvenile

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[5] Oregon Biodiversity Information Center. (2010). Rare, Threatened and Endangered Species of Oregon. Institute for Natural Resources, Portland State University, Portland, Oregon.

[6] Nieves-Puigdoller, K., Björnsson, B.T., McCormick, S.D. (2007). Effects of Hexazinone and Atrazine on the Physiology and Endocrinology of Smolt Development in Atlantic salmon. *Aquatic Toxicology.* 84(1): 27-37.

[7] NMFS. (2011). NMFS Endangered Species Act Section 7 Consultation, Biological Opinion: Environmental Protection Agency registration of pesticides containing 2,4-D, triclopyr BEE, diuron, linuron, captan, and chlorothalonil. Washington, D.C.: U.S. Department of Commerce.

Coho salmon. Laetz et al. concluded that "salmon exposed to mixtures containing some of the most intensively used insecticides in the western United States showed either concentration-additive or synergistic neurotoxicity as well as unpredicted mortality."[8] The information presented above demonstrates that forest practices in Oregon, and specifically in the Highway 36 investigation area, are posing immediate danger to ESA-listed Coho salmon and critical aquatic habitats.

Specific Comments

The following are PRC's comments and recommendations regarding the OHA's Conclusions 9 – 13.

Issue 1: The OHA concluded that there is insufficient information to confirm that local pesticide applications are the source of pesticide found in residents' urine, but concluded that such applications may be a contributing source of human exposure.

Comment 1: The unresolved question regarding the source of pesticide exposure presents a public health risk that needs to be addressed immediately. PRC agrees with the OHA's recommendations for continual release of data regarding pesticide application and the development of consistent pesticide application record-keeping. Additionally, PRC strongly agrees with OHA's recommendation that state agencies implement a notification system concerning imminent pesticide applications to sensitive populations. PRC has valuable experience and insight for improving regulatory standards and would like to be a consulted in this process.

Issue 2: The OHA was unable to determine air as a potential pathway of exposure.

Comment 2: The fact that there is currently no proper pesticides air monitoring program in the region is very concerning. AgDRIFT modeling indicated that pesticides were drifting over 300 ft with simple input parameters that only represent a constant application meteorological condition and terrain. Given the variability of meteorological conditions and terrains in the investigation area, pesticide drift is more likely than AgDRIFT modeling indicates. Thus, air quality data is critical to sufficiently assess public health risks and addresses residents' concerns regarding pesticides usage. Pesticide drift management is focused on aerial drift, but PRC recognizes that that volatilization is also an important transport mechanism that should be considered. PRC agrees with the OHA's recommendation for widespread passive air monitoring before and during pesticide applications in the fall and spring seasons of pesticide application. However, PRC also strongly recommends the use of active air sampling (AAS) in addition to passive air sampling (PAS). We recommend that both methods be implemented, because AAS provides a short-term resolution (< 1 month), whereas PAS provides a long-term resolution (seasonal trends). We also recommend that a continuous sampling AAS technique be used because episodic sampling will not be able to properly represent

[8] Laetz, Cathy, A., et al. (2009). The Synergistic Toxicity of Pesticide Mixtures: Implications for Risk Assessment and the Conservation of Endangered Pacific Salmon. *Environmental Health Perspectives*. 117(3): 348-353.

pesticides drift events. For more information regarding the basis of PRC's recommendations, please refer to the publication by Hayward et al.[9] in Environmental Science & Technology.

Issue 3: The OHA concluded that drinking water, soil, and homegrown food are not potential pathways of residents' exposure.

Comment 3: Drinking water, soil, and homegrown foods are not be the only potential sources of residents' exposure. Environmental data collected by the investigation team is not representative of the region's environment and residents' daily activities. While the data collected by the investigation team does support the OHA's conclusions, this dataset represents localized exposure pathways within the vicinity of residents' homes. This investigation did not fully consider all potential pathways of residents' exposure, because it failed to acknowledge residents travels and use of the region's outdoor setting. Recreational uses of Triangle Lake and other surface waters (e.g., creeks and ponds) present a reasonable and plausible route of pesticide exposure, because residents frequently use these bodies of water for recreating. Additionally, other recreational activities such as hiking, camping, and hunting are activities that can lead to residents' exposure to pesticides. Pesticide trespass onto public-use area should be in consideration as it poses health risks not only to local residents but also visitors of this region that seek recreational opportunities that are present. PRC strongly recommends collection of additional environmental data that will be representative of the environment and watershed(s) in the Highway 36 investigation area. This information will help to fill important information gaps. An in-depth environmental monitoring campaign of the aquatic and terrestrial ecosystem, as well as biota sampling, will provide the necessary information to determine pesticides exposure source(s) and pathway(s).

In conclusion, PRC is an advocate of a whole watershed approach to land management and the protection of native aquatic species. The presence of pesticides in the environment raises our concern for the well-being of ESA-listed Coho salmon, steelhead and other aquatic organisms. We recognize that the problem is not limited to aquatic species. Improper pesticide use affects a wide range of communities, from human to wildlife, that rely on the natural resources and intrinsic values that a healthy watershed provides. The encroachment of pesticides in the watershed and residential areas, as evidenced by the urine analysis and the water sampling, are indications that current pesticide practices in the Highway 36 region are not adequate. Analysis utilizing AgDRIFT Stream Assessment provided strong evidence that the problem of pesticide drift can be minimized with the development of strict buffer zones to protect residents and aquatic species (See Appendix A). Thus, PRC recommends that the OHA work with Oregon Department of Environmental Quality, Oregon Department of Forestry, EPA and NMFS to investigate the creation of buffer zones fully protective of human and aquatic health.

