Managing Household Hazardous Waste in Oregon

Tools for Setting Priorities for HHW Materials, Geographic Areas, and Populations

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In the interest of waste prevention, this report is intended for electronic distribution and viewing. If a hard copy is required, please print double-sided on recycled paper.

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Executive Summary

The Oregon Department of Environmental Quality is implementing its *2005-2011 Household Hazardous Waste Management Plan.* The primary purpose of DEQ's Household Hazardous Waste (HHW) program is to minimize risks from HHW to Oregonians and the environment. One of the first actions called for in the plan is an assessment of what household hazardous wastes and materials pose the greatest risks to human health and the environment: a Priority Assessment study. This report presents the results of the Priority Assessment.

DEQ's consultant for the project, Cascadia Consulting Group, developed methodologies and researched academic, government, and other literature to help set priorities among products and substances, areas of the state (counties), and populations. Priorities for household hazardous waste collection, waste prevention and education, and market change activities, which are three primary elements of DEQ's *2005-2011 HHW Plan*, were also suggested.

Please note that **few comprehensive, risk-based tools already exist to set priorities for household hazardous waste management.** Many HHW programs have not formally ranked or prioritized substances and activities, and those that have done so have primarily relied upon expert opinion. This project represents an attempt to develop a rational, science-based method for assessing relative priorities in the context of a state government with finite resources. The consultant conducted a literature review, compiled scientific data, and developed two spreadsheet tools that DEQ can use to help assess product and geographic priorities. Both of these spreadsheet tools use multiple criteria to develop ratings and present ranked priority results.

The spreadsheet tools and methods developed in this project are initial attempts to develop a rational method for assessing HHW priorities. The project was not, however, an exhaustive scientific study of risk, such as might be possible at the federal government level. Accordingly, the tools and methods are not without limitations. Lack of data on some chemicals, products, and geographic or population factors required several simplifying assumptions. For example, little information exists about the quantity and concentration of toxic substances in consumer products, a fact that required use of estimation techniques rather than concrete data. Nevertheless, the methodology developed and data compiled will *increase the likelihood that DEQ is effectively targeting the products and substances that pose the greatest risks to human health and the environment in Oregon*.

This Executive Summary features key results and conclusions of this Priority Assessment work. For more details, discussions of methodology, and descriptions of how DEQ, in its ongoing efforts, can use the spreadsheet tools developed by the consultant, please see the full report and its appendix.

Overall Findings

Following are key findings that emerged from the assessment of products and substances, geography, and populations in Oregon.

- **Pesticides, strong cleaners, and heavy metals likely represent the greatest HHW threats** to human health and the environment in Oregon. Pesticides (including herbicides, insecticides, and fungicides, among others) rate highly because of their impacts to human and environmental health and their widespread use in Oregon. Strong cleaners rate highly because of their corrosive nature, frequency and severity of in-home exposures, and widespread use in Oregon. Heavy metals rate highly due to their high human and environmental toxicity.

- **Multnomah, Washington, Clackamas, Marion, Lane, and Jackson counties rate as high geographic priorities primarily due to population and density criteria.** These counties are the most populous counties in the state and have higher population density and degree of urbanization than most others. These counties also have exposure and vulnerability concerns related to household hazardous waste.

- **The City of Portland is a clear geographic priority.** Even if population and density criteria are not included, Portland rated highly due to the high vulnerability of its environment: the degraded water quality of its streams and the presence of critical salmon habitat. If population and density criteria are also considered, then Portland is the top-rated geography.

- **Umatilla, Morrow, and Malheur counties rated as high geographic priorities due to exposure and vulnerability.** The exposure and vulnerability ratings for these counties were high enough to offset their lower ratings for population and density criteria.

- **Latex paint, a very common product collected at HHW facilities, rated low** for human and environmental health impacts and could be a candidate for transition to alternative management methods such as reuse, recycling, or to the solid waste system (e.g., dry and dispose). DEQ is currently assessing the costs and benefits of discontinuing the collection of latex paint at collection events; an appendix to this study's full report addresses this topic.

- **Young children are particularly susceptible to exposure from HHW.** Young children are uniquely vulnerable to toxics because their internal systems are still developing and could be permanently damaged. Children also face greater exposure per pound of body weight than do adults, are more likely to place items in their mouths, and could suffer harmful effects over a longer potential future lifespan than adults.

- **A number of other populations also face greater risks**, including asthma sufferers, senior citizens, and ritualistic users of mercury. In addition, populations that handle their waste outside of the regular solid waste system, such as by burning, may be more likely to manage HHW improperly.

