APPENDIX J

FOREST CHEMICALS

INTRODUCTION

This appendix discusses the potential effects of the use of forest chemicals on water quality and fish and wildlife vitality, including a comparison of the three Forest Practices Rules alternatives currently being considered by the Forest Practices Board. The two main categories of chemicals currently in use in forest management are fertilizers and pesticides. This appendix discusses the potential impacts of pesticide application only, because no changes are proposed to current fertilizer application rules under any of the alternatives.

Pesticides

Pesticides used in forest management include a wide variety of chemicals introduced to the forest environment with the intent of controlling or halting the proliferation of nuisance organisms. Pesticides are commonly grouped according to one of three target organisms: plants (herbicides), insects (insecticides), and fungi (fungicides). Pesticides are distributed to the target environment by means of mechanical methods, including hand spraying, machine spraying, and aerial application (generally by helicopter). Pesticide application rates and timing vary considerably depending on season, target species, forest type, and location. In general, pesticide application rates on forested lands are fairly infrequent, with roughly one to two applications every 40 or 50 years. Applications can occur more frequently if needed, but typically they are relatively infrequent. The effects of individual pesticides usually are determined by the active ingredients. In addition, prior to application, almost all pesticides are combined with a surfactant (i.e., a surface-active agent) or other adjuvant (i.e., a pharmacological agent added to increase or aid the chemical's effect) to control and improve the desired effect. Although these additives present lesser threats to the environment than the active ingredients in the pesticides, their impacts can be significant (Washington Department of Agriculture et al., 1993).

The widespread use of pesticides in forest management and the difficulty in controlling their distribution after application can result in adverse impacts on water quality and fish and wildlife species following application. Once released into the forest environment, pesticides can have a wide range of fates and impacts, depending on their specific chemical properties, the methods and conditions of application, and the environmental conditions into which they are introduced. The intended purpose is for the pesticide to be absorbed by the target organisms and metabolized within those organisms without contact with other nontarget organisms. However, in practice, some of the pesticides released into the environment never encounter their target organisms. Instead, these pesticides may either degrade naturally over time without direct impact on sensitive organisms, or be transported by wind and water to other environments where they may encounter any number of nontarget organisms. The complex and uncertain fate of these transported chemicals is the primary focus of this appendix.

METHODS

The data and information presented in this appendix were gathered through an extensive literature review, as well as through interviews with state agency and business representatives in the forest management industry. Most of the information on the affected environments in Washington state was obtained from public sources of environmental information. Information on the use and application of forest pesticides was obtained through a variety of sources, including public agencies involved in forest management and forest pesticides, private landowners, and several distributors of forest pesticides in Washington. Data on the fate, transport, and toxicity of forest pesticides were gathered through a thorough literature review of related information.

Much of the information presented in this appendix is of a general nature, given the wide range of pesticides and environmental conditions under consideration. Detailed information on pesticide use in specific areas is not readily available and would require further research depending on the area and pesticide of interest. Details on the toxicity and characteristics of individual pesticides were obtained during the literature review and are readily available but are only partially presented in this appendix. The large number of pesticides registered in Washington state (190 distinct products and 282 different adjuvants) and the wide range of effects of these pesticides on the environment require a somewhat general analysis of the impacts of forest pesticides and the potential impacts associated with each proposed forest management alternative.

DESCRIPTION OF THE ALTERNATIVES

The main text of the Forest Practices Rules EIS describes the three alternatives under consideration by the Forest Practices Board. The following paragraphs focus on the differences among the three alternatives pertinent to the issues of forest pesticide use and application, with particular emphasis on forest pesticide impacts on water resources. Information on the water typing definitions used under each alternative is also included in the main text and other supplemental appendices of the EIS. Finally, it is important to note that several other laws and regulations, in addition to those discussed in this EIS, apply to the conduct of forest practices (WAC 222-50). Moreover, some of these are administered by other agencies and may require permits from such agencies prior to the conduct of certain forest practices. For example WAC 222-16-070 (pesticide uses with the potential for a substantial impact on the environment) requires the applicator to first go through the evaluation of site specific aerially applied chemicals in order to get approval for their application. In this case, this preliminary requirement addresses the available information on the toxicity of the specific pesticide and the proposed applications. Thus, the alternatives discussed below are general application rules, subject to additional state and federal regulations.

Alternative 1

Alternative 1 represents the No-action Alternative under which the current Forest Practices Rules (WAC 222) would remain unchanged. The rules considered under the No-action Alternative are defined in the *Washington Forest Practices Rule Book* dated November 1998. These current Forest

Practices Rules primarily regulate the handling, storage, and application of forest pesticides to prevent adverse impacts on humans, lands, fish, wildlife, aquatic habitat, and water quality.

Alternative 1 includes basic and straightforward requirements on the handling, storage, and disposal of forest pesticides consistent with applicable state and federal requirements. In addition, Alternative 1 specifies that forest pesticides cannot be applied within 200 feet of residences or within 100 feet of land used for agriculture unless approved by the adjacent landowner. This assumes that applications that are allowed by the landowners would still be subject to the applicable buffers for any surface waters on the property. Ground application of forest pesticides using power equipment requires a 25-foot buffer on Type A or B wetlands and all typed waters (excluding Type 4 and 5 waters without surface water). Pesticides may be applied within this 25-foot buffer if applied by hand to specific targets. Aerial application of pesticides (the most common application method) requires a 50-foot buffer on all typed waters, excluding Type 4 and 5 waters without surface water. All forest pesticides may be applied to riparian management zones (RMZ) and wetland management zones (WMZ), provided that they are applied by hand. In addition, under special circumstances, Washington DNR may authorize power and aerial applications within RMZs if it can be shown that there will be no impact to surface waters. Details on the water typing system for Alternative 1 can be found in the main text of the Forest Practices Rules EIS.

Alternative 2

Alternative 2 is similar to Alternative 1 for rules governing handling and storage requirements, including labeling and applicable water quality standards, but contains additional requirements targeting the protection of aquatic resources and wetlands.

Alternative 2 states that the goal of zero drift and zero entry of pesticides to waters is very difficult to accomplish and therefore proposes the implementation of best management practices (BMPs) designed to "eliminate the direct entry of pesticides to water (defined as the entry of medium to large droplets), while minimizing off-target drift" (WDNR, 1999). In addition, Alternative 2 proposes to "minimize the entry into riparian zones of pesticides that would cause significant damage to riparian vegetation" (WDNR, 1999). The additional restrictions are designed to enable forest managers to effectively manage riparian areas to maximize riparian health and function while protecting water quality. Alternative 2 recommends a range of buffer widths depending on water type, environmental conditions, and the method of application. Tables 1, 2, and 3, adapted from the *Forests and Fish Report* (WDNR, 1999), summarize the recommendations embodied in Alternative 2.

Alternative 3

Alternative 3 is very similar to Alternative 2 but includes three minor additions. First, plants with cultural value would be protected from forest pesticides. Second, hand application of forest pesticides would be prohibited within 50 feet of all typed waters. Finally, in cases where forest pesticides are necessary to help restore riparian management zone functions, an alternative plan would be required.

Table 1. Alternative 2: Pesticide Application Buffers on Type S and Type F streams

		Wind			
		Favorable		Calm or Unfavorable	
Nozzle Type	**Application Height**	**Buffer on Water**	**Offset from Inner Zone**	**Buffer on Water**	**Offset from Inner Zone**
Regular Nozzle [1/]	Low (≤16 feet)	Width of inner zone	As needed for safety	100 feet or inner zone, which is greater	50 feet
	Medium (17-50 feet)	Width of inner zone	As needed for safety	250 feet	–
	High (51-65 feet)	Width of inner zone	As needed for safety	325 feet	–
Raindrop Nozzle (or other nozzles that result in the same size spray droplets) [2/]	Low (≤16 feet)	Width of	As needed for safety	Width of inner zone	20 feet
	Medium (17-50 feet)	Width of inner zone	As needed for safety	Width of inner zone	20 feet
	High (51-65 feet)	Width of inner zone	As needed for safety	125 feet or inner zone, whichever is greater	20 feet

[1/] Coarse spray droplets = approximately 9% of spray-droplet volume ≤ 150 u
[2/] Ultra coarse spray droplets = approximately 1% of spray-droplet volume ≤ 150 u
Source: *Forests and Fish Report* (FPB) 1999.

Table 2. Alternative 2: Pesticide Application Buffers on Type N Streams with Flowing Waters and Type B Wetlands Smaller than 5 Acres

	Wind	
	Favorable	Calm or Unfavorable
Nozzle Type	**Buffer on Water or Wetland**	**Buffer on Water or Wetland**
Regular Nozzle [1/]	50 feet	100 feet
Raindrop Nozzle or nozzles that result in the same size spray droplets) [2/]	50 feet	70 feet

[1/] Coarse spray droplets = approximately 9% of spray-droplet volume ≤ 150 u
[2/] Ultra coarse spray droplets = approximately 1% of spray-droplet volume ≤ 150 u
Source: *Forests and Fish Report* (FPB) 1999.

Table 3. Alternative 2: Pesticide Application Buffers on Type A and Type B Wetlands

		Wind			
		Favorable Wind		Calm or Unfavorable Wind	
Nozzle Type	**Application Height**	**Buffer Wetland**	**Offset from WMZ**	**Buffer Wetland**	**Offset from WMZ**
Regular Nozzle [1/]	Low (≤16 feet)	Width of WMZ	As needed for safety	150 feet	–
	Medium (17-50 feet)	Width of WMZ	As needed for safety	250 feet	–
	High (51-65 feet)	Width of WMZ	As needed for safety	325 feet	–
Raindrop Nozzle (or other nozzles that result in the same size spray droplets) [2/]	Low (≤16 feet)	Width of WMZ	As needed for safety	Width of WMZ	20 feet
	Medium (17-50 feet)	Width of WMZ	As needed for safety	Width of WMZ	20 feet
	High (51-65 feet)	Width of the WMZ	As needed for safety	125 feet or WMZ, whichever is greater	20 feet

[1/] Coarse spray droplets = approximately 9% of spray-droplet volume ≤ 150 u
[2/] Ultra coarse spray droplets = approximately 1% of spray-droplet volume ≤ 150 u
WMZ = wetland management zone.
Source: *Forests and Fish Report* (FPB, 1999).