[9] Hayward, S. J., Gouin, T., & Wania, F. (2010). Comparison of Four Active and Passive Sampling Techniques for Pesticides in Air. Environmental Science & Technology, 44(9), 3410-3416.

ENVIRONMENTAL MONITORING PLAN
Highway 36 Corridor

Introduction

The Oregon Health Authority (OHA) published an Exposure Investigation (EI) report on May 9, 2013, pertaining to pesticide exposure risk to residents along the Highway 36 corridor. Biological data (i.e. urine samples) collected by the OHA and privately by residents indicated that residents have been exposed to the pesticides 2,4-Dichlorophenoxyacetic acid (2,4-D) and atrazine. However, the limited environmental data collected by the EI investigation team was a limiting factor in determining the source(s) and exposure pathway(s) of these pesticides.

The purpose of this Environmental Monitoring Plan (EMP) is to collect the necessary data to determine the source(s) and exposure pathway(s). Environmental monitoring of water and air quality at various locations will provide the essential environmental data to fill information gaps present in the EI of Highway 36 corridor. This EMP outlines a preliminary approach to investigate the presence of pesticides in various environments—aquatic, riparian, and residential. Further development and refinement of the EMP is expected and PRC encourages the OHA to consult with the Oregon Department of Environmental Quality (DEQ), the U.S Environmental Protection Agency (EPA) and the U.S. Geological Survey (USGS) in the development of any monitoring plan. PRC would like to participate in those discussions should such a plan be contemplated.

Design of the sampling timeline is a critical element of this EMP because 2,4-D and atrazine are readily degraded in the environment. A temporal sampling effort will capture the background baseline concentration, and eventual degradation and/or transport of pesticides in the environment. The details of pesticide transport given by a temporal dataset will provide the insight necessary for the development of a notification and warning system for sensitive human populations.

A comprehensive monitoring plan will provide a complete assessment of the settings in which residents live in. This information can be used to determine the extent of the risk that use of pesticides have on public health and the environment in the Highway 36 region. More importantly, information collected can provide a tool for decision-makers to implement changes to pesticide practices to protect the public health and the environment.

Project Description

In order to assess pesticide exposure source(s) and pathway(s), we recommend that environmental monitoring of air and water occur during the spring and fall seasons, with at least six sampling regions within the Highway 36 corridor. Sample site selections are based on proximity to known locations of aerial application of pesticides, to aquatic environments and areas with public access. In addition to the six proposed study regions, we recommend monitoring of air and tap water at public buildings, such as schools,

markets, gasoline stations, etc. Residents in the investigation area should be consulted to identify locations of high priority. We also recommend two separate datasets: short-term and long-term. The short-term dataset will be used to assess acute pesticide exposure risk to residents and native aquatic species. The long-term dataset will be used to assess chronic pesticide exposure. Combined, these datasets will illustrate the pesticide concentrations in the environment that residents and native aquatic species inhabit.

Environmental data (air, water, sediment and biota) should be collected before aerial spray events to provide background conditions, followed by a temporal sampling regiment. This sampling timeline will provide the necessary data for appropriate comparison and analysis of pesticide drift and persistence in the environment. In addition to aerial drift, pesticide runoff can be characterized by additional temporal sampling following a precipitation event. While drift and runoff can be differentiated, the methods presented in this EMP do not allow differentiation of pesticide volatilization. The collection of sediment with water samples will provide information about the partition of pesticide between water and sediment. The partition information will provide valuable insight into to the fate of pesticides in the aquatic environment and can be used to assess exposure risk.

The scope of this EMP is extensive and encompasses a large study area. Thus, this environmental monitoring project requires multi-agency participation from the OHA, DEQ, EPA and USGS as well as cooperation from pesticide applicators. Additionally, this project presents an excellent opportunity to involve university research communities, such as at the University of Oregon, Oregon State University, and the Oregon Health Sciences University for technical and personnel resource supports.

Method

Surface water, pore water, sediment, biota (invertebrates and amphibians), and air data should be collected before and after known pesticide applications to monitor for a range of pesticides. Pesticides of special interest are 2,4-D and atrazine. Monitoring should occur during the fall and spring season when the pesticides of interest are used. In addition, tap/drinking water should be collected from the municipal water supply on a weekly basis throughout the monitoring season.

Active and passive sampling techniques should be used to collect surface water and air data. The combination of both active and passive sampling will provide short-term and long-term exposure information.

We recommend that water quality and atmospheric data be collected to accompany surface water, pore water, sediment, and air samples. Water quality data should include flow rate, temperature, pH, turbidity, dissolved oxygen, conductance, total dissolved solids (TDS), and alkalinity. Stream flow rate should be determined, as outlined by the EPA Stream Flow.[10] Handheld multiparameter instruments (*e.g.*, YSI Professional Plus)

[10] EPA. 5.1 Stream Flow. Retrieved from the EPA website: http://water.epa.gov/type/rsl/monitoring/vms51.cfm

can be used to measure temperature, pH, dissolved oxygen, specific conductance, and TDS. Chemical field kits and turbidity meters (CHEMetrics, Inc.) can be used to measure alkalinity and turbidity, respectively. In addition, we also recommend the collection of meteorological data, including wind speed, direction, temperature, relative humidity, and precipitation. Given the potential for highly variable weather conditions, meteorological data needs to be measured at air monitoring sites.

Sampling should occur before the application of pesticides to adequately characterize the baseline level of pesticides. Following an application event, a temporal sampling effort (*e.g.*, 6 hr, 24 hr, 48 hr, 5 days, and 14 days) should be conducted to characterize the persistence (if any) of pesticides in the proximate area. A second temporal sampling effort should be conducted if precipitation occurred near the 14 day period (e.g. 6 hr. 24 hr, and 48 hr).