Suggested Priorities for HHW Plan Elements

In addition to the overall findings presented above, this Priority Assessment suggested possible priorities for DEQ's activities under its *2005-2011 HHW Plan* elements of collection, waste prevention and education, and market change. Following are summaries of the options presented in the full report.

- **Collection systems to place particular emphasis on pesticides and heavy metals** due to their high health and environmental impacts. Collection systems are also necessary for products that pose risks but where few safe disposal alternatives are available: for example, fuels, oil-based paints, used motor oil, and polishes. In some areas existing collection systems can be expanded to include additional products or could benefit from increased promotion, whereas in other areas new service is needed because little currently exists.

- **Waste prevention and education programs to target products with significant risks and for which least-toxic alternatives exist.** Examples of products that would be strong candidates for waste prevention and education efforts include strong cleaners (particularly highly corrosive products like strong acids and bases) and pesticides.

- **Additional education to help reduce risks by focusing on safe use and storage and proper disposal.** Proper disposal practices are particularly important in areas where common mishandling practices are more likely to result in exposure by humans or the

environment: areas with combined sewer overflows, or CSOs (e.g., Clatsop County, City of Portland); high septic system use (e.g., Wheeler, Crook, Jefferson, Josephine counties); or unlined landfills or incinerators. Safe use and storage is particularly important for strong cleaners and other household maintenance products (such as polishes), as well as pesticides, auto batteries, rechargeable batteries, fuels, pool chemicals, and antifreeze.

- **Market change strategies focusing on highly toxic substances.** Over the long term, the most cost-effective approach for DEQ to manage HHW is likely to be the elimination or minimization of hazardous materials in household products. Market change is particularly suited to highly toxic substances where consumer education or end-of-life collection cannot adequately manage risks. Substances that received high ratings in this Priority Assessment include several pesticides, heavy metals, nitrobenzene (an ingredient in some polishes), and lindane (an ingredient in some lice shampoo). Further research may also be needed to stay abreast of emerging threats that could be addressed through market change. For example, emerging research on nonylphenol ethoxylates, which are ingredients in some detergents, suggests that they may pose significant human and environmental risks.

- **Additional market change strategies focusing on high-volume but less toxic products.** Market change strategies can also apply to products that may not be as toxic but where large quantities demand solutions. Market change approaches may be particularly suited for such products where significant alternatives exist or where momentum is already underway. For example, national product stewardship dialogues have recently focused on latex paint and electronics. In addition, automobile service stations currently handle fuels and used motor oil and could potentially be a partner for alternative collection of these products.

DEQ will be using this study's research, methods, spreadsheet tools, and findings to help inform and guide allocation of Oregon's resources for HHW collection (including grants to local governments and DEQ-funded collection events, among other activities), waste prevention and education activities, and market change or product stewardship initiatives. For further discussion of this project's methodology, findings, and intended uses of the spreadsheet tools, please see the full report.

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1 Introduction and Overview

Since 1991, Oregon's Department of Environmental Quality has promoted alternatives to and safe management of Household Hazardous Waste (HHW) and offered collection services to residents in communities around the state. HHW collection needs and infrastructure and services have evolved since the early 1990s, and in 2005, DEQ adopted an updated six-year Plan for managing Oregon's HHW, the *Household Hazardous Waste Management Plan for the State of Oregon: 2005-2011*.

The primary purpose of DEQ's HHW Program is to **minimize risks from HHW to Oregonians and the environment**. In keeping with this overall mission, the primary goals for the *2005-2011 HHW Plan* are to **reduce the generation of household hazardous waste** and **ensure the provision of HHW services addressing the highest risks first**.

To guide DEQ in allocating its program resources to address the materials and situations that pose the greatest risks to human health and the environment, the *HHW Plan* calls on the Department to conduct a Priority Assessment to evaluate these risks. In 2006, DEQ hired Cascadia Consulting Group to assist the agency with this priority-setting process. The Priority Assessment is designed to evaluate data and scientific information and develop decision-making tools to help DEQ allocate HHW program resources using risk-based criteria. The Priority Assessment seeks to answer three fundamental questions:

- **What hazardous materials** and waste in and from the household pose the greatest danger to human health and the environment?

- **Where in Oregon** are risks to human health and the environment from HHW likely to be the greatest?

- **Which populations** are likely to experience the greatest risks from HHW?