AFFECTED ENVIRONMENT

All forest land governed by the Forest Practices Act is subject to various state and federal regulations on forest chemical use and application. The regulations governing forest pesticide use and application apply to all regions within the state, encompassing a wide range of environmental conditions. To appropriately consider the environmental effects of forest pesticides, therefore, it is important to understand the varying environmental conditions in Washington state. However, the fate and transport of specific pesticides also depends on specific conditions of the site where they are applied. Climate, soil, and water conditions in particular play important roles in the fate and transport of forest pesticides. Because environmental conditions vary widely across the state, it is beyond the scope of this appendix to assess all conditions under which forest pesticides are applied. Instead, the following paragraphs provide a general characterization of the natural environment potentially affected by forest pesticide application under a wide range of conditions state-wide.

Climate

A distinctly varied climate characterizes Washington state, primarily resulting from two major features, the Cascade range and the prevailing marine influence of the Pacific Ocean (USGS, 1998). Weather in the western part of the state is generally mild, with the Pacific Ocean generating warmer, less severe winters and cooler, drier summers. The winters are notably wet (typically 80 percent of the total annual precipitation falls in the winter), while summers are generally dry, with areas of inconsistent, localized thunderstorms (USDA, 1988). Weather east of the Cascade range is more severe than that of the west side (colder winters and drier, warmer summers), although the Pacific weather patterns are still the dominant influences.

Rainfall patterns are also strongly influenced by the Pacific weather patterns and the mountain ranges, with generally heavy rain in areas west of the mountains and much drier weather in the rain shadows east of the major ranges. The coastal forests have the greatest amount of precipitation, with up to 150 inches of precipitation per year, much of it falling as rain. Precipitation over the western slopes of the Cascade forests is nearly as intense, generating roughly 100 to 150 inches annually, with heavy snow in the higher elevations (during the winter months) and persistent rain in the lower elevations. The Puget Sound region generally receives 30 to 50 inches of precipitation per year. Beyond the crest of the Cascade range, annual precipitation decreases dramatically to 20 inches or less in some areas, although most of the forests are located in mountain areas or uplands (e.g., Wallowa Mountains, Blue Mountains, Okanogan Highlands) where precipitation increases with elevation (USDA, 1988).

Soils

Soil types and characteristics vary greatly across the state, often with dramatic differences in localized areas as a result of significant tectonic, volcanic, and glacial activity. The physical and chemical characteristics of soils have a great influence on the fate and transport of forest pesticides. For example, the soil porosity controls the ability of a pesticide to infiltrate to shallow or deep groundwater, while chemical characteristics can influence the degradation or persistence of forest pesticides. In general, soils in the region are relatively young and unstable, given recent and ongoing volcanic and glacial activity. The resulting above-average erosion potential for many of the forested soils can lead to increased transport of forest pesticides (USDA, 1988). The influence of site-specific soil characteristics on the fate and transport of particular forest pesticides, however, must be assessed on a case-by-case basis.

Water

SURFACE WATER

The wet Pacific weather systems, heavy rains on the western slopes of the Cascades, and desert-like conditions east of the Cascades create a myriad of surface water conditions in Washington state. Literally all forested lands in Washington have distinct surface water features, ranging from small, intermittent streams to the very large Columbia and Snake rivers. Most of these rivers and streams support complex aquatic ecosystems, including stocks of threatened or endangered Pacific salmon and numerous other aquatic communities. Likewise, Puget Sound represents a complex and valuable marine resource to Washington state that potentially could be harmed by the application of forest pesticides. In this appendix, the impacts associated with forest pesticide use are assessed relative to surface waters in general, given the wide range of conditions encountered throughout the state.

GROUNDWATER

Groundwater depths, volumes, uses, and vulnerability to contamination vary considerably across Washington state. Groundwater provides drinking water for 60 to 70 percent of the population throughout the state. In large areas east of the Cascade mountain range, 80 to 100 percent of available drinking water is obtained from groundwater resources. As a whole, over 95 percent of Washington's public water supply systems use groundwater as their primary water source (EPA, 1999c). In addition, some areas of the state, including most of Island and San Juan Counties, rely solely on groundwater sources for potable water.

Groundwater is also often connected directly or indirectly to rivers, streams, lakes, and other surface water bodies, with the exchange of water occurring between these resources. In some areas of the state, groundwater contributes significantly to the base-flow in streams and summer-flow to lakes. Depending on the geologic and hydrologic conditions of the aquifer, contaminated groundwater may discharge to surface areas within one day, or may take as long as a thousand years or more (EPA, 1986). In addition, surface waters can contribute to groundwater recharge. Impacts on groundwater, therefore, also can lead to impacts on surface waters (and vice versa) as well as to aquatic organisms.

Sole-Source Aquifers

Certain areas of Washington state acquire 100 percent of their potable water from groundwater sources (sole-source aquifers). Arid areas east of the Cascades as well as saltwater islands in the Puget Sound region are particularly dependent on sole-source aquifers. State and federal programs and regulations that address groundwater quality and nitrate contamination (e.g., the Safe Drinking Water Act) mandate the routine monitoring of public supply wells to protect groundwater quality.

WETLANDS

Wetlands of varying size and quality are found throughout Washington's forested lands. Wetlands are diverse and extremely valuable ecological resources providing numerous hydrologic, chemical, and biological benefits to the environment. Wetlands also provide an important link between terrestrial and aquatic ecosystems. Although wetlands are fairly resilient to chemical inputs, their capacity to assimilate forest pesticides is limited (Mitsch and Gosselink, 1993).

The Forest Practices Rules primarily focus on limiting physical disturbance in and around wetlands, although the impact of forest pesticides is also a concern. In particular, the rules are concerned with potentially excessive levels of herbicides in wetlands that could damage native plant species, allowing unwanted invasive species to dominate.

Existing Forest Chemical Use

The use of forest chemicals presents a variety of environmental threats, including those to human health, marine and freshwater organisms, and terrestrial ecosystems. The severity of the threat associated with a given chemical depends largely upon the properties of the chemical, but is also influenced by the environment to which it is introduced and the organisms it may encounter. In general, the primary chemicals of concern in forest practices are pesticides, with less concern surrounding the use and application of fertilizers. Fertilizers can have significant detrimental effects on the environment, but these effects often are easier to predict and control than the effects of pesticides. Nevertheless, this appendix discusses only the potential impacts of pesticides, as no changes are proposed to current fertilizer application regulations under any of the alternatives.

In addition to the active pesticide ingredient, most forest pesticides are combined with a surfactant or adjuvant before application to control and improve the desired effect. Adjuvants encompass a wide variety of products including acidifiers, attractants, buffers, defoaming agents, deposition aids, extenders, spray colorants, spreader-stickers, surfactants, and thickeners. The adjuvants are added to perform one or more of the following functions: improve foliage wetting and coverage, reduce evaporation rate of the spray, improve weatherability of spray deposit, enhance penetration and translocation, adjust pH, and improve the compatibility of mixtures (Washington Department of Agriculture et al., 1993). Although adjuvants can have toxicity equal to or greater than the active pesticide ingredients, adjuvants typically are not part of the original pesticide formulation and are not subject to the Federal Insecticide, Fungicide, and Rodenticide Act requirements for registration. As a result, much of the environmental fate, transport, and toxicity data available for pesticides are not currently available for many adjuvants (Washington Department of Agriculture et al., 1993). In general, although some adjuvants can be highly toxic to humans or wildlife, most present a lesser threat to the environment than the active ingredients in the pesticides. Nonetheless, a list of adjuvants registered with Washington Department of Agriculture (and their toxicities) is included at the end of this appendix (Attachment A2). The majority of this appendix, however, focuses on the use and impacts of pesticides.

The net impact of a pesticide on the environment is commonly assessed based on the toxicity of the chemical and the information that is known regarding the fate and transport of the chemical. The U.S. Environmental Protection Agency (EPA) registers each pesticide product in the United States and assigns it a hazard category (I through IV) based on acute toxicity as well as skin and eye irritation (EPA, 1999a). Products in category I are most hazardous and carry the word *DANGER* on their labels. Products in category II are labeled *WARNING*, while those in categories III and IV are labeled *CAUTION*. Note however, that the EPA hazard classification is based on the greatest potential hazard associated with the full product formulation. For example, a relatively nontoxic product (via ingestion, inhalation, or skin absorption) could be placed in the highest hazard category if it were known to cause extreme eye irritation (Dickey, 1999). This rating system therefore allows for some inconsistency between the label ratings and toxicity ratings to different organisms under different scenarios.

In addition to the EPA labeling system, many state agencies and private groups have researched the various active ingredients in many pesticides to assess their physical and chemical properties including (but not limited to); persistence (half-life), mobility, carcinogenic effects, reproductive effects, nerve or endocrine disruption, and toxicity to various organisms including fish, birds, rodents, and others. Water quality standards have been established or recommended for many chemicals, although these are typically based on human or plant toxicology concerns (Neary and Michael, 1996) and may not be representative of impacts on other aquatic or terrestrial organisms. More stringent guidelines for the protection of aquatic life have been developed, but only for a few of the chemicals in use. Extensive narrative criteria (i.e., statements prohibiting certain actions or conditions) also apply to pesticide applications in Washington, but these can be difficult to interpret or enforce in practice. Ongoing research and study efforts are working to better identify potential impacts and to help modify applicable standards.

The Washington Department of Agriculture currently lists 190 registered pesticides (see Attachment A1 at the end of this appendix) encompassing a wide range of toxicities, solubilities, and half-lives (persistence). Of these 190 chemicals, 10 to 15 of them represent approximately 90 percent of the total mass of pesticides applied to forested lands in Washington state (Table 4). The rest are used only in localized areas (i.e., less than approximately 100 acres per year) or virtually not at all. The information presented in Table 4 provides a brief but informative look at the characteristics of the most common pesticides that influence their toxicity in the natural environment. Given the large number of products and the somewhat limited scope of this appendix, it is not feasible to address all of the pesticides in use or all of their known properties. Instead, the goal of this section is to present a general qualitative analysis of the most commonly applied pesticides. However, because the remaining pesticides are registered and can be applied to forest lands as needed, an evaluation of the impacts associated with pesticide use must include all 190 products in considering all potential pesticide applications and impacts.

The notes in the last column of Table 4 summarize the important chemical properties of each pesticide. Based on information that is available from reliable sources of toxicological data, these properties are briefly discussed in the following sections.

CARCINOGENIC EFFECTS OF PESTICIDES

Many different state, federal, and private institutions dedicate a great deal of research time and effort to evaluating the potential for these chemicals to cause cancer in humans or other organisms. The information generated often can be inconclusive, resulting in a variety of rating systems and assessments for the same chemical. The information presented in Table 4 represents a summary of different sources of carcinogenic data. The term “not classifiable” indicates that one or more reliable studies produced results that do not allow for specific classification regarding the likelihood of carcinogenic effects in humans.