The following chart outlines the sampling and analysis methods for the different sample types proposed by the EMP. The sampling method was not identified for some sample types because it is assumed that established standard operating procedures would be used. Specific analysis methodology is listed for 2,4-D and atrazine because different analytical methods are needed. This summary chart is presented to provide the basis for further discussion and improvement of the sampling and analysis techniques that would be implemented in any environmental monitoring plan.

Sample Type	**Sampling Method**	**Analysis Method**		
		2,4-D	Atrazine	General
Surface water				
Passive	POCIS[11]	LC-ES/ITMS	LC-ES/ITMS	EPA 1699
Active		EPA 8151A	EPA 508.1	EPA 1699
Tap water		EPA 8151A	EPA 508.1	EPA 1699
Pore water		EPA 8151A	EPA 508.1	EPA 1699
Sediment		EPA 8321B	USGS 5-C3	EPA 1699
Air				
Passive	PUF Disk	EPA TO-10A	EPA TO-10A	EPA TO-10A
Active	PUF Disk w/ LV-AAS**	EPA TO-10A	EPA TO-10A	EPA TO-10A
Biota		EPA 1699	EPA 1699	EPA 1699

* Liquid chromatography-electrospray ion trap mass spectrometry
** Low volume active air sampling

Site Description The investigation area is located along the Highway 36 corridor in Lane County, OR between Junction City and Mapleton. The majority of residents and farms are located in valleys that are downslope of private forestry operations that practice clear cutting and pesticide application (aerial and ground). Lane County is a coastal region of the Western Cascade with varying topography and climate. Forestry in this region occurs

[11] USGS. (2004). Polar Organic Chemical Integrative Sampler. Retrieved from USGS website: http://www.cerc.usgs.gov/pubs/center/pdfdocs/pocis.pdf

on mountainsides that have slopes of 40 to 70 degrees and 1000-foot change in altitude. The mountain landscape contains ridges and valleys which are associated with highly variable air movement. [12] This coastal region also receives very high annual precipitation (50 to 150 inches) between October and June[13] . The steep and variable topography of the region, and high precipitation, allow for high probability of pesticide drift and runoff downslope of application sites.

The fauna of the Western Cascades includes large and small herbivores and carnivores (elk, deer, beaver, otter, etc.), a variety of birds (blue and ruffed grouse, mountain quail, owls, hawks, songbirds, etc.), and anadromous fish (Coho, Chinook, Chum, Pink salmon, Steelhead and sea-run Cutthroat trout). Additionally, the region is habitat for more than 7,000 species of arthropods, amphibians, reptiles and slugs.[14] The distribution of the fauna of the Western Cascade can vary and certain species may not be present in some areas. For instance, Chum and Pink salmon are not found in the investigation area.

There are six (6) proposed surface water monitoring regions within the investigation area, represented in Figure 1 and 2. These regions were selected to represent the vast network of watersheds present in the OHA's EI area that are accessible by the public for recreational opportunities. Additionally, the region's watersheds are designated by the Oregon Department of Fish and Wildlife (ODFW) as salmon and steelhead habitat; Fish Creek is considered Core Cold Water Habitat.

Individual sample sites at the six proposed study regions should be treated as unique samples that define a particular area, and should not be combined for analytical purposes. The three samples ('sites') collected at each sample site should also be treated as unique samples, but can be combined for analytical purposes to achieve detection limit.
The actual location of sampling may differ from locations proposed in this EMP. However, selection of alternative sample sites should have close proximity to active pesticide applications (aerial and ground). PRC would like to be involved in the actual selection of monitor sites.

[12] Turner, Stuart. (2011). Potential Off-Target Pesticide Movement: Aerial Application in the Oregon Coastal Range. BOF Meeting Minutes April 29, 2011 Attachment 18
[13] Forester Service. (n.d.) Chapter 25, Ecological Subregions of the United States: Western Cascades. Retrieved July 24, 2013 from http://www.fs.fed.us/land/pubs/ecoregions/ch25.html#M242B
[14] USDA Forest Service. (n.d.)