To answer these questions and conduct the Priority Assessment, Cascadia reviewed existing literature and conducted interviews regarding HHW risks and material priorities; built a model to analyze chemical information and rank products and substances based on various risk attributes; assembled and evaluated geographic data related to HHW generation and vulnerability; and examined population factors likely to increase exposure or susceptibility to HHW hazards. Other portions of this research and analysis project addressed behavior change and latex paint collection; those efforts are included as appendices to this report.

This report includes the following sections:

- **Chapter 2 – Approach and Methodology.** This chapter provides an overview of the literature review findings and general background on the approach to and development of the ranking model for hazardous products and substances (more details on the model appear in Chapter 3).

- **Chapter 3 – Priority Products and Materials: The Product Ranking Tool.** This chapter explains the development and function of a tool for ranking hazardous products and substances and presents preliminary results of this tool.

- **Chapter 4 – Geographic Priorities: The Geography Ranking Tool.** This chapter describes the creation and use of a tool for collating and examining geographic features and attributes that may increase the likelihood of human exposure or environmental hazards associated with HHW.

- **Chapter 5 – Population Risk Factors: Exposure and Vulnerability.** This chapter discusses various population factors that may correlate with increased generation of, exposure to, or sensitivity to household hazardous waste.

- **Chapter 6 – Integration with HHW Management Plan.** This chapter integrates the findings of the previous chapters into the collection, waste prevention and education, and market change elements of DEQ's *2005-2011 HHW Plan*.

- **Appendices.** Appendix A presents more details on the methodology for assigning ratings for various attributes for the chemicals and materials contained in the Product Ranking Tool. Appendix B includes a literature review on the topic of household hazardous waste prevention and behavior change, and Appendix C presents the results of an analysis of latex paint collection.

2 Approach and Methodology

Oregon's approach to setting priorities for household hazardous waste is innovative, yet rational. While a wealth of information exists on the hazards and risks of individual chemicals, including those found in hazardous household materials, relatively few studies or programs appear to have performed comparative risk assessments or taken a rigorous approach to setting priorities for product categories. A literature review found that models that rank HHW products have primarily relied on expert opinion, though other models exist that rank chemicals (particularly industrial feedstocks or releases) using quantitative data on health effects, environmental impacts, and chemical or physical hazards. The Product Ranking Tool presented in the following chapter draws on existing models for hazard ranking.

During the literature review, the consultant searched publication databases including Entrez Pubmed, Proquest, and Expanded Academic ASAP. The consultant also performed general internet searches using Google and Google Scholar. Search terms included combinations of the following terms: household hazardous waste (HHW); material; substance; risk; assessment; population (and/or "among"); priorities; and individual chemical names or categories, such as pesticides, mercury, and cleaners. The consultant also searched individual publications and programs including *Environmental Health Perspectives*, *Environmental Science and Technology*, the National Toxicology Program, the National Library of Medicine's Hazardous Substances Data Bank and Household Products Database, various U.S. Environmental Protection Agency databases and models, and the University of Washington's Collaborative for Health and the Environment (CHE) Toxicant and Disease Database.

Additional information on leading efforts to rank hazardous products came from interviews with program staff or consultants. Interviews included Ken Armstrong of King County's Local Hazardous Waste Management Program in Washington State; Chris Geiger and Alicia Culver regarding San Francisco's Environmentally Preferable Purchasing Program; Pamela Brody-Heine regarding the Zero Waste Alliance's Chemical Assessment and Ranking System (CARS); and Shayla Barrett regarding Purdue University's Indiana Relative Chemical Hazard Scores.

The literature review found few existing rankings of household hazardous products and none that ranked household hazardous products primarily using quantitative inputs. Several programs, including San Francisco's Environmentally Preferable Purchasing Program, ranked products for potential city purchase using expert opinion to generate those rankings. In the San Francisco program, product categories were independently scored by two members of the project team using 11 technical criteria.

The literature review and input from DEQ and the project's expert advisory team,[1] however, did uncover several models that quantitatively rank chemical components individually. Quantified hazard ranking programs varied based on their primary focus (e.g., environmental health, worker safety), ranking criteria (e.g., carcinogenicity, flammability), weighting of criteria, and number of chemicals included.