Table 4. Common Pesticides used in Washington State Forest Practices

Product	Ingredient	EPA Overall Toxicity [1/]	Type	Notes [2/]
Weedone **	2,4-D Ester	High	Herbicide	Low persistence; moderate mobility; slightly toxic to fish and wildlife
Arsenal **	Isopropylamine salt of imazapyr	Low	Herbicide	High persistence; very low mobility; low toxicity to fish and wildlife
Chopper	Isopropylamine salt of imazapyr	Low	Herbicide	High persistence; very low mobility; low toxicity to fish and wildlife
Garlon 3A	Triclopyr	High	Herbicide	Carcinogenic effects are not classifiable; moderate persistence; very high mobility; very low toxicity to fish and wildlife
Garlon 4 **	Triclopyr	Low	Herbicide	Carcinogenic effects are not classifiable; moderate persistence; very high mobility; very low toxicity to fish and wildlife
Oust Herbicide **	Sulfometuron methyl	Low	Herbicide	No evidence of carcinogenic effects; persistence and mobility are variable depending on environment; slightly nontoxic to practically nontoxic to fish and wildlife
Pathfinder II	Triclopyr butoxyethyl ester	Low	Herbicide	Carcinogenic effects are not classifiable; moderate persistence; very high mobility; very low toxicity to fish and wildlife
Pronone 25G	Hexazinone	Low	Herbicide	Carcinogenic effects are not classifiable; moderate persistence; low mobility; low to moderate toxicity to fish and wildlife
Roundup** (without surfactant)	Glyphosate	Medium	Herbicide	No evidence of carcinogenic effects; moderate persistence (especially in water); extremely low mobility; practically nontoxic to fish, may be slightly toxic to aquatic invertebrates; use of surfactant (e.g., used in Roundup Original) significantly increases toxicity to fish and wildlife
Transline	Clopyralid	Low	Herbicide	Low persistence; moderate to high mobility; low toxicity to fish and wildlife
Velpar DF	Hexazinone	High	Herbicide	Carcinogenic effects are not classifiable; moderate persistence; low mobility; low to moderate toxicity to fish and wildlife
Velpar L Herbicide	Hexazinone	High	Herbicide	Carcinogenic effects are not classifiable; moderate persistence; low mobility; low to moderate toxicity to fish and wildlife
Weedar 64	2,4-D Dimethylamine	High	Herbicide	Possible carcinogen; low persistence; low mobility; low toxicity to fish and wildlife

[1/] The overall toxicity is based on the EPA hazard categorization (I through IV) which measures acute toxicity and skin and eye irritation of pesticide chemicals (EPA, 1999a). High toxicity refers to chemicals in category I, medium toxicity refers to chemicals in category II, and low toxicity refers to chemicals in categories III and IV. EPA hazard categories reflect the greatest potential hazards and do not necessarily reflect expected toxicity to all species of fish and wildlife.

[2/] Low persistence represents an average reported half-life less than 30 days, moderate persistence represents a half-life of 30 to 100 days, and high persistence represents a half-life greater than 100 days. Mobility is based on an experimentally derived adsorption coefficient that reflects the likelihood of leaching through soil or adsorbing to sediments. Toxicity levels represent general statements about the expected impacts to most species of fish and wildlife. Summary information was obtained from one or more of the following sources: U.S. Department of Agriculture (1984); U.S. Fish and Wildlife Service (1984); Weed Science Society of America (1989); Howard (1991); Dickey (1999); Extoxnet (1999); EPA (1999b); Johansen (1999 personal communication).

** Of the more common products, these were identified most frequently or were specifically highlighted as a particularly common product (Dalrymple [1999 personal communication], Hiner [1999 personal communication], Wasson [1999 personal communication]).

PERSISTENCE OF PESTICIDES

The persistence of a chemical refers to the natural rate of degradation (or half-life) of a chemical. The persistence of a pesticide, therefore, plays an important role when evaluating the probability that it will be transported away from the environment to which it was delivered. The rate and process of degradation vary widely among pesticides (or even for the same chemical) depending on the physical, chemical, and biological conditions to which it was applied. For example, the half-life of a given pesticide is generally different depending on whether it is measured in soil or in water. Likewise, the chemical and microbiological properties of the environment play a key role in the rate of degradation of many pesticides. The information presented in Table 4, therefore, is very general and reflects differing reports from various field and laboratory observations under varying conditions.

Low persistence refers to a chemical with an average reported half-life less than 30 days. Moderate persistence represents a half-life of 30 to 100 days, and chemicals with high persistence have a half-life greater than 100 days. In general, the longer the half-life of the pesticide (higher persistence), the more likely that it will still be active if and when natural wind- or stormwater runoff-induced erosion transports the pesticide from where it was applied. Less persistent pesticides tend to rapidly degrade to their (unless specified) less toxic constituents.

MOBILITY OF PESTICIDES

Mobility is the other major property that helps determine the transport of a given chemical. Mobility refers to an experimentally derived adsorption coefficient that reflects the ability of the chemical to bind to soil particles. The methods for determining the soil adsorption coefficient are fairly standard (Howard, 1991). Once obtained, the coefficients can be used to determine the likelihood of leaching through soil or adsorbing to sediments, using the criteria of Swann et al. (1983) (Howard, 1991). High mobility refers to a pesticide that does not bind strongly to sediments and therefore is easily transported from the treated area (often leaching to groundwater). Low mobility refers to pesticides that form strong bonds with soils and sediments and are less likely to be transported from the treated area.

PESTICIDE TOXICITY TO FISH AND WILDLIFE

The toxicity of certain pesticides to various species of fish and wildlife is almost entirely determined by experimentation on a limited number of test organisms. Toxicity tests are conducted using various test organisms to determine acute (short-term, lethal) and chronic (extended exposure) toxicity levels, often reported as lethal concentration (LC_{50}) and effect concentration (EC_{50}) for 50 percent of the test organisms. However, the sensitivity of different organisms to the same pesticide can vary significantly from species to species, even within the same genus (U.S. Fish and Wildlife Service, 1984). An assessment of a given pesticide's toxicity to fish and wildlife, therefore, does not represent a definitive statement on the pesticide’s toxicity to all organisms, but rather a general statement about the likely impacts to most species of fish and wildlife. Most of the more common pesticides used in Washington state generally were found to have low toxicity to fish and wildlife.

ENVIRONMENTAL IMPACTS

The environmental impacts of forest pesticides can be very complex and variable across Washington state. In particular, the complex fate and transport of forest pesticides make predicting the net impact to the environment difficult. Likewise, the large number of different pesticides in use and the varying (and to some degree uncertain) application rates make specific predictions a near impossibility. Finally, the potential additive, antagonistic, or synergistic effects of multiple chemical interactions add additional complexity and uncertainty to statewide impact assessments. Nevertheless, it is possible to make a meaningful general assessment of the environmental impacts of forest pesticides.

Some data are available regarding pesticide levels found in Washington state streams and groundwater. However, many of these data focus on pesticides used for agricultural production and not those commonly used in forest management. Although there is some overlap between the pesticides used for both practices, typically it is not possible to determine which pesticides originated from agricultural sources versus those contributed from forested land. In addition, agricultural applications typically occur with much greater frequency (i.e., annually), whereas forest chemical applications typically occur decades apart.

Nonetheless, a few recent studies have analyzed pesticide contamination in streams and groundwater in Washington state (USGS, 1996a,b,c, 1997a,b, 1999; Ecology, 1993) and throughout the United States and Canada (Neary and Michael, 1996). One study conducted in the Puget Sound region found measurable levels of pesticides in most small streams and some streambed sediments (USGS, 1997b). Most of the pesticides detected were not registered forest practices chemicals (and therefore did not come from forest applications). However, a few were registered forest pesticides and one (Triclopyr) is one of the more commonly used forestry pesticides (see Table 4). Other studies focused on groundwater contamination in Washington state found similar results (USGS, 1996a,b,c). Several pesticides were detected in most groundwater samples, although most of those detected were not registered forest management pesticides. However, a few of the pesticides frequently detected were registered for forest application. In particular, 2,4-D, Atrazine, and Simazine were commonly detected in groundwater samples across the state. Again, however, these pesticides are also registered for and heavily used in agricultural and urban practices, and they should not be assumed to originate solely from forest applications.

Neary and Michael (1996) also found similar results in their research in the United States and Canada. In general, forest chemical applications did not result in violations of water quality standards, although low levels of contamination were almost always detectable after forest chemical applications. Concentrations exceeding instantaneous water quality standards were recorded in cases where stream buffers were not used or where applications occurred over dry or ephemeral streams. The study also acknowledges that standard processes for setting water quality standards for herbicides have not been established, and consensus regarding acceptable in-stream concentrations is lacking.

A 1993 Ecology study (Ecology, 1993) focusing directly on BMP effectiveness for forestry applications found that the existing rules (Alternative 1) were generally ineffective at meeting applicable water quality standards, Forest Practices Rule requirements, and/or certain product label restrictions. Ecology found spray drift to be a major factor influencing water quality contamination and recommended increased buffers to further protect water quality.

Overall, the research to date has found measurable levels of pesticides in surface waters following forestry application, although most of those pesticides present were detected at low concentrations, usually well below water quality standards when 50-foot buffers were used. However, some pesticides were detected at concentrations that exceed more stringent guidelines for the protection of aquatic life (freshwater-chronic criteria) or health advisories for drinking water. Although only a few studies have focused directly on forestry applications, the research indicates the potential for certain chemicals to enter and persist in surface waters and groundwater supplies under current practices. In such cases, the net impacts on aquatic organisms would depend on exposure times and the individual organism's sensitivity to specific chemicals.

Impacts Common to All Alternatives

There are some potential impacts that could occur with nearly equal probability under all alternatives. Severe weather conditions with extreme wind or extreme rainfall could significantly increase the probability of forest pesticides entering nearby surface waters. Wind conditions strong enough to carry medium to large aerially applied pesticide droplets a distance greater than approximately 300 feet could result in significant chemical loading to surface waters adjacent to application sites under any of the alternatives. Likewise, unusually intense rain events over recently treated lands could transport significant levels of forest pesticides to surface waters through surface or shallow subsurface runoff, soil erosion, and contaminated soil transport. Although the concentrations would likely be somewhat diluted with the high volume of precipitation and runoff, the chemical load could be significant. Normal rainfall could also transport pesticides to surface waters, but the expected rates would differ among the alternatives (see below).