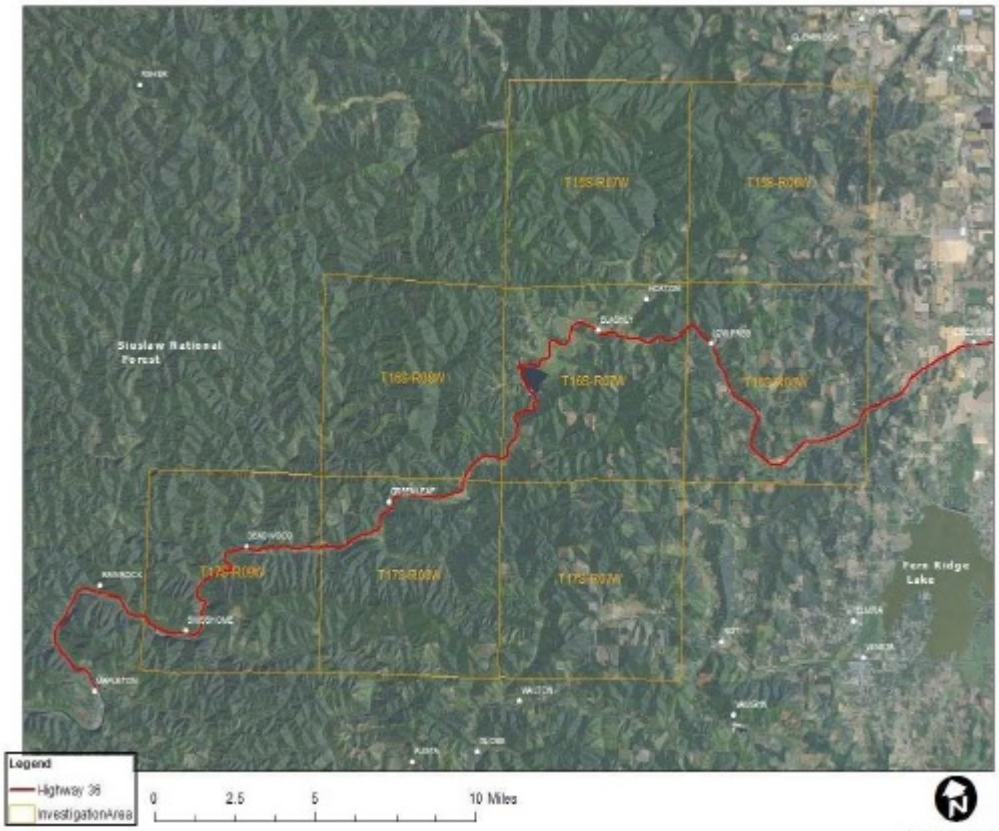


Figure 1. OHA-identified investigation area.

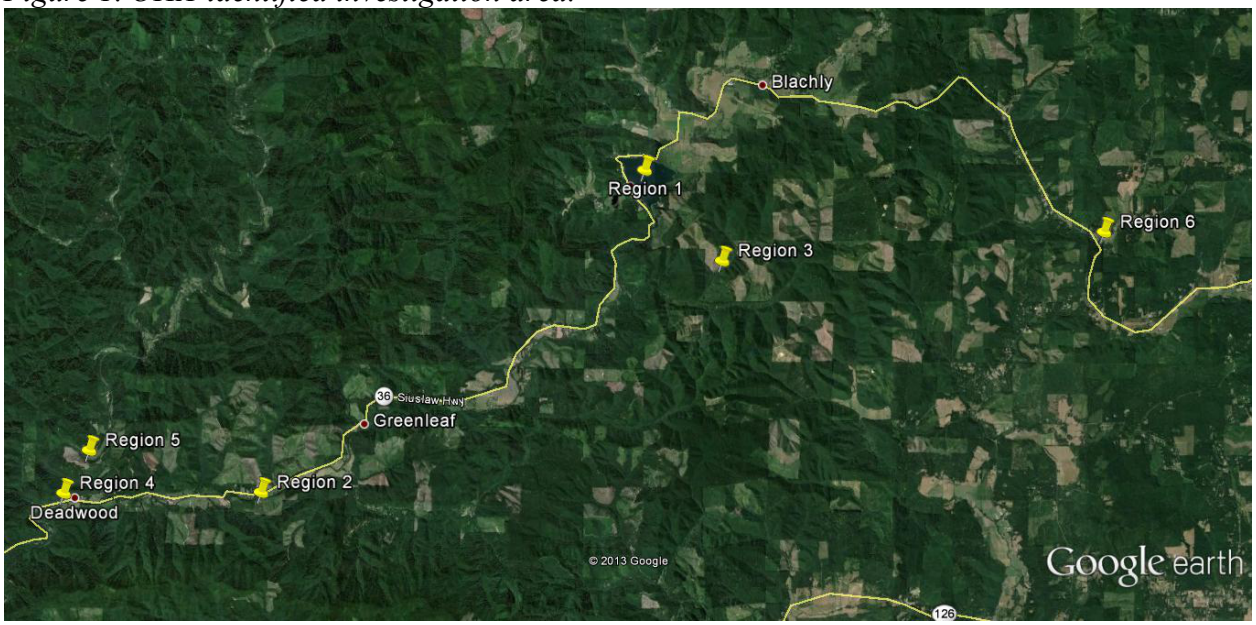


Figure 2. Overview of the six study regions' location within the OHA's Highway 36 investigation area.