One reason that quantitative rankings have been done for chemical components, but not products, may be that quantified data in user-friendly formats are readily available for individual chemicals, but not for household products or product categories. While data on the hazards of products exist, they are neither readily available in database formats nor necessarily

[1] Dr. Philip Dickey of the Washington Toxics Coalition, Dr. Joan Rothlein of Oregon Health and Science University, and Annette Frahm of Sage Environmental all provided review and valuable input of this study's methodology and findings. However, the opinions and conclusions presented are solely those of Cascadia Consulting Group, Inc.

standardized. A primary source of data on product hazards are Material Safety Data Sheets (MSDS), which are designed for considering the hazards of a single product, not for comparing and ranking many different products. MSDSs contain fairly standardized data but often do not contain sufficient detail on all constituents and are not known to be available in a single publicly available database. For example, the National Library of Medicine's Household Products Database, which is based in part on MSDSs, lists only one product that contains mercury – a particular brand of concrete colorant – seemingly excluding the more common mercury-containing thermostats, thermometers, and fluorescent light bulbs.

In contrast, data on the basic properties of individual chemicals, including flammability, corrosiveness (acid/base), and reactivity, are more readily available. Data on basic health impacts, including carcinogenicity and noncancer toxicity (both acute and chronic), are also available for many chemicals in such databases as the U.S. Environmental Protection Agency's Integrated Risk Information System (IRIS).

Analysis of the environmental impacts of chemicals is often secondary to research on human health effects, and these impacts are not consistently tracked and compiled in a comprehensive manner. Quantifying the environmental impact of a chemical depends heavily on which properties of the chemical are considered (e.g., persistence, ease of transport through water, bioaccumulation), which part of the environment is considered (e.g., amphibians, birds, mammals, dissolved oxygen levels, food chains, global climate), and how each component is ranked. The complexity of quantifying environmental impacts means that environmental scores generally are not comparable across different models. Fortunately, the U.S. EPA has created the Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI), which ranks several hundred chemicals, including their ecotoxicity, and will be discussed further in the section covering the Product Ranking Tool.

Based on findings from the literature and review of existing models, the consultant's approach to assessing priorities for HHW products involves compiling quantitative and qualitative data on human health impacts, environmental impacts, and physical or chemical hazards of individual chemicals, as well as assessments of product volume and reported poisonings. As discussed further in the following chapter, these data for each attribute are assigned scores of 1 through 5, which are then combined, using weighting of the criteria, to yield priority rankings of specific products and chemicals contained in household hazardous waste.

The Priority Assessment also involves a review of geographic and population data to help identify where in Oregon risks to human health and the environment from HHW are likely to be the greatest and which populations are likely to experience the greatest risks from HHW. Finally, this report integrates the findings across substances and products, geographic areas, and populations to help DEQ establish its overall priorities for HHW management, including collection, education and prevention, and market transformation.

2.1 Project Boundaries

No universally accepted definition of household hazardous waste exists to guide choices about what materials, products, or activities should be considered in this assessment. Nevertheless, for the purposes of this study, the following guidelines were used.

- Materials and products used by consumers in the household were included if, when disposed, they would generally be considered household hazardous waste.[2] Products that may pose some risk while in the home but would not be accepted at household hazardous waste facilities in Oregon (e.g., vinyl furnishings that may off-gas in the home) were generally excluded. A few such products (e.g., polycarbonate plastics) were included on a very preliminary basis for experimental purposes only but may warrant further attention in future expansions of this assessment.

- Impacts of upstream (e.g., manufacturing) processes were not considered. The focus of the project was on assessing risks at the home (sometimes called "use phase" in this report) or in disposal.

- This project does not attempt to weigh the relative importance of HHW versus other efforts of Oregon state agencies (including within DEQ).

[2] Use of consumer-like products by businesses was also considered in this assessment if those products were not central to the primary business activity. In other words, motor oil and antifreeze generated by auto repair shops would be excluded since these materials form a core service of the business, whereas cleaning products used by employees in an office environment would be included.

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3 Priority Products: The Product Ranking Tool

One of the primary goals of the Household Hazardous Waste Priority Assessment project is to develop and execute a rational, risk-based method to assess which household hazardous wastes likely pose the greatest danger to public and environmental health.

To address this goal, the consultant designed a methodology and spreadsheet tool, compiled relevant data on hazardous products and substances, and performed the assessment. This spreadsheet, termed the Product Ranking Tool, serves as the central resource for identifying products and substances to be evaluated, compiling scientific data, choosing program priorities that help inform the rankings, and calculating and presenting results. The Product Ranking Tool is an interactive Microsoft Excel spreadsheet that allows for users to adjust inputs and view results. Because of this interactive element and flexibility, the consultant's hope is that the Tool can serve as a long-term resource for the Department of Environmental Quality as new substances or wastes present themselves and new information becomes available. On the other hand, the spreadsheet tool cannot be the single definitive resource on product or substance risk; instead it is a planning tool for internal DEQ use that facilitates data compilation and analysis. Accordingly, the Product Ranking Tool, like other materials developed in the Priority Assessment project**, should be used to inform and guide, but not direct, DEQ's policies and programs.**