Most pesticide applications will also include the use of one or more pesticide adjuvants. Impacts to humans, fish, and wildlife could result from increased exposure to the pesticide additives used during forest pesticide applications; however, data on the toxicity of adjuvants is limited. Although some adjuvants may present significant environmental threats, this appendix focuses on the generally greater impacts associated with pesticides.

In addition, each of the alternatives under consideration allows for forest chemical applications over some dry or ephemeral stream segments. As noted earlier, Neary and Michael (1996) and Ecology (1993) both report instances where applications over dry channels resulted in very high in-stream concentrations of chemicals. Thus, applications over dry streambeds could result in significant adverse impacts on water quality and aquatic organisms. Any such impacts would also be temporary as the contamination would eventually be flushed through the system.

As stated earlier, it is important to note that several other laws and regulations, aside from the Forest Practices Rules, apply to the conduct of forest practices (WAC 222-50). In particular, all alternatives are subject to WAC 222-16-070 (pesticide uses with the potential for a substantial impact on the environment) which requires all aerial applications to first go through a site specific evaluation to obtain approval for all aerial applications. In this case, this preliminary process addresses the available information on the toxicity of the specific pesticide and the potential impacts of the proposed applications. The regulations imposed by this preliminary analysis are highly situation specific. In the more extreme circumstances, the required "key for the evaluation of site specific use of aerially applied chemicals" (WAC 222-16-070) may identify the application as "Class IV Special." This, in turn, would trigger "an environmental checklist in compliance with the State Environmental Policy Act (SEPA), and SEPA guidelines, as [the applications] have been determined to have potential for a substantial impact on the environment. It may be determined that additional information or a detailed environmental statement is required before these forest practices may be conducted" (WAC 222-16-50). Thus, the analysis presented in this appendix focuses on an evaluation of each alternative with the purpose of making comparisons among the three alternatives, and is not intended to include a discussion of all applicable forest chemical regulations.

Lastly, any accidental or intentional misuse of forest pesticides could result in significantly greater environmental impacts than would be expected under normal applications. The impacts discussed under each alternative are the most likely expected impacts, assuming that normal application rates are used and all label requirements are met.

Alternative 1 Impacts

SURFACE WATER IMPACTS

The Forest Practices Rules specified under Alternative 1 could result in impacts on surface waters in Washington state as a result of pesticides reaching surface waters during, or after forestry applications.

The allowance of hand application of pesticides within the riparian management zone should not result in overspray of pesticides to the degree that the chemicals would directly enter surface waters. Because of the slow surface and subsurface runoff from forested lands, the relatively infrequent pesticide applications, and the generally low toxicity of most pesticides, the application of most pesticides in the riparian management zone are not expected to result in significant impacts on water quality. However, application of highly persistent pesticides or pesticides with high mobility could result in surface water contamination through localized runoff or erosion. The overall impact would be situation- and pesticide-specific, depending on the specific pesticide's properties as well as the timing, duration, and extent of contamination. In addition, it is important to note that chemical applications in the riparian management area are beneficial in managing riparian areas by helping to promote and sustain preferred species growth and survival. Alternative methods for vegetation management (e.g., mechanical thinning) have been found to result in greater sedimentation impacts on water quality (Neary and Michael, 1996) and therefore may be less desirable than chemical treatments.

The 50-foot buffer required for aerial applications on all Type 1, 2, and 3 waters and flowing portions of Type 4 and 5 waters presents a significant risk of pesticides entering surface waters. A 50-foot buffer does not produce a high level of protection from wind that could transport medium to large aerially applied droplets directly to surface waters under some weather conditions (Ecology, 1993). Although the entry of pesticides into surface waters does not necessarily result in significant impacts (e.g., very low levels of pesticide contamination may not even be measurable), research has found a 50-foot buffer to be only partially effective to ineffective at protecting water quality (Ecology, 1993). Note, however, that in some situations, the dichotomous key presented in WAC 222-16-070 (pesticide uses with the potential for a substantial impact on the environment) indicates that some aerial applications within 100 feet of surface waters might trigger Class IV Special restrictions to further protect water quality (depending on the chemical and condition of the surface water). Thus, additional restrictions beyond those required by Alternative 1 may apply under some circumstances. Nonetheless, the 50-foot buffer poses an overall high risk of pesticide spray drift to surface waters that could result in water quality impacts.

Alternative 1 also does not include any special provisions or modifications for pesticide application based on weather conditions or equipment (i.e., wind speed, application height, nozzle type, droplet size, etc.). Variations in wind conditions, droplet size, air shear (function of nozzle angle and air speed), nozzle height, and boom length all have a significant influence on pesticide spray drift (SDTF, 1997a; Ecology, 1993). By not accounting for these variations, Alternative 1 allows for a significant risk of surface water contamination caused by adverse weather, and/or inappropriate equipment use and selection. The impacts on surface waters could be significant, depending on the specific pesticide properties and the condition of the affected surface water.

Detailed studies have been conducted on the incidence and impact of pesticide spray drift during aerial applications (SDTF, 1997a). Data generated through numerous field studies indicate that droplet size is the most important factor in determining spray drift potential, followed by the combined effects of equipment parameters, application technique, and weather. The data generated by the Spray Drift Task Force indicate that in a typical field aerial application, 98 percent of the total applied active ingredient stays on the field and only 2 percent drifts (SDTF, 1997a). Variations in wind conditions, droplet size, air shear (function of nozzle angle and air speed), nozzle height, and boom length can all play an important role in determining pesticide spray drift. Under most experimental conditions studied by the Spray Drift Task Force, the 50-foot buffer required under Alternative 1 would result in a risk of impacts on surface waters (SDTF, 1997a).

In addition, the application of pesticides to dry portions of Type 4 and 5 waters could result in the transport of these pesticides to downstream surface waters when flow returns to these streams. With low to moderately persistent pesticides the impacts are expected to be minor, because the chemicals would degrade fairly quickly, before flow returns to the stream (i.e., within a few weeks). With highly persistent or highly mobile pesticides, however, the effect could be comparable to that of a direct application to the surface water if a storm event occurs. As noted earlier, studies have detected extremely high concentrations of chemicals in surface waters resulting from applications over dry streambeds (Neary and Michael, 1996; Ecology, 1993). However, any associated impacts would be relatively short-lived, because the pollutants would be transported through the system with the first few storm events when flow returns to the dry system. Note that none of the alternatives provides any greater protection of dry streambeds; therefore the impacts would be the same under all alternatives.

When applying pesticides using power equipment from the ground, the 25-foot buffer required for all typed waters (excluding dry Type 4 and 5 waters) and all Type A and B wetlands should adequately protect surface waters from receiving significant pesticide overspray. Studies conducted by the Spray Drift Task Force indicate that in a typical field application, more than 99.9 percent of the applied active ingredient stays on the field, and less than one tenth of one percent drifts (corresponding to 0.08 ounces measured at a distance of 25 feet downwind; SDTF, 1997b). As with aerial applications however, droplet size (along with wind speed and nozzle height) can lead to significant increases in spray drift. The studies show that in general, spray drift resulting from ground applications can be kept very low by using careful application procedures. However, as with hand and aerial applications, a 25-foot buffer does not provide a high level of protection from highly mobile or highly persistent pesticides that may be transported to surface waters through erosion or stormwater runoff. A significant rain event could result in the transport of airborne or soil-bound pesticides to nearby surface waters. However, as stated earlier, the slow runoff from forested lands, relatively infrequent application of pesticides, and generally low toxicity of the most common pesticides are expected to limit surface water contamination. The net impacts would be site- and chemical-specific but could still result in adverse impacts on surface waters under certain conditions.

Hand application of pesticides within the wetland management zone should not result in significant impacts on surface waters, provided that those pesticides are applied only to specific targets and the required application rates are not exceeded. The 200-foot buffer required for applications around residences (unless the application is acceptable to the resident or landowner), designed to limit contamination of residential land in general, should also provide incidental protection of any surface waters near residences. This assumes that applications that are allowed by the landowners still would be subject to the applicable buffers for any surface waters on the property. The 100-foot buffer on agricultural land could result in spray drift of pesticides to agricultural land that in turn could allow the transport of forest pesticides to surface waters (SDTF, 1997b). This scenario is unlikely, however, and is not considered a significant threat to surface water contamination.

Any leaks, drips, and spills of pesticides could contaminate forest soils. The potential impacts of an accidental spill are highly dependent on the effectiveness of the required containment and cleanup procedures. If effective safety and cleanup measures are not implemented and contaminated soils erode, the contaminants could be passed to downstream waters. Finally, possible impacts on surface waters could occur through contaminated groundwater flow to surface waters. The extent of these impacts is difficult to predict but depends on the degree of contamination of the groundwater, the volume of water exchanged, the length of time between contamination of groundwater and contact with surface water, and the persistence and mobility of the pesticide in question.

Overall, pesticide applications under Alternative 1 present potential risks of surface water contamination and are expected to result in the potential for impacts on surface waters. Studies on surface water contamination in Washington state (USGS, 1997b, 1999; Ecology, 1993) report potentially significant levels of some common forest pesticides (e.g. 2,4-D, triclopyr), some of which are directly associated with forest applications. Other studies (Neary and Michael, 1996) found similar results in other regions of the U.S., although in most situations the levels recorded were low. Nonetheless, the data illustrate that under some environmental and application conditions (e.g., winds, saturated soils, frequent storm events, etc.), significant levels of pesticides could reach surface waters and could lead to surface water contamination or present a threat to aquatic organisms. Although the frequency of forest chemical applications is low, the potential impacts associated with a given application could likely be reduced with additional protective measures.

GROUNDWATER IMPACTS

Alternative 1 includes specific provisions to limit groundwater contamination resulting from forest chemical applications. Groundwater protection is provided under WAC 222-16-070 (pesticide uses with the potential for a substantial impact on the environment), where the Forest Practices Rules require an evaluation of site-specific use of aerially applied pesticides. As part of this evaluation, forest land managers must address: 1) whether the application is occurring over groundwater with a high susceptibility to contamination as specified in EPA 910/9-87-169 or in documentation provided by the Washington Department of Ecology, and 2) whether a pesticide currently in use is a state-restricted pesticide for the protection of groundwater under WAC 16-228-164(1).

Nonetheless, possible groundwater impacts could occur through contaminated surface water recharge to groundwater. The extent of these impacts is difficult to predict but depends on the degree of contamination of the surface water, the volume of water exchanged, and the mobility and persistence of the chemical contaminant. The following paragraphs discuss the impacts on groundwater contamination under Alternative 1 for pesticide applications, including impacts on sole-source aquifers.