Study Region 1: Triangle Lake

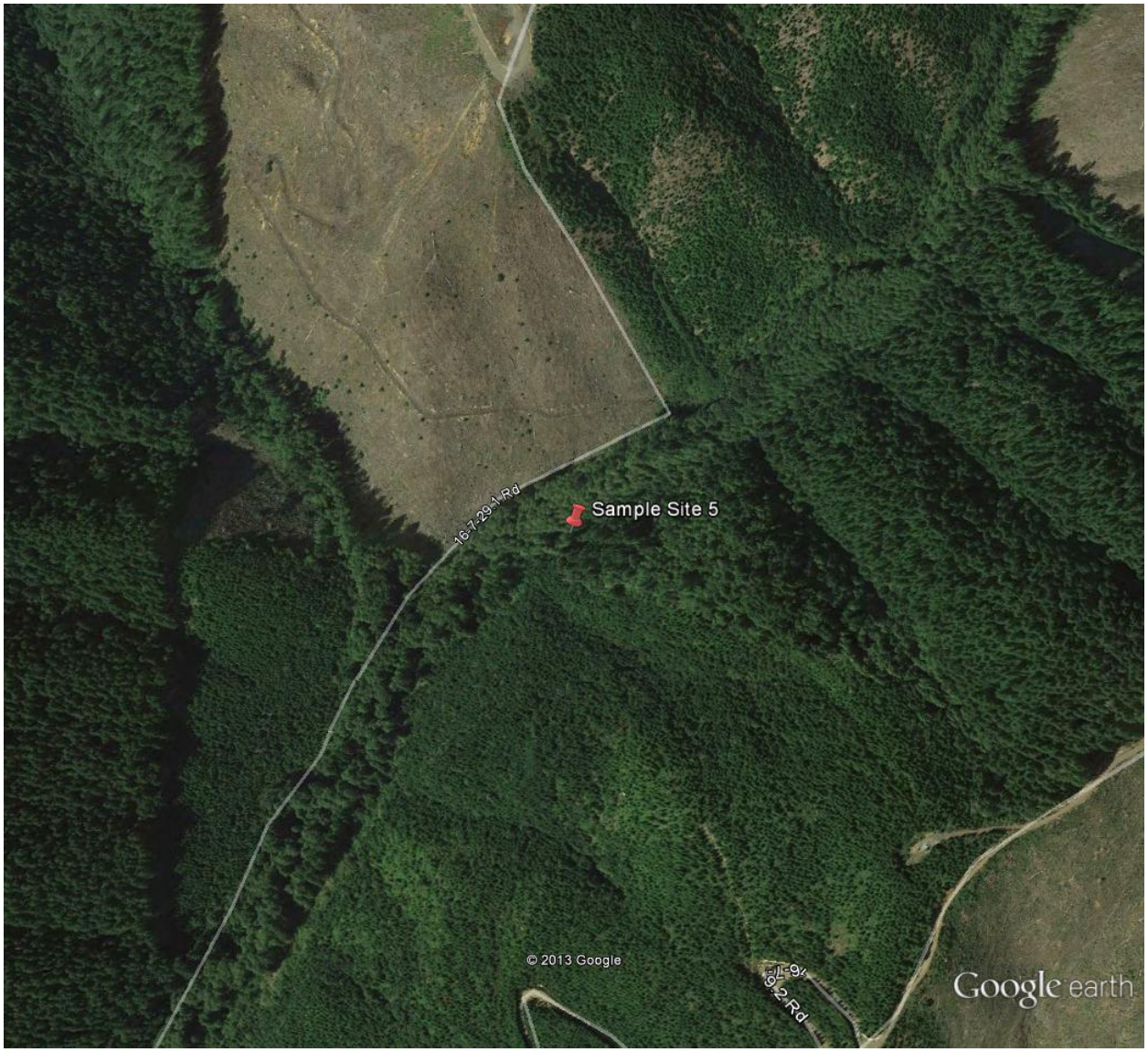
The Region 1 study area is Triangle Lake. Triangle Lake is an important recreational destination in the area and would make an ideal location for environmental assessment. There will be three sample sites for this study area: Sample Site 1 (44°10'25.86"N, 123°34'49.95"W), Sample Site 2 (44°10'15.29"N, 123°34'5.30"W), Sample Site 3 (44° 9'50.64"N, 123°34'17.58"W). Each sample site will include 3 sites parallel to the bank as shown in diagram below. The distance between each sampling site is not represented by the distance between yellow dots in diagram.

Study Region 2: Lake Creek between Deadwood and Greenleaf

The Region 2 study area is located between townships Deadwood and Greenleaf. This region is chosen for its proximity to clear cut forest, and location between two townships. There will be one sample site for this study area: Sample Site 1 (44° 5'46.28"N, 123°42'7.70"W). This sample site will include 3 sites across the stream channel as shown in diagram below. Distance between each sampling site is not represented by the distance between yellow dots in diagram. Additional sample sites may be added as necessary.

Study Region 3: Fish Creek

The Region 3 study area is Fish Creek. This region is chosen for its proximity to clear cut forest, because it is a major tributary to Lake Creek, and because it provides recreational opportunities to the general public. There will be one sample site for this study area: Sample Site 1 (44° 9'1.92"N, 123°32'58.37"W). This sample site will include 3 sites across the stream channel. Sample sites are not shown in diagram because the water path is not clearly indicated. Additional sample sites may be added as necessary.



Study Region 4: Deadwood Landing County Park

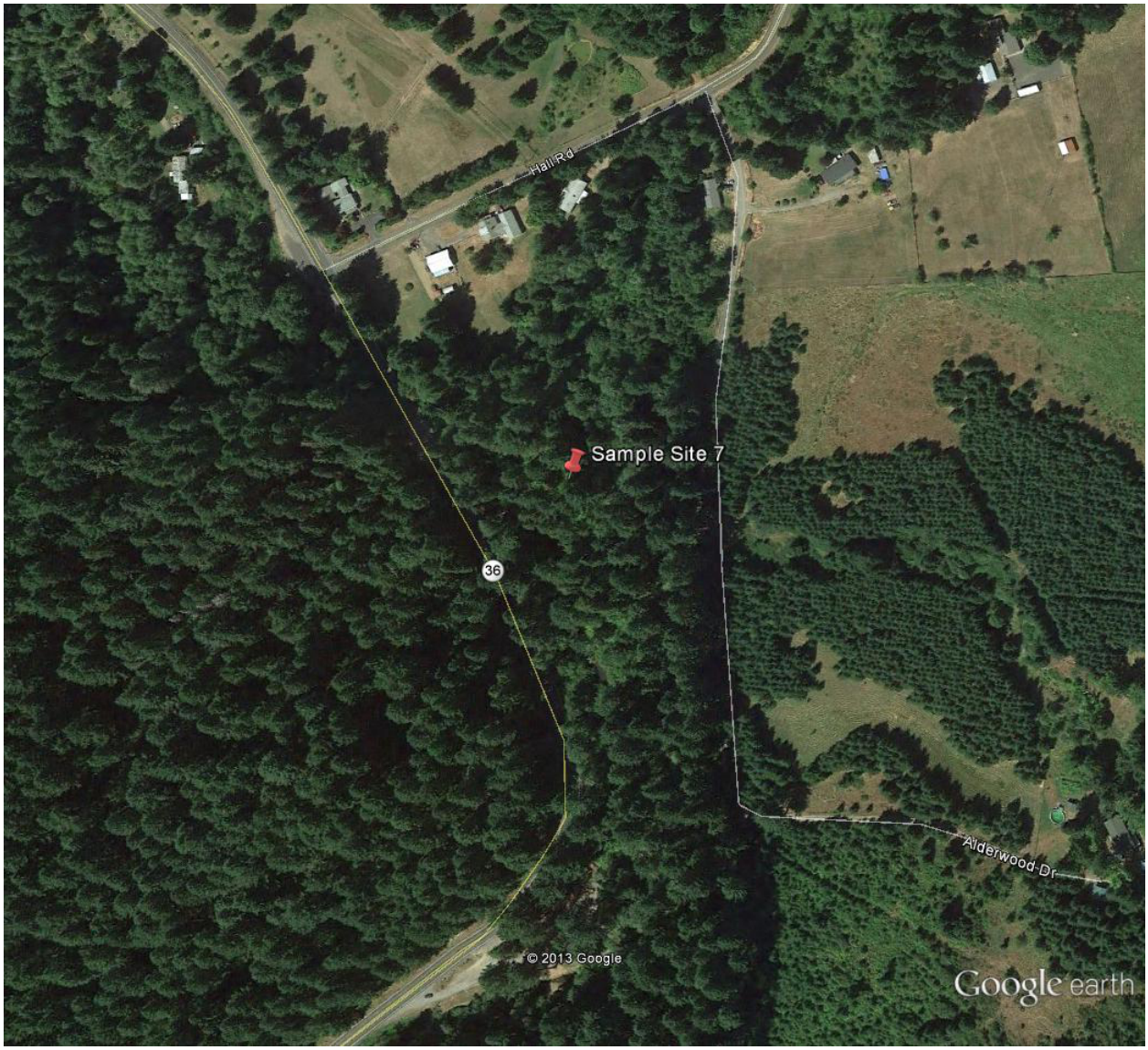
The Region 4 study area is Deadwood Landing County Park. This region is chosen for its public access and recreational opportunities. There will be one sample site for this study area: Sample Site 1 (44° 5'41.15"N, 123°46'1.47"W). This sample site will include 3 sites across the stream channel as shown in diagram below. Distance between each sampling site is not represented by the distance between yellow dots in diagram. Additional sample site may be added as necessary.