3.1 Methodology and Use of the Product Ranking Tool

This section of the report describes the assessment method developed and the process for populating the Product Ranking Tool with scientific and risk-based data. The information in this section is intended both to document the process used by the consultant as well as provide guidance to users at DEQ for how to use and update the tool in the future. The steps include:

a. Select products and substances for evaluation;

b. Match products to substances;

c. Identify criteria for assessing products and substances;

d. Weight criteria according to relative importance for DEQ management efforts, if such policies or decisions have been made;

e. Rate products and substances against criteria;

f. Perform calculations and rank products and substances; and

g. Interpret results.

The following sections describe each step in this product ranking process.

a. Select Products and Substances for Evaluation

The focus of this project was on household hazardous waste. Rather than attempting to develop an exhaustive or legal definition of HHW, we instead took the practical approach of including in the Product Ranking Tool: (1) items currently collected by HHW programs in Oregon; (2) other

household hazards identified by academic or government literature; and (3) other hazardous substances used in the home, as suggested by the project team.[3] This approach resulted in the identification of over 50 product types and over 70 substances to be evaluated in this assessment. Clearly, this group of products and substances is just a small subset of the hundreds or thousands of products and substances used in consumer products, but the limited data available and limited resources for this project necessitated a focused approach. The following table summarizes the substances evaluated in this assessment.

[3] Sources consulted include DEQ staff, the European Commission (2002), Ruckart *et al.* (2004), the American Association of Poison Control Centers Toxic Exposure Surveillance System (2004), and the project's expert advisors: Dr. Joan Rothlein of OHSU, Dr. Philip Dickey of the Washington Toxics Coalition, and Annette Frahm of Sage Environmental (formerly of King County, Washington). Industrial pollutants were generally excluded, even if ultimately found in the home (such as lead fallout from a smelter or mercury accumulated in fish).

Table 1. Materials Included in the Product Ranking Tool
(Please see spreadsheet tool for precise product-substance matching)

Product Category	Product Type or Subcategories	Substances Rated
Adhesives/glues	spray adhesives, rubber cement, superglue	hexane, cyanoacrylate
Ammunition/explosives	ammunition, explosives	lead, potassium nitrate
Art supplies	pigments	cadmium, chromium, cobalt, lead
Automotive fluids	antifreeze, motor oil	ethylene glycol, naphthalene, benzene, phenol
Batteries	alkaline, rechargeable, automotive	cadmium, nickel, lead, zinc, potassium hydroxide, sulfuric acid
Cleaners	ammonia, strong acids, strong bases, bleach, spot removers, detergents and surfactants, disinfectants, other cleaners	ammonia, sodium hypochlorite, hydrochloric acid, trichloroethylene, tetrachloroethylene ("perc"), acetone, butane, trisodium phosphate, phenol, nonylphenol (and ethoxylates), hexane, sodium hydroxide
Electronics	computers	lead, octa-PBDE
Fertilizers	household fertilizers	potassium nitrate
Fuels/gases	propane, liquid fuel	propane, petroleum distillates, benzene, butane
Inks, dyes		benzene, naphthalene
Insect repellants	mothballs, DEET	naphthalene, para-dichlorobenzene, DEET
Mercury-containing products	thermostats, thermometers, CFLs	mercury
Paint	latex paint, oil-based paint, paint remover, rust proofing	vinyl acetate, styrene, formaldehyde, petroleum distillates, benzene, xylene, tolulene, methylene chloride
Pesticides	herbicides, fungicides, insecticides, molluscicides, moss killer, fumigant, lice medication, preservatives, rodenticide	glyphosate, MCPP, 2,4-D, metaldehyde, zinc, chlorothalonil, carbaryl, chlorpyrifos, trifluralin, arsenic, malathion, naphthalene, methoxychlor, dimethoate, acephate, rotenone, sodium cyanide, permethrin, propoxur, methyl bromide, dichloropropene, pentachlorophenol, brodifacoum
Pharmaceuticals	oral contraceptives, lice shampoo	ethinylestradiol, lindane
Photographic chemicals	fixer	silver, ammonium thiosulfate
Polishes		petroleum distillates, nitrobenzene, naphthalene, hydrofluoric acid
Pool/spa chemicals		sodium hypochlorite, muriatic acid
Solder		lead, cadmium
Solvents	turpentine, mineral spirits, banned solvents, other solvents	turpentine, petroleum distillates, toluene, xylene, methanol, trichloroethane, tetrachloromethane, hexane, methyl ethyl ketone, acetone
Wood filler		acetone, toluene