The likelihood that a given pesticide would contaminate a groundwater aquifer depends in part on geologic and hydrologic conditions that vary considerably across the state. Local conditions determine how rapidly groundwater moves, whether it is connected directly or indirectly to surface waters and how groundwater withdrawals affect surface waters, the depth of the water below the soil surface, and how effectively soils attenuate or filter out the chemical contaminants (EPA, 1986). This complex interaction between soil and water makes it difficult to predict the likelihood and extent of groundwater contamination.

Water solubility (measured in parts per million, or ppm) and adsorption to soil (indicated as K_d, K_{oc}) are the two major chemical characteristics that determine a pesticide's tendency to leach through the soil profile with infiltrating water. Most pesticides that have low water solubility also have a strong tendency to bond to soil particles, although there are exceptions (Extoxnet, 1999). The properties of the soils upon which the pesticides are applied can also influence the likelihood of a pesticide leaching to groundwater. Soils with high porosity and high infiltration rates may move pesticides through the soil column more quickly, before they have time to sorb to particles or degrade naturally. In addition, soils high in clay and organic matter tend to sorb particles better than sandy soils low in organic matter (Extoxnet, 1999).

Table 5 presents a summary of the chemical and physical properties that influence the potential for groundwater contamination. Many of the 190 pesticides registered in Washington state (even several of the most commonly used pesticides) exceed one or more of these levels and therefore have some potential to contaminate groundwater.

A recent study of pesticide contamination in public supply wells in Washington state found pesticides in only 6 percent of 1,103 randomly selected public supply wells across Washington (USGS, 1996a). However, only 27 pesticides were analyzed, most of which are common agricultural and residential pesticides but not common forest management pesticides. Moreover, the few forest management pesticides that were detected did not necessarily originate from forest lands. Nonetheless, the study provides a measure of the likelihood of groundwater contamination from pesticide use and application.

Table 5. Chemical and Physical Properties of Pesticides that Influence the Potential for Groundwater Contamination

Property	Levels Reflecting Potential for Groundwater Contamination
Water solubility	Greater than 30 ppm
K_d	Less than 5, usually less than 1
K_{oc}	Less than 300-500
Henry's Law Constant (volatility)	Less than 10^{-2} atm-m^{-3} mol
Speculation	Negatively charged at ambient pH
Hydrolysis half-life	Greater than 25 weeks
Photolysis half-life	Greater than 1 week
Field dissipation half-life	Greater than 3 weeks

Source: EPA (1986).

A related study focuses on groundwater contamination in the Puget Sound basin in particular, evaluating the vulnerability of various aquifers in the region (USGS, 1997a). Based on the geologic and hydrologic factors discussed above, and on land use patterns in the region, the study assesses the potential vulnerability of groundwater to nitrate contamination. The study specifically focuses on nitrate, because nitrate contamination levels have been identified as good indicators of the relative risk of groundwater contamination from other chemicals (EPA, 1996). As might be expected, the USGS (1997a) study concludes that shallow wells underlying coarse-grained glacial deposits in areas of high fertilizer or pesticide use are most vulnerable to nitrate contamination. Although the study is focused on the Puget Sound region in particular, it provides useful information for areas subject to some forest chemical applications that also rely exclusively on groundwater for drinking water supplies (e.g., Island County), discussed further below.

The complete USGS (1997a) study includes several informative color illustrations. One figure in particular, a "groundwater vulnerability map of the Puget Sound basin," presents a detailed illustration of groundwater vulnerability presented as the probability of detecting nitrate at concentrations of 3 milligrams per liter or greater in wells in the Puget Sound basin. Most of the higher risk areas were found east of the Puget Sound shoreline between major areas of development (Everett, Seattle, Tacoma, and Olympia) with additional high-risk areas identified in the Lower Nooksack River Valley. The study and figures all can be found on the internet at *http://wa.water.usgs.gov/fs.061-97/* (USGS, 1997a).

Because Alternative 1 provides specific provisions for groundwater protection, statewide application of forest pesticides should not result in significant impacts on groundwater quality. However, impacts on groundwater could occur in localized regions with particularly vulnerable aquifers and in regions where highly persistent and mobile pesticides are applied.

Effects on Sole-Source Aquifers

The widespread use of pesticides is a concern to sole-source aquifer users and could lead to groundwater contamination in sole-source aquifers unless adequate protective measures are taken.

Alternative 1 does not include any specific provisions for the protection of sole-source aquifers, but does provide for the protection of groundwaters having a high susceptibility for contamination.

The USGS groundwater study discussed above identifies areas in the Puget Sound basin with a high susceptibility to nitrate contamination in groundwater (USGS, 1997a). Based on the mapped information presented in the USGS report, the majority of the islands in the Puget Sound region are not highly susceptible to groundwater contamination. However, some very localized areas show a relatively high vulnerability to contamination. Although high levels of agricultural or urban land use predominate in most of these areas, other areas may justify special precautions with regard to forest pesticide applications. Overall, Alternative 1 is not expected to result in significant impacts on sole-source aquifers..

FISH AND WILDLIFE IMPACTS

The potential impacts of a given forest pesticide depend not only on the specific properties of the chemical, but also on the sensitivity of the species of concern and on environmental conditions. Given the broad scope of this analysis, the numerous potential species of concern, and the large number of forest pesticides used in Washington state; an evaluation of the impacts of forest pesticides on fish and wildlife must be somewhat general and qualitative. Moreover, the impacts of forest pesticide use on fish and wildlife largely depend on the likelihood and extent to which the chemicals may be transported to surface waters. As noted earlier, several studies have documented the presence of many different pesticides in Washington state streams (USGS, 1996c, 1997b; Ecology, 1993), occasionally at levels that exceed guidelines for the protection of aquatic life. While the source of this contamination is generally considered to be agricultural or urban land uses rather than forest applications, forest pesticides definitely contribute to pesticide loadings.

Although some forest pesticides may have impacts on terrestrial organisms, the alternatives under consideration are almost identical with regard to forest pesticide applications that occur away from water resources. The following paragraphs, therefore, focus on potential fish and wildlife impacts associated with pesticide applications near surface waters, presented in a manner that facilitates a meaningful comparison among alternatives.

The application of pesticides to forested lands does pose a risk of impacts on fish and wildlife. The likelihood that a pesticide can be transported to a river, stream, or wetland has a significant bearing on its probable impact on aquatic species. Therefore, the evaluation of a pesticide's impact on any aquatic organism (for all alternatives) assumes that the pesticide reaches surface waters based on conclusions of the surface water impacts section included under each alternative.

Given the potential for Alternative 1 to result in the risk of pesticide contamination of surface waters, this alternative could also result in localized fish and aquatic wildlife impacts. In addition, impacts on aquatic organisms and amphibious species in dry streambeds may also occur where organisms remain active in the damp substrates of the dry streambeds. However, as mentioned earlier, the sensitivity of different organisms to the same pesticide varies greatly from species to species, even within the same genus (USFWS, 1984). An assessment of a given pesticide's toxicity to fish and wildlife does not represent a definitive statement on its toxicity to all organisms but rather a general statement about the likely impacts on most species of fish and wildlife.

Most of the more common pesticides used in Washington were found to have low toxicity to fish and wildlife (see Table 4). However, the other less commonly applied pesticides (see Attachment A1) present a wide range of potential impacts on fish and wildlife. Some are less toxic to fish and wildlife than those listed in Table 4 and likely present little or no threat to fish and wildlife. Others are significantly more toxic and could result in impacts under Alternative 1.

Alternative 1 is not expected to result in any acute (short-term, lethal) impacts on fish and wildlife. The concentration required for most pesticides to cause lethal effects is greater than that expected to occur under Alternative 1. However, Alternative 1 could result in less than lethal (chronic) impacts on fish and wildlife resulting from low but significant levels of exposure that could occur under certain environmental conditions. Exposure to sublethal concentrations of pesticides could cause a variety of direct and indirect impacts on salmon by stressing or weakening the fish, or significantly reducing their ability to feed, avoid predators, defend territories, and maintain their position in the stream. Extensive research is currently underway to better identify the anticipated impacts associated with low levels of pesticides. In addition, pesticides can also interfere with the food supply of fish or alter their aquatic habitat, even when the concentrations are too low to affect the fish directly. Because these impacts would be short-term (i.e., pollutants would be flushed out during the first few rain events), the impacts are not expected to be significant.

Many terrestrial species, amphibious species, and plant species also could be affected by exposure to low levels of toxicants under Alternative 1. Impacts on specific species in specific locations require assessment on a site-by-site basis. However, Alternative 1 could potentially result in impacts on a variety of nontarget aquatic and riparian plants (especially algae, periphyton, and phytoplankton). These impacts, in turn, could indirectly affect fish and wildlife by altering their habitats.

Alternative 2 Impacts

SURFACE WATER IMPACTS

Alternative 2 is similar to Alternative 1 but contains additional requirements targeting the protection of water resources. Alternative 2 includes the implementation of best management practices (BMPs) designed to "eliminate the direct entry of pesticides to water (defined as the entry of medium to large droplets), while minimizing off-target drift" (WDNR, 1999).

By recommending variable buffer widths for aerial applications depending on water type, environmental conditions, and the method of application, Alternative 2 would result in a lower risk of surface water impacts than Alternative 1 (Ecology, 1993). Specifically, by adjusting the buffer widths to suit wind conditions, nozzle types, and application heights, Alternative 2 would reduce pesticide drift into surface waters compared to Alternative 1. Studies conducted by the Spray Drift Task Force (1997a) and Ecology (1993) indicate that under the conditions specified under Alternative 2 (variable width depending on wind, application height, nozzle type), the risk of impacts on surface waters should be minor. The data indicate that the large buffers required when drift potential is high should generally limit drift spray to roughly less than 1 percent of the total active ingredient applied to Type S and F streams. However, the allowance for higher altitude applications (greater than 50 feet) does present an increased risk of pesticide drift to surface waters. The potential impacts on Type N streams would be slightly greater than to Type S and F streams (given the smaller buffers) but still would be minor. Buffer widths specified for Alternative 2 also are correlated with the critical management or habitat zones identified for each water type. Therefore, Alternative 2 also would minimize impacts to water resources by prohibiting some applications within the inner zones and riparian management zones identified for each water type. Alternative 2 also recommends using the maximum applicable buffer width in situations where the recommended buffer width and recommended offset from the critical surface water zones are different.