Study Region 5: Deadwood Creek

The Region 5 study area is Deadwood Creek. This region is chosen for its proximity to clear cut forest, its role as a major tributary to Lake Creek, and its public recreational opportunities. There will be one sample site for this study area: Sample Site 1 (44° 6'18.87"N, 123°45'35.71"W). This sample site will include 3 sites across the stream channel as shown in diagram below. Distance between each sampling site is not represented by the distance between yellow dots in diagram. Additional sample sites may be added as necessary.

Study Region 6: Alderwood State Park

The Region 6 study area is Alderwood State Park. This region is chosen for its public access and recreational opportunities. There will be one sample site for this study area: Sample Site 1 (44° 9'26.09"N, 123°25'21.55"W). This sample site will include 3 sites across the stream channel. Sample sites are not shown in diagram because the water path is not clearly indicated. Additional sample site may be added as necessary.



Appendix A
AGDRIFT MODELING RESULT
Tier III Forestry

Model Inputs

Constants
- Aircraft: Hiller Soloy Turbine
- Drop Size Distribution: ASAE Medium to Coarse
- Flight Line: 20
- Swath Width: 1.2x Wingspan
- Swath Displacement: Fraction of Swath Width (0.2)
- Wind Direction: -90 degree
- Atmospheric Stability: Overcast
- Canopy Type: None
- Surface Roughness: 0.0246
- Spray Materials
  - Specific Gravity (Carrier): 1
  - Specific Gravity (Nonvolatile): 1.14
  - Evaporation Rate: 84.76 (μm^2/°C/sec)
  - Nonvolatile Fraction: 0.0176
  - Active Fraction: 0.0026
  - Spray Volume Rate: 0.719 (gal/ac)

Variables
- Boom Height: 10 to 100 ft (feet)
- Wind Speed: 4 to 10 mph (mile per hour)
- Temperature: 40 to 70 °F
- Relative Humidity: 40 to 100 %
- Upslope angle: 45 to 60 degree

Base Model

The base model represents typical pesticide application conditions in the investigation area. Input for variables were determined through spray record data.

Variables
- Boom Height: 40 ft
- Wind Speed: 4 mph
- Temperature: 60°F
- Relative Humidity: 60 %
- Upslope angle: 45 degree

Model Sensitivity Test

The base model was used to assess sensitivity of temperature, relative humidity, slope angle, boom height, and wind speed to deposition distance. Changes to temperature and relative humidity did not produce noticeable change to the deposition distance. Different slope angles did produce noticeable change in deposition curve, but is relatively insignificant. Changes to boom height and wind speed showed significant change in deposition distance.

Temperature

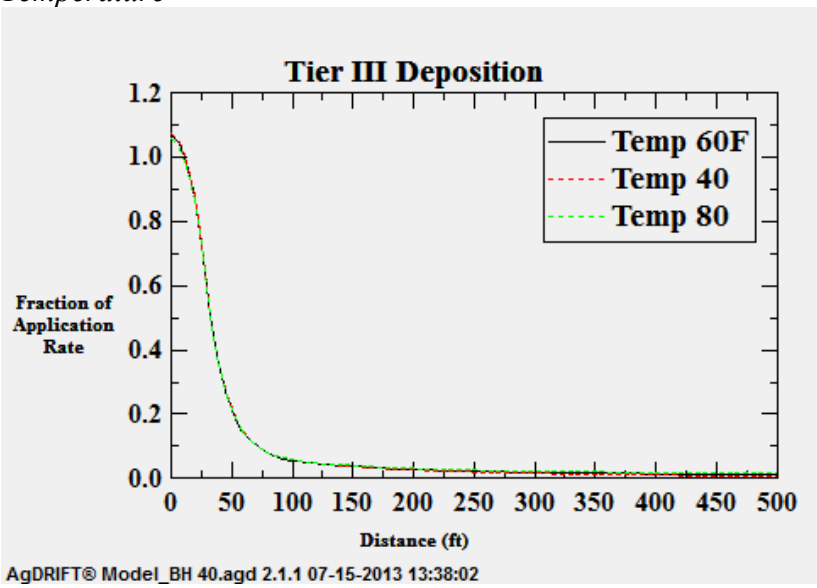


Figure 3. Deposition profile for different temperature scenarios.