b. Match Products to Substances

Table 1 details the products and substances evaluated in this assessment. Note that products are evaluated based in large part on the substances they contain. Accordingly, the consultant identified substances believed to be representative for each product type. Substances identified as representative for a category were generally those believed to be both common and to have significant potential impacts. Sources consulted during matching of products to substances included the National Library of Medicine's Household Products Database (HPD) and Hazardous Substances Data Bank (HSDB), government reports on constituents of HHW products[4], and, to a lesser extent, publicly generated information sources such as *Wikipedia.*

The matching of products and substances was not one-to-one; many substances could be assigned to a given product type or a substance could be assigned to several different product types. However, each product was ultimately assessed based on the worst substance it contained. For example, alkaline batteries were matched with two substances, zinc and potassium hydroxide. If zinc were determined to pose greater risks than potassium hydroxide, then alkaline batteries would be evaluated based solely on zinc and not based on potassium hydroxide. Although this method ensures that the presence of a highly toxic material will not be "diluted" by other lower-risk substances contained in the product, it also presents a limitation: if multiple hazardous substances are present in a product, the potential compounded effects or interaction of those substances is not assessed. Similarly, the availability of any given substance within a product could not be assessed. Continuing the above example of alkaline batteries, the protective casing of a battery nearly always contains the zinc and potassium hydroxide within the battery, preventing exposure.

DEQ may make modifications to the chemicals evaluated as it uses this tool in the future. For example, research findings continue to emerge on the effects of phthalates, brominated flame retardants, and bisphenol A. Although these particular chemicals were evaluated on a preliminary basis in the current study, DEQ could assess them or other substances using this tool in the future as further research emerges.

c. Identify Criteria for Assessing Products and Substances

In order for the identified substances to be ranked according to priority, basic criteria must be established against which each product and substance can be rated. The primary criteria identified in this HHW Priority Assessment for substances are *Health Impacts*, *Environment Impacts*, and *Hazard Potential*; additional criteria for products are *Generation* and *Poisonings. Generation* is an assessment of the relative quantity of product believed to be in use in Oregon households. *Poisonings* is an assessment of the number and severity of poison center calls related to each product. *Poisonings* is used as a substitute for the concentration or availability of hazardous or toxic substances in the product (since, presumably, exposure and resulting poisonings can only occur if the substance of concern is both in sufficient concentration and available).

Data in the scientific literature, however, are not neatly organized according to these five headings. In addition, DEQ was interested in ensuring that more specific criteria were also

[4] For example the following source was used to identify substances contained in used motor oil: Irwin, Roy et al., 1997. "Oil, Used Motor Oil Entry." *Environmental Contaminants Encyclopedia.* National Park Service Water Resources Division. King County (Washington)'s Local Hazardous Waste Management Program has also compiled some fact sheets about common HHW products that were consulted in this process.

included, particularly for *Health Impacts* and *Hazard Potential* ratings since these types of impacts have multiple components. For example, substances can cause cancer or they can be more generally toxic but not cause cancer. Similarly, substances can pose multiple types of hazards, including corrosiveness, reactivity, and flammability. For these reasons, the consultant identified secondary criteria under two of the primary substance criteria, as follows.

Table 2. Primary and Secondary Criteria Used in the Product and Substances Assessment

Primary Criteria	Secondary Criteria
Substance Criteria	
Health Impacts	Cancer
	Noncancer
Environment Impacts	Ecotoxicity
Hazard Potential	Corrosiveness
	Reactivity
	Flammability
Product Criteria	
Generation	*None*
Poisoning/Availability	*None*

Given DEQ's existing areas of focus and the types of impacts likely to occur from household hazardous waste, these criteria are considered to be adequate for the current priority-setting effort. At a future date, however, DEQ may wish to consider adding additional possible impacts such as global warming potential, contributions to smog or acidification, and/or eutrophication, among others. Although these criteria were considered briefly for this study, comprehensive data were not available and the above criteria were determined to be adequate for current purposes.

In addition, please note that criteria such as persistence and potential for bioaccumulation were also considered. The primary data source used to assess health and environmental impacts was a multimedia model that incorporated human exposure modeling, including the concepts of bioaccumulation and persistence.[5] Therefore, these two concepts were not included as separate criteria.