Alternative 2 restrictions on ground applications of pesticides with power or hand equipment provide for greater protection of Type S or F waters compared to Alternative 1. Specifically, ground application with power equipment is not permitted within the core and inner zones of Type S and F waters, and hand applications are not allowed within the core zones of Type S or F waters (unless prescribed to meet specific localized requirements). In addition, operators must maintain a 25-foot "no application" buffer strip around Type A or B wetlands and on all sides of all other surface waters resulting in a greater reduction in the potential for surface water contamination. The increased buffer distances will result in greater protection from spray drift, a reduced risk of transport by stormwater runoff, and a reduced risk of transport by contaminated soil erosion than under Alternative 1.

Overall, the increased attention given to the required buffer widths under Alternative 2 reduces the risk of surface water impacts. However, because Alternative 2 still allows for pesticide application over dry segments of some watercourses, a significant risk of localized surface water contamination is still present (Neary and Michael, 1996). Likewise, even with the increased buffer widths on most surface waters, Alternative 2 could allow low levels of pesticides to reach surface waters, either directly or through surface or subsurface runoff, erosion, and sediment transport. Nevertheless, the risk of impacts would be reduced relative to Alternative 1.

GROUNDWATER IMPACTS

Groundwater impacts associated with Alternative 2 are expected to be similar but slightly less than under Alternative 1. Direct impacts on groundwater from pesticide leaching to groundwater aquifers would occur at the same rate under Alternative 2 as with Alternative 1. However, because the increased buffer widths required under Alternative 2 would result in fewer surface water impacts, the likelihood that contaminated surface water would reach and contaminate groundwater is also reduced.

Effects on Sole-Source Aquifers

Alternative 2 is expected to result in similar but slightly lower impacts on sole-source aquifers compared to Alternative 1. The increased buffer widths required for pesticide applications under Alternative 2 may result in slightly less sole-source aquifer contamination because of a reduction in the potential for contaminated surface water to groundwater interactions. Overall, however, the impacts are expected to be nearly identical to Alternative 1 (i.e., no significant impacts).

FISH AND WILDLIFE IMPACTS

Impacts on fish and wildlife under Alternative 2 are expected to be less than those associated with Alternative 1. The increased buffer widths and associated decrease in surface water contamination would reduce the level of contaminants that reach aquatic organisms. Likewise, Alternative 2 proposes to minimize the entry of pesticides into riparian zones that could cause significant damage to riparian vegetation, thereby reducing indirect effects on fish and wildlife through habitat preservation. In addition, although Alternative 2 includes more stringent restrictions on chemical applications within riparian management zones (compared to Alternative 1), Alternative 2 is also designed to enable forest managers to effectively manage riparian areas by allowing the application of pesticides for hardwood or noxious weed control.

Alternative 3 Impacts

SURFACE WATER IMPACTS

Alternative 3 is nearly identical to Alternative 2, with the exception of three main additions. Under Alternative 3, plants with cultural value would be protected from forest pesticides, hand application of forest pesticides would be prohibited within 50 feet of all typed waters, and forest pesticide applications needed to restore riparian management zone functions would require an alternative plan. Therefore, surface water impacts from pesticide applications under Alternative 3 are expected to be slightly less than under Alternative 2 and significantly less than Alternative 1.

The increased buffer required for hand applications near surface waters under Alternative 3 would significantly reduce the amount of pesticides that reach surface waters directly compared to Alternative 1, and only slightly reduce the potential for contamination compared to Alternative 2. The recommended 50-foot buffer for all hand applications is greater than that required under both Alternatives 1 and 2, with the exception of the core zone buffer on westside type S and F streams required under Alternative 2 (westside core zone is 50 feet). However, as with Alternatives 1 and 2, low levels of pesticides may reach surface waters through stormwater runoff or soil erosion and sediment transport. In addition, alternative plans required for forest pesticide applications when restoring riparian management zones under Alternative 3 are expected to reduce the amount of pesticides that may potentially enter surface waters, while maintaining the forest manager's ability to effectively manage riparian areas. Although the alternative plans would be determined on a site-by-site basis, the chosen methods could pose a risk of indirect water quality impacts through site disturbance and erosion (e.g., from mechanical thinning). Any alternative plans to be implemented would be designed to successfully manage riparian vegetation and would be appropriately reviewed in order to prevent impacts on surface waters.

GROUNDWATER IMPACTS

The potential groundwater impacts resulting from pesticide application under Alternative 3 are expected to be nearly identical to the impacts associated with Alternatives 1 and 2. The only difference is that the minor reduction in the potential for pesticide drift to surface waters under Alternative 3 could result in a slight decrease in the level of pesticides reaching groundwater compared to Alternatives 1 and 2 (through a reduction in the exchange with potentially contaminated surface waters, as discussed above).

Effects on Sole-Source Aquifers

Alternative 3 is expected to result in similar but slightly lower impacts on sole-source aquifers compared to Alternatives 1 and 2. The increased buffer widths required for pesticide applications under Alternative 3 may result in slightly less sole-source aquifer contamination, through a reduction in the potential for contaminated surface water to interact with and adversely impact groundwater. Overall, the potential impacts to sole-source aquifers are expected to be nearly identical under all alternatives.

FISH AND WILDLIFE IMPACTS

Impacts on fish and wildlife under Alternative 3 are expected to be less than those associated with Alternatives 1and 2. The increased buffer widths and associated decrease in surface water contamination expected with Alternative 3 would reduce the levels of contaminants that could potentially reach aquatic organisms compared to Alternatives 1 and 2. Likewise, Alternative 3 proposes to reduce the entry of pesticides into riparian zones while maintaining the forest manager's ability to effectively manage riparian areas, thereby reducing indirect effects on fish and wildlife through habitat preservation. Impacts on amphibians are also expected to be reduced, while impacts on terrestrial species are expected to be the same relative to Alternatives 1 and 2.

Cumulative Impacts

Regardless of whether they are significant or not, the potential impacts that could occur under any of the above alternatives would contribute to the cumulative pesticide loads on water resources in Washington state. In particular, numerous other private and public agencies apply significant amounts of pesticides to their lands. In both urban and rural areas, land owners alone use a considerable amount of pesticides each year in their homes and gardens. A 1995 survey found that nationwide, home and garden users accounted for 10 percent of total pesticide use in the United States, representing a total of 133 million pounds of pesticides applied (EPA, 1997). Industrial, commercial, and government uses accounted for an additional 150 million pounds in 1995. This category includes Washington state forest practices applications, as well as federal applications within national forests and national parks. The greatest user of pesticides in the United States is the agricultural sector. In 1995, agricultural uses accounted for 939 million pounds of applied pesticides, representing 77 percent of total applications in the United States (EPA, 1997).

Although the impacts associated with forest chemical applications in Washington state may not be significant, and the frequency of application is generally much lower than for other uses, forest chemical applications contribute to overall cumulative impacts) on water resources in Washington state. Thus, efforts to reduce any impacts associated with forest practices would be beneficial.

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ATTACHMENT A1

Department of Agriculture Registered Pesticides 1999

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Attachment A1. Department of Agriculture Registered Pesticides 1999

Name	Ingredient	Toxicity	Type
2,4-D Amine 4	2,4-D Dimethylamine	Danger	Herbicide
Access	Picloram Isooctylester	Caution	Herbicide
Access	Triclopyr	Caution	Herbicide
Acecap 97 Systemic Insecticide Implants	Acephate	Caution	Insecticide
Acme Hi-Dep	2,4-D Diethanolamine	Danger	Plant Growth Regulator
Acme Hi-Dep	2,4-D Dimethylamine	Danger	Herbicide
Agronil 500 Fungicide	Chlorothalonil	Warning	Fungicide
Agronil 720 Agricultural Fungicide	Chlorothalonil	Warning	Fungicide
Allpro Dursban 2e	Chlorpyrifos	Warning	Insecticide
Arsenal Appl Conc(Loblolly Pine Tank Accord 1+Years)	Isopropylamine Salt of Imazapyr	Caution	Insecticide
Arsenal Appl Conc(One Yr Old Loblolly Pine Release)	Isopropylamine Salt of Imazapyr	Caution	Herbicide
Arsenal Appl Conc(Tank Accord&Garlon4/Forest Site Prep)	Isopropylamine Salt of Imazapyr	Caution	Herbicide
Atrazine 4l (Conifer - Tank Mixes)	Atrazine	Caution	Herbicide
Azinphosmethyl 2ec	Azinphos Methyl	Danger/Poison	Insecticide
Azinphosmethyl 50w Soluble	Azinphos Methyl	Danger/Poison	Insecticide
Azinphosmethyl 50w Soluble	Azinphos Methyl	Danger/Poison	Insecticide
Basamid Granular Soil Fumigant	Dazomet	Warning	Fungicide
Basamid Granular Soil Fumigant	Dazomet	Warning	Herbicide
Basamid Granular Soil Fumigant	Dazomet	Warning	Nematicide
Biobit Hp	Bacillus Thuringiensis Variety Kurstaki	Caution	Insecticide
Biobit Hp Wetable Powder	Baccillus Thuringiensis Subsp. Israelensis	Caution	Insecticide
Biobit Xl	Baccillus Thuringiensis Subsp. Israelensis	Caution	Insecticide
Bravo 500	Chlorothalonil	Warning	Fungicide
Bravo Ultrex	Chlorothalonil	Danger	Fungicide
Bravo W-75	Chlorothalonil	Danger	Fungicide
Carbaryl 4l	Carbaryl	Caution	Insecticide
Carbaryl 4l	Carbaryl	Caution	Plant Growth Regulator
Carbaryl 50 Wp	Carbaryl	Warning	Insecticide
Carbaryl 50 Wp	Carbaryl	Warning	Plant Growth Regulator
Carbaryl 90df Insecticide	Carbaryl	Warning	Insecticide
Carbaryl 90df Insecticide	Carbaryl	Warning	Plant Growth Regulator
Casoron 4g	Dichlobenil	Caution	Herbicide
Chopper Rtu-Basal & Cut Surface Herbicide	Isopropylamine Salt Of Imazapyr	Caution	Herbicide
Clean Crop Carbaryl 4l Insecticide	Carbaryl	Caution	Insecticide
Clean Crop Carbaryl 4l Insecticide	Carbaryl	Caution	Plant Growth Regulator
Clean Crop Low Vol 6 Ester(Conifer Release)	2,4-D Isooctyl 2-Octyl Ester	Caution	Herbicide
Condor Oil Flowable Bioinsecticide	Baccillus Thuringiensis Subsp. Israelensis	Caution	Insecticide
Countdown Flowable Fungicide	Chlorothalonil	Warning	Algaecide Slimicide
Countdown Flowable Fungicide	Chlorothalonil	Warning	Fungicide
Countdown L & G Agricultural, Turf & Orna Fungicide	Chlorothalonil	Warning	Fungicide

Attachment A1. Department of Agriculture Registered Pesticides 1999 (continued)