Relative Humidity

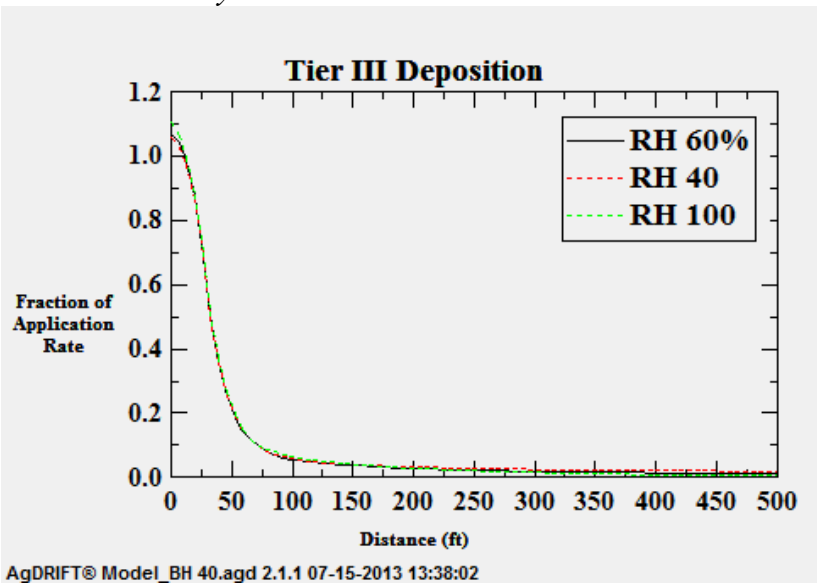


Figure 4. Deposition profile for different relative humidity scenarios.

Slope Angle

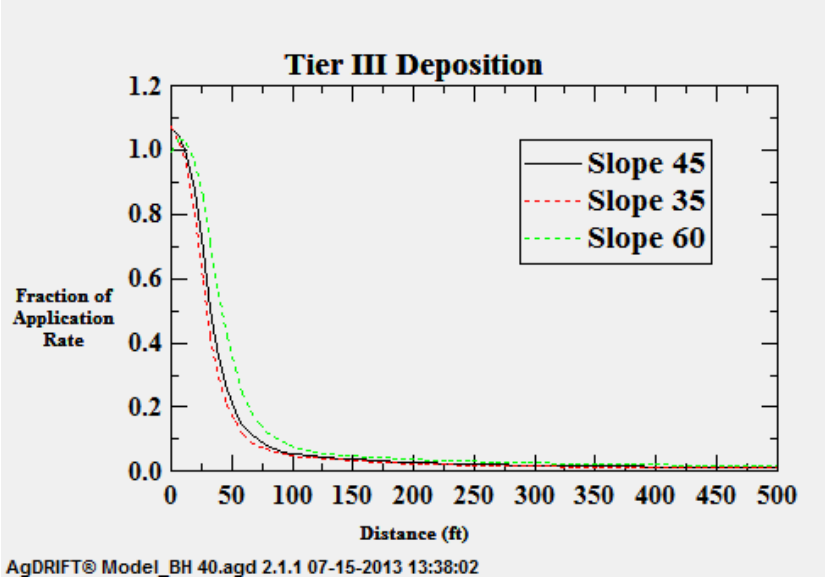


Figure 5.Deposition profile for different slope angle scenarios.

Boom Height

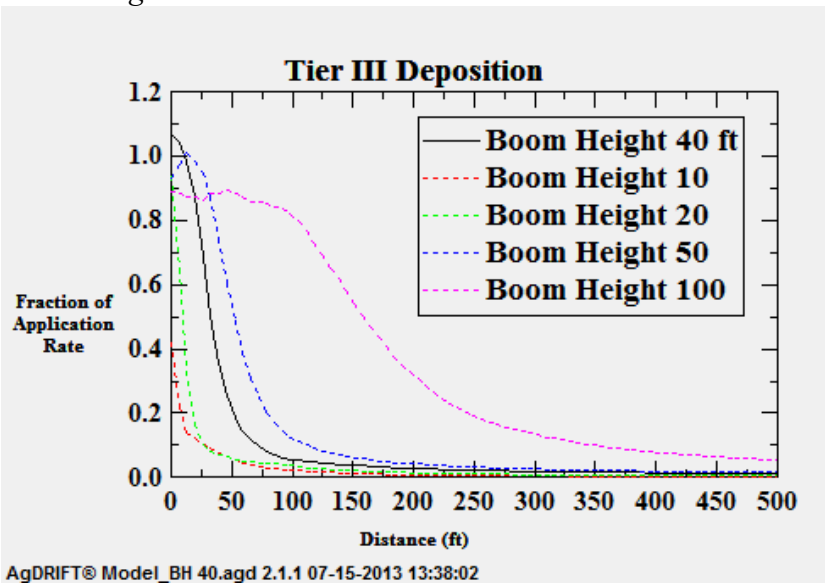


Figure 6. Deposition profile for different boom height scenarios.