[5] The model used was the EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts, or TRACI. According to Bare (2003), "Prior to the development of TRACI, many researchers used simple measures of toxicity (Heijungs et al. 1992) or scoring procedures based on persistence, bioaccumulation, and toxicity (Swanson and Socha 1997) to provide indicators for human toxicity. These methods yielded proxy indicators that did not fully quantify the potential for effects, but simply provided a measure of a related parameter. By incorporating a sophisticated multimedia model followed by human exposure modeling, the current methodology within TRACI provides a more sophisticated output that is related to the potential impacts being quantified."

d. Weight Criteria According to Relative Importance for DEQ Efforts

The five primary criteria (human impacts, environmental impacts, hazard potential, generation, and poisonings) and six secondary criteria are used in the Product Ranking Tool to help determine the overall priority rating of each substance. Although each criterion is clearly important to consider, policy, scientific, or programmatic considerations may suggest that some criteria are more important than others in determining the agency's overall HHW priorities. The Product Ranking Tool therefore provides flexibility by allowing the user to place more or less emphasis on each criterion used. Specifically, weighting factors of 0 through 10 can be assigned to each criterion to represent the relative importance of that criterion to DEQ.[6]

At present, all primary and secondary criteria are assigned equal priority weightings of 10 because there was no clear rationale for weighting certain criteria higher or lower than the others. DEQ may wish to adjust future choices of priority weightings in accordance with new information or initiatives at the time or based on established agency priorities. Note that the consultant conducted some sensitivity analysis with alternate priority weighting settings (such as setting each criterion to 5 and assessing changes in the results). Although such changes do alter the precise rankings of several products and substances, the dominant findings presented in Section 3.2 below remained stable.

e. Rate Products and Substances against Criteria

Some previous priority-setting exercises in other jurisdictions have used a panel of experts to assign ratings to substances for various criteria, based on subjective "professional opinion," often in a single meeting or short series of meetings. For this exercise, DEQ was interested in developing a rational method based directly on existing scientific data, wherever possible. Accordingly, the consultant sought to find a limited number of comprehensive or nearly comprehensive, multi-substance data sources upon which they could base the analysis. In particular, the consultant selected the U.S. Environmental Protection Agency's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) and the National Library of Medicine's Hazardous Substances Data Bank (HSDB) as the primary data sources for the substance criteria of health impacts, environmental impacts, and hazard potential. TRACI was developed by the EPA to assist in impact assessment for pollution prevention initiatives, among other purposes.[7] The HSDB is a database that focuses on the toxicology of potentially hazardous chemicals.[8] Both data sources have undergone extensive peer review.

For ratings conducted at the product level (generation and poisonings), additional data sources were used. Poisonings were rated based on data published by The American Association of Poison Control Centers (AAPCC). AAPCC publishes a summary of all poison center calls according to their topic (i.e., product) and severity of outcomes. Generation was estimated based

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[6] Note that the ratings assigned to secondary criteria affect only their relative contribution within a primary criterion and do not directly affect the contribution of that primary criterion to the overall outcome. Therefore, if all secondary criteria under *Health Impacts* receive the same rating, it does not matter whether that rating is 1, 5, 10, or some other number: the final *Health Impacts* rating will not be affected.

[7] More information on TRACI can be found on the EPA's website, at http://www.epa.gov/nrmrl/std/sab/traci/. In addition, the most complete description of the method used to develop TRACI was published as Bare, Jane et al., 2003. "Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts." *Journal of Industrial Ecology* Volume 6, Number 3-4: 49-77.

[8] The HSDB is available online at http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB.

on limited actual sales and use data plus additional assumptions as described further below and in Appendix A.

The procedure for rating each substance is described in the following section. For further detail, please see Appendix A as well as the notes contained in the spreadsheet tool itself.

1. **Rate each substance as a 1 (low) through 5 (high) for human cancer impacts, human noncancer health impacts, and ecotoxicity, based on data in TRACI**, if TRACI rated the substance. TRACI does not use a 1 through 5 scale to rate substances, but the consultant converted their ratings to a 1 through 5 scale by using quintiles. For example, the worst 20% of substances rated in TRACI received a "5" rating. If TRACI did not rate the substance, the consultant used qualitative information in the HSDB to assign a numerical rating. In some cases, particularly for pesticides, the consultant also consulted *pesticideinfo.org* which gives qualitative assessments of chemicals used in pesticides.

2. **Rate each substance as a 1 through 5 for reactivity and flammability based on the National Fire Protection Association's "Code 704" ratings.** The National Fire Protection Association's (NFPA) Code 704 ratings define the "fire diamond" used by emergency personnel and commonly displayed on chemical transport trucks and in buildings. Because these ratings are assigned by the NFPA as 0 through 4, the consultant converted them to 1 through 5 by adding 1 to each substance's NFPA rating.