Name	Ingredient	Toxicity	Type
Crymax	Bacillus Thuringiensis Variety Kurstaki	Caution	Insecticide
Cutlass	Baccillus Thuringiensis Subsp. Israelensis	Caution	Insecticide
Daconil 2787 -Flowable Fungicide	Chlorothalonil	Warning	Algaecide Slimicide
Daconil 2787 -Flowable Fungicide	Chlorothalonil	Warning	Fungicide
Daconil Ultrex -Turf Care	Chlorothalonil	Danger	Fungicide
Dimilin 25w	Diflubenzuron	Caution	Insecticide
Dimilin 25w	Diflubenzuron	Caution	Invertebrate Control
Dipel 2x Wdg	Baccillus Thuringiensis Subsp. Israelensis	Caution	Insecticide
Dipel 2x Wettable Powder	Baccillus Thuringiensis Subsp. Israelensis	Caution	Insecticide
Dipel 4l	Bacillus Thuringiensis Variety Kurstaki	Caution	Insecticide
Dipel 6af	Baccillus Thuringiensis Subsp. Israelensis	Caution	Insecticide
Dipel 8af	Baccillus Thuringiensis Subsp. Israelensis	Caution	Insecticide
Dipel Df	Bacillus Thuringiensis Variety Kurstaki	Caution	Insecticide
Dipel Worm Killer	Baccillus Thuringiensis Subsp. Israelensis	Caution	Insecticide
Drexel Diazinon Insecticide	Diazinon	Warning	Insecticide
Dursban 4e	Chlorpyrifos	Warning	Insecticide
Ensign 720	Chlorothalonil	Warning	Fungicide
Expedite Grass & Weed Ii	Glyphosate	Caution	Herbicide
Ezject -Selective Injection Herbicide Capsules	Glyphosate	Caution	Herbicide
Foray 48b	Bacillus Thuringiensis Variety Kurstaki	Caution	Insecticide
Foray 48f Biological Insecticide Flowable Conc.	Bacillus Thuringiensis Variety Kurstaki	Caution	Insecticide
Foray 76b	Baccillus Thuringiensis Subsp. Israelensis	Caution	Insecticide
Fort Dodge Gopher Bait	Strychnine	Danger/Poison	Rodenticide
Garlon 3a	Triclopyr	Danger	Herbicide
Garlon 3a (Forestry)	Triclopyr	Danger	Herbicide
Garlon 4	Triclopyr	Caution	Herbicide
Garlon 4 (Forestry Use)	Triclopyr	Caution	Herbicide
Garlon 4 (Tordon K Mix Recommendation Woody Plant)	Triclopyr	Caution	Herbicide
Gordon's Amine 400 2,4-D Weed Killer	2,4-D Dimethylamine	Danger	Herbicide
Isk Daconil Weather Stik Flowable Fungicide	Chlorothalonil	Warning	Algaecide Slimicide
Isk Daconil Weather Stik Flowable Fungicide	Chlorothalonil	Warning	Fungicide
Jteatons Answer For Cntrl Of Pocket Gophers	Diphacinone	Caution	Rodenticide
M-44 Cyanide Capsules	Sodium Cyanide	Danger/Poison	Vertebrate Control
Malathion 5ec	Malathion	Warning	Insecticide

Attachment A1. Department of Agriculture Registered Pesticides 1999 (continued)

Name	Ingredient	Toxicity	Type
Malathion Ulv	Malathion	Caution	Insecticide
Malathion Ulv Conc	Malathion	Caution	Insecticide
Mattch Bioinsecticide	Pseudomonas Fluorescens	Caution	Insecticide
Mcpa Amine Herbicide	Mcpa Dimethylamine	Danger	Herbicide
Mcpa Ester	Mcpa Isooctyl Ester	Warning	Herbicide
Mole & Gopher Bait	Zinc Phosphide	Caution	Rodenticide
Monterey 7 Carbaryl Insecticide	Carbaryl	Caution	Insecticide
Mvp Bioinsecticide	Delta Endotoxin 0f B. T.	Caution	Insecticide
Mvp Ii Bioinsecticide	Baccillus Thuringiensis Subsp. Israelensis	Caution	Insecticide
Mycotrol 22wp	Beauveria Bassiana Gha	Caution	Insecticide
Nomix Sweep	Glyphosate	Caution	Herbicide
Opti-Amine	2,4-D Dimethylamine	Danger	Herbicide
Oust Herbicide	Sulfometuron Methyl	Caution	Herbicide
Pathfinder Ii	Triclopyr Butoxyethyl Ester	Caution	Herbicide
Pathway	2,4-D Triisopropanolamine	Warning	Herbicide
Pathway	Picloram Triisopropanolamine	Warning	Herbicide
Prentox 5lb Malathion	Malathion	Warning	Insecticide
Pronone 25g	Hexazinone	Caution	Herbicide
Pyrenone Crop Spray Insecticide	Piperonyl Butoxide	Caution	Insecticide
Pyrenone Crop Spray Insecticide	Pyrethrins	Caution	Insecticide
Redeem	Triclopyr	Danger	Herbicide
Riverdale Mcpa L.V.4 Ester	Mcpa Isooctyl Ester	Warning	Herbicide
Roundup Original (Forest & Utility R-O-W)	Glyphosate	Warning	Herbicide
San 415 Sc 321v	Baccillus Thuringiensis Subsp. Israelensis	Caution	Insecticide
Sevin 4f Brand Carbaryl Insecticide	Carbaryl	Caution	Insecticide
Sevin 4f Brand Carbaryl Insecticide	Carbaryl	Caution	Plant Growth Regulator
Sevin 50w	Carbaryl	Warning	Insecticide
Sevin 50w	Carbaryl	Warning	Plant Growth Regulator
Sevin Brand 80wsp Carbaryl Insecticide	Carbaryl	Warning	Insecticide
Sevin Brand Rp4 Carbaryl Inseciticide	Carbaryl	Caution	Insecticide
Sevin Brand Rp4 Carbaryl Inseciticide	Carbaryl	Caution	Plant Growth Regulator
Sevin Brand Xlr Plus Carbaryl Insecticide	Carbaryl	Caution	Insecticide
Sevin Brand Xlr Plus Carbaryl Insecticide	Carbaryl	Caution	Plant Growth Regulator
Sevin Sl	Carbaryl	Caution	Insecticide
Simazine 4l Herbicide	Simazine	Caution	Herbicide
Simazine 90df Herbicide	Simazine	Caution	Herbicide
Sostram Atrazine 4l	Atrazine	Caution	Herbicide
Sostram Atrazine 90df	Atrazine	Caution	Herbicide
Supanil 720	Chlorothalonil	Warning	Fungicide
Sur-Noxem	Methoxychlor	Caution	Insecticide
Terranil 6l Flowable Ag Fungicide	Chlorothalonil	Warning	Fungicide
Thalonil 90df Ag Fungicide	Chlorothalonil	Danger	Fungicide

Attachment A1. Department of Agriculture Registered Pesticides 1999 (continued)

Name	Ingredient	Toxicity	Type
Thuricide 32lv	Baccillus Thuringiensis Subsp. Israelensis	Caution	Insecticide
Thuricide 64lv	Baccillus Thuringiensis Subsp. Israelensis	Caution	Insecticide
Thuricide-48lv	Baccillus Thuringiensis Subsp. Israelensis	Caution	Insecticide
Tordon 22k	Picloram Potassium Salt	Caution	Herbicide
Tordon K	Picloram Potassium Salt	Caution	Herbicide
Tordon K(Garlon 4 Mix Reccomendation Woody Plants)	Picloram Potassium Salt	Warning	Herbicide
Tordon Rtu	2,4-D Triisopropanolamine	Warning	Herbicide
Tordon Rtu	Picloram Triisopropanolamine	Warning	Herbicide
Transline	Clopyralid, Monoethanolamine Salt	Caution	Herbicide
Turfgo Msma Turf Herbicide	Msma	Caution	Herbicide
United Hort Supply Msma Turf Herbicide	Msma	Caution	Herbicide
Valent Dibrom 8 Emulsive	Naled	Danger	Insecticide
Velpar Df	Hexazinone	Danger	Herbicide
Velpar L Herbicide	Hexazinone	Danger	Herbicide
Weed Rhap A-4d	2,4-D Dimethylamine	Caution	Herbicide
Weedar 64 Broadleaf Herbicide	2,4-D Dimethylamine	Danger	Herbicide
Weedar Brand 64 Broadleaf Herbicide	2,4-D Dimethylamine	Danger	Herbicide
Zeneca Dacnil Ultrex Turf Care	Chlorothalonil	Danger	Fungicide
Zeneca Daconil Weather Stik Flowable Fungicide Turf Car	Chlorothalonil	Warning	Fungicide
Zoecon Altosid Liquid Larvicide Concentrate	Methoprene	Caution	Insecticide
Zoecon Altosid Liquid Larvicide Mosquito Growth Regulat	Methoprene	Caution	Insecticide
Zp Rodent Bait Place Pac	Zinc Phosphide	Caution	Rodenticide

ATTACHMENT A2

Department of Agriculture Registered Adjuvants 1999

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Attachment A2. Department of Agriculture Registered Adjuvants 1999

Name	Toxicity
38-F Drift Retardant	Caution
41-A Drift Retardant	Caution
Actamaster	Caution
Actamaster Soluble Crystal Spray Adjuvant	Caution
Activate 3	Caution
Activate Plus	Warning
Activator 90	Caution
Activator 90(Tree Fruit & Vines)	Caution
Ad 100	Caution
Ad Wet 90	Caution
Ad-Here Xl	Caution
Ad-Spray 80	Warning
Adsee 100-80	Caution
Adsee 775	Caution
Adsee 801	Caution
Aerodyne-Amic	Danger
Agfoam	Danger
All-Purpose Spray Adjuvant	Caution
Amigo Vegetable Oil Surfactant	Caution
Ammonium Sulfate Spray Grade	Caution
Ams Plus	Caution
Ams Premium Blend Sprayable Ammonium Sulfate/Polymer	Caution
Apex 90tm	Caution
Apsa-80 All Purpose Spray Adjuvant Concentrate	Warning
Assist	Caution
Ballast	Warning
Bayfolan Plus	Caution
Bio-Film	Caution
Bioplus Ss 100	Caution
Bivert	Caution
Blendex	Warning
Blendex Vhc	Warning
Bond	Warning
Break Thru	Caution
Break-Thru	Warning
Break-Thru	Warning
Buffer P.S.	Warning
Buffer Xtra Strength	Warning
Buffer Xtra Strength	Warning
Buffer-M	Caution
Buffer-Ten	Danger