Wind Speed

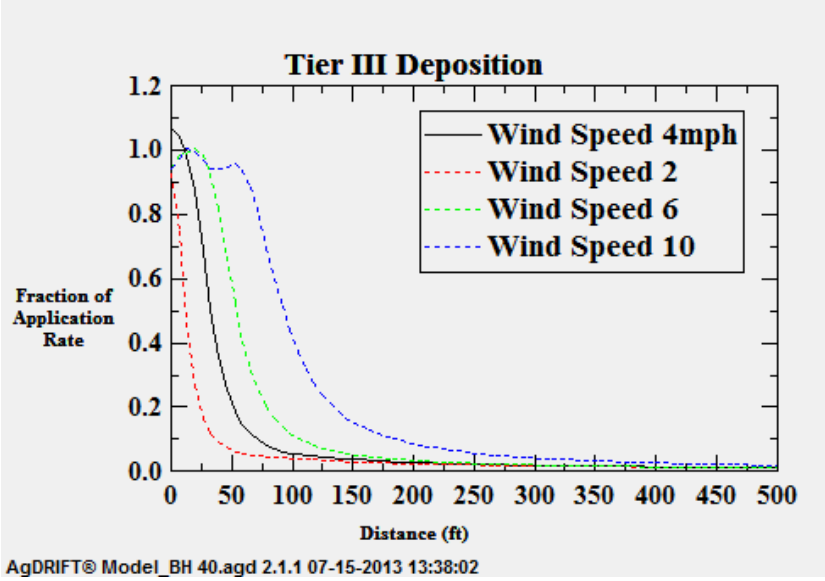


Figure 7. Deposition profile for different wind speed scenarios.

Stream Assessment

Stream assessment analyses were performed using base model. Default geometry inputs were used for stream assessment with the exception of the distance from edge of application area to center of stream (DFEAACS). Two inputs, 60 and 300 ft, were used as DFEAACS to assess current buffer zone regulation versus court ordered buffer zone resulting from Washington Toxics Coalition, et al. v. EPA 2004.

Stream Assessment Inputs

- Spray Line Length: 328.08 ft
- Turn-Around Time: 30 sec
- Stream Width: 9.84 ft
- Stream Depth: 1.64 ft
- Flow Rate: 396.3 gal/s
- Riparian Interception Factor: 0
- Instream Chemical Decay Rate: 0
- Recharge Rate: 0

The result indicates drastic reduction of in-stream contamination at all four time points. A 60 ft buffer zone scenario results in 150 to 245 ng/L between 1,000 and 13,000 ft. With a 300 ft buffer zone, stream contamination decreased to 12 to 15 ng/L.

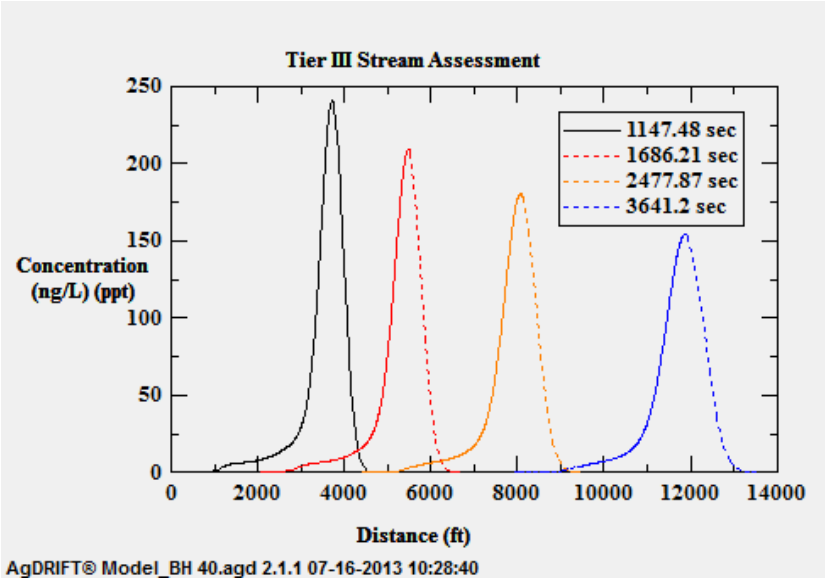


Figure 8. Base inputs with 60ft buffer zone

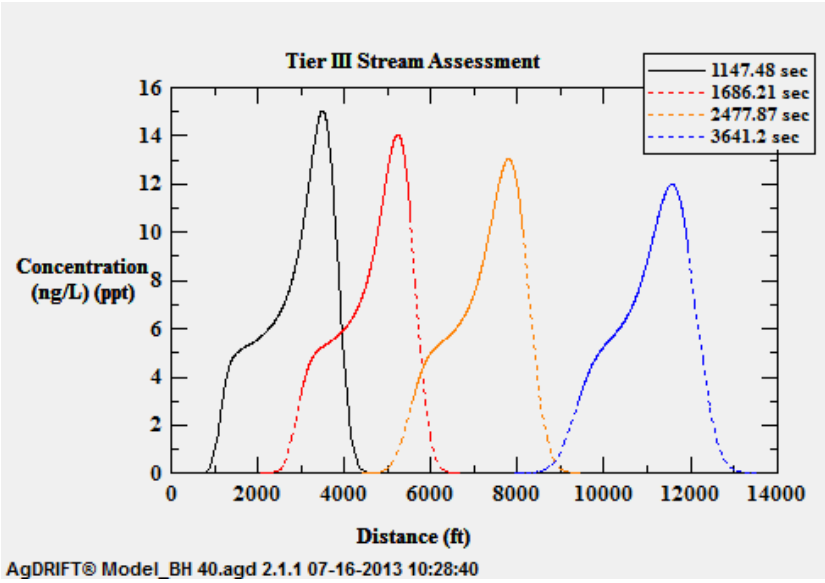


Figure 9. Base inputs with 300ft buffer zone