Attachment A2. Department of Agriculture Registered Adjuvants 1999 (continued)

Name	Toxicity
Buffered Edge	Caution
Bulls Eye Drift Management/Deposition Aid	Caution
Bupher Mg 0-10-0	Caution
Capsil 30	Caution
Cayuse Absorption Activator	Caution
Cd 90 Plus	Caution
Choice Water Conditioning Agent	Caution
Cide-Kick	Caution
Cide-Kick Ii	Caution
Class 17% Concentrate	Caution
Class Act	Caution
Class Cl77 Nonionic Spreader-Sticker	Caution
Class Complete Compatability	Caution
Class Preference	Caution
Clean Crop Veg-Oil Surfactant	Caution
Cmr Can-Hance	Caution
Cmr Herbicide Activator	Caution
Cmr Orgarnic Oil Adjuvant	Caution
Cmr Silicone Surfactant	Danger
Cmr Spreader Sticker	Caution
Coax - Insect Feeding Stimulant	Caution
Cohere Nonionic Spreader-Sticker Adjuvant For Pest Spry	Warning
Cohort Dc	Warning
Combat Plus	Caution
Combine	Caution
Comp-Ad	Caution
Complex	Warning
Cooke Sticker	Caution
Crockers Fish Oil Sticker-Spreader	Caution
Crop Oil Conc	Caution
Crop Oil Conc. Non-Ionic Surfactant	Caution
Crop Oil Concentrate	Caution
Crop Oil Concentrate	Caution
Crop Oil Concentrate	Caution
Crop Oil Concentrate Nonionic Adjuvant	Caution
Crop Oil-M	Caution
Dash Hc Spray Adjuvant	Warning
De-Foamer Ag Foam Control	Caution
Depo Concentrate	Caution
Depo Rtu	Caution
Deposit	Caution

Attachment A2. Department of Agriculture Registered Adjuvants 1999 (continued)

Name	Toxicity
Dispatch	Warning
Dri Nonionic Surfacant	Caution
Driftgard Ii	Caution
Drop Zone Dc	Warning
Dynamark	Caution
Dyne-Amic	Caution
E-Z Mix	Warning
Entry Ii	Danger
Exactrol	Caution
Exit	Caution
Fast Break	Warning
Fighter F	Caution
First Choice 4440 Spreader/Sticker	Caution
First Choice Am-Sul Solution	Caution
First Choice Break Thru	Warning
First Choice Buffer Spreader Adjuvant	Caution
First Choice Crop Oil Concentrate	Caution
First Choice Depheat 2	Danger
First Choice Excel 90	Caution
First Choice Exciter	Caution
First Choice Parasol Spreader/Sticker	Caution
First Choice Spray Kicker	Caution
First Choice Surphtac Adjuvant	Danger
First Choice Ultra Pro	Caution
First Choice Watermaxx Soil Penetrant	Caution
Flexafoam Am Foaming Agent	Danger
Flothru Soil Penetrant 24	Caution
Flozine	Caution
Foam Buster	Caution
Foam Buster	Caution
Foam Fighter	Caution
Foamer	Caution
Forest Crop Oil	Caution
Formula 358	Caution
Freeway	Warning
Fynol-4	Caution
Galactic	Caution
Galactic Hv	Caution
Get-Down	Caution
Glyco-Trol	Caution
GRO-Wet Granular	Caution

Attachment A2. Department of Agriculture Registered Adjuvants 1999 (continued)

Name	Toxicity
GRO-Wet Liquid	Caution
Grounded Deposition Agent For Soil Applied Pesticides	Caution
GSL 90 Plus	Caution
GSL Nu-Stik 44	Caution
GSL OSO Wet	Caution
GSL Promaid	Danger
GSL Simulaid Spreader-Activator	Caution
Hasten Spray Adjuvant	Warning
Helena Agri-Dex	Caution
Herbimax	Caution
Home Run Methylated Soy Adjuvant	Caution
Hopkins Plyac	Caution
Hopkins Unite	Danger/Poison
Hy-Stop Spray Buffer	Caution
Hyper Active	Danger
Indicate 5	Caution
Induce	Warning
Insure-Xl	Caution
Invade Plus	Caution
Ivod	Caution
Jlb Oil Plus - Spray Adjuvant	Caution
Kinetic	Caution
Kinetic	Caution
Kinetic Hv	Caution
Kinetic Hv	Caution
Kombind Compatibilit	Caution
Kover	Caution
Lastick	Caution
Latron Ag-44m	Danger
Latron Ag-98	Warning
Latron B-1956	Caution
Latron Cs-7	Warning
Li 700 Penetrating Surfactant	Caution
Li-700(Fruit Tree & Vine Crops)	Caution
Lilly/Miller Spray Aid	Caution
Lilly/Miller Sta-Stuk 'M'	Caution
M-90 Non-Ionic Spreader Activator	Caution
M-Hance	Caution
M-Sul-45	Caution
Magnify	Caution
Master Nurserymen Spay-Grip	Caution

Attachment A2. Department of Agriculture Registered Adjuvants 1999 (continued)

Name	Toxicity
Miller Nu-Film-Ir	Caution
Monterey Cal-Phos 0-23-0	Caution
Monterey Herbicide Helper	Caution
Monterey Npk 8-8-2	Caution
Monterey Super 7	Danger
Monterey X-100	Caution
Monterey Zip 0-8-0	Caution
Monterey Znp 10-12-0	Caution
Monterey Zpk 0-16-9	Caution
Monterey-Nature's Own Spray Helper	Caution
More	Caution
Mso Concentrate Methylated Seed Oil	Caution
Nalco-Trol	Caution
Nalco-Trol Ii	Caution
Nalcotrol	Caution
Nalcotrol	Caution
Nalcotrol	Caution
Nalcotrol Ii	Caution
Nalquatic	Caution
Napier Su250	Caution
No Foam	Caution
No Foam A	Caution
No Foam A	Caution
No Foam Adjuvant	Caution
No Foam B	Caution
No Foam B	Caution
No Foam Dry Defoamer	Caution
No. 233 Wet-Sol Concentrate	Caution
No. 235 Wet-Sol 99	Caution
No.237 Wet-Sol 80	Caution
Nonionic 100 Surfactant	Caution
Nonionic 90 Surfactant	Caution
Nu-Film-17	Caution
Nu-Film-P	Caution
Nuchem 90-Nf	Caution
Nutra Wet (4-14-7)	Caution
Nutrient Buffer 0-8-0 Plus	Caution
Nutrient Buffer 10-12-0	Caution
Nutrient-Buffer 11-4-6	Caution
Nxs Dc	Caution
Optima Adjuvant For Herbicide Sprays	Danger

Attachment A2. Department of Agriculture Registered Adjuvants 1999 (continued)

Name	Toxicity
Pacidifier	Warning
Penetrator	Caution
Penetrator Plus	Warning
Penewet #11	Caution
Penox	Caution
Peptoil	Caution
Ph	Caution
Phaser 2	Caution
Placement Deposition and Retention Agent	Caution
Plex Sticker Extender	Danger
Precision Spray Control	Caution
Prime Oil	Caution
Prime Oil Ii	Caution
Pro-Foam	Caution
Qfc Tack-90	Caution
Quark	Warning
Quest	Warning
R-11 Spreader-Activator	Caution
R-56 Spreader-Sticker	Caution
R-900 Penetrator-Activator	Caution
Rain Fastnew Technology Surfactant	Caution
Redi-Vert	Caution
Regulaid	Caution
Request	Caution
Respond Granular	Caution
Respond Liquid	Caution
Respond Tablet	Caution
Retain	Caution
Riverside Tc Spray Tank Cleaner	Warning
Rna Bu-Ph-Er	Caution
Rna Crop Oil Conc 1915	Warning
Rna Hold-On	Caution
Rna Methoxylated Oil	Warning
Rna Spreader-Binder	Warning
Rna Tri-Ad 73	Danger
Rocket Dl	Caution
S-K-H Agricultural Adhesive	Caution
Saturall 85	Caution
Silwet L-77	Caution
Silwet L-77 Surfactant(Organosilicone)	Danger
Slippery Water	Caution

Attachment A2. Department of Agriculture Registered Adjuvants 1999 (continued)

Name	Toxicity
Sodium Bisulfate	Caution
Sorba Spray Zkp	Caution
Sorba-Spray Mg	Caution
Sorba-Spray Mg 0-10-0	Caution
Sorba-Spray Mip 0-10-0	Caution
Sorba-Spray Zbk 1-0-6	Caution
Sorba-Spray Znp 10-12-0	Caution
Spodnam	Caution
Sponto 168-D	Caution
Spra Dar	Caution
Spray Prep	Caution
Spray Start	Caution
Spray-Aide	Caution
Spreader 90	Caution
Spreader Hf	Caution
Sta Put Deposition Aid	Caution
Sta-Put	Caution
Sta-Put	Caution
Sta-Put Deposition Aid	Caution
Sta-Put Deposition Aid	Caution
Stik	Caution
Stimulator Plus	Caution
Strike Zone Dc	Warning
Summit Ten Tm	Danger
Sun-It Ii Spray Adjuvant	Caution
Super Spread 90	Caution
Superb	Caution
Support	Caution
Surf Aid	Caution
Surf-Ac 820	Caution
Surf-Ac 910	Caution
Surfix	Warning
Surfix	Caution
Surphtac Ii	Danger
Surphtac Ii Adjuvant	Caution
Sylgard 309	Caution
Sylgard 309 Silicone Surfactant	Warning
Take-Down	Danger
Tankmate F	Caution
Tme	Caution
Tme (Forest)	Caution

Attachment A2. Department of Agriculture Registered Adjuvants 1999 (continued)

Name	Toxicity
Transcend	Danger
Tri-Fol	Caution
Tripleline Foam-Away Defoamer	Warning
Ultra 90	Caution
Ultra 90-Nf	Caution
Umbrella	Caution
Unifilm 100	Warning
Unifilm 707	Caution
Unifilm Nf	Caution
United Hort Supply GRO-Wet Granular	Caution
United Hort Supply GRO-Wet Liquid	Caution
United Hort Supply Respond	Caution
United Hort Supply Respond Concentrated Wetting & Penet	Caution
United Hort Supply Respond Granular	Caution
Vegetable Oil Conc	Caution
W.E.B. Oil	Caution
Wex	Caution
Wilbur Ellis Mor-Act Adjuvant	Caution
Windbrake Drift Retardant	Caution
Windcheck Deposition Aid And Drift Retardant	Caution
X-77 Spreader	Danger