3. **Rate each substance as a corrosive/irritant based on qualitative information in the HSDB** about the chemical's effect on human skin or tissue. Ratings of "5" were assigned to substances described as "extreme" or "severe" irritants, with lower ratings assigned for more moderate descriptions using terms such as "moderate" or "may cause irritation." Ratings of 1 were assigned if no corrosive or irritant properties were described in the HSDB.

4. **Rate each product for poisonings based on Poison Center call data.** The American Association of Poison Control Centers publishes a summary of all poison center calls according to their topic (i.e., product) and severity of outcomes. The number and severity of calls for each product were both assigned 1 through 5 ratings and these two ratings were then averaged to produce an overall rating for "poisonings".

5. **Rate each product for generation based on limited available data or logical assumptions.** For generation, no comprehensive data set was available, so the consultant estimated benchmark quantities for several iconic HHW products (based on sales estimates from other areas) and rated other products by logically considering whether there was likely more or less of each product than the benchmark. Further information on this approach is provided in the appendix.

Complete information and data were not available for every chemical or product assessed. Whenever a judgment was made to assign a rating based on qualitative information, a brief description of the rationale for assigning that rating was inserted as a comment in the Product Ranking Tool. Please see Appendix A for more detail about rules developed to guide the assignment of 1 through 5 ratings.

The following page displays a picture of the primary interface for the Product Ranking Tool.

Figure 1. Interface of the Product Ranking Tool
(Results shown are for display purposes only; in addition, only top 13 are shown to enable display on one page.)

Oregon Department of Environmental Quality

Household Hazardous Waste Product Ranking Tool

May 24, 2007

Program Priorities

Criteria	Weighting Factor
Health Impacts	10
Environment Impacts	10
Hazard Potential	10
Generation	10
Poisonings/Availability	10

These three criteria comprise the "Substance Rating", below, which refers to the rating for the worst consitutuent substance in the product. All substance ratings are reported on the Substance Interface and the assignment of substances to products occurs on the "Products to Substances" worksheet.

Results

	Product	Product Category	Overall Rating	Substance Rating	Generation	Poisonings	Substance Rated for This Product	Substance Health Impacts	Substance Enviro Impacts	Substance Hazard Potential
1	Strong Acids	Cleaners	3.3	2.6	4	4.5	hydrochloric acid	1.5	3.0	3.3
2	Herbicides - residential	Pesticides	3.3	2.8	5	3.0	glyphosate	3.0	4.0	1.3
3	Strong Bases	Cleaners	3.1	2.4	4	4.5	sodium hydroxide	2.5	2.0	2.7
4	Insecticides - banned	Pesticides	3.1	4.0	1	2.5	DDT	5.0	5.0	2.0
4	Insecticides - residential	Pesticides	3.1	2.8	3	4.0	malathion	2.5	4.0	2.0
6	Auto Batteries	Batteries	3.0	2.8	3	3.5	lead	4.5	3.0	1.0
6	Rechargeable Batteries	Batteries	3.0	3.5	2	2.5	cadmium	4.5	4.0	2.0
8	Ammonia	Cleaners	2.9	2.6	4	3.0	ammonia	2.0	3.0	2.7
9	Other cleaners	Cleaners	2.9	2.2	4	4.0	tetrachloroethylene	3.5	1.0	2.0
9	Used Motor Oil	Automotive fluids	2.9	2.8	3	3.0	naphthalene	2.5	4.0	2.0
11	Fumigants	Pesticides	2.9	3.1	2	3.0	dichloropropene	3.0	3.0	3.3
12	Herbicides - banned	Pesticides	2.8	3.1	2	3.0	sodium cyanide	3.5	4.0	1.7
13	Polishes	Polishes	2.8	3.2	2	2.5	nitrobenzene	3.0	4.0	2.7
13	Detergents and surfactants	Cleaners	2.8	3.1	2	3.0	nonylphenol (and ethoxyl	2.5	4.0	2.7

f. Perform Calculations and Rank Products and Substances

Once priority weightings are assigned and each product or substance is rated against each criterion, a composite rating is calculated. This resulting composite rating for each substance is essentially an average of the ratings it received under each criterion. More specifically, the calculation involves two steps:

1. Calculate 1 through 5 impact ratings for each primary criterion based on ratings of the secondary criteria. The mathematical calculation is a weighted average using the secondary criteria's priority weightings (0 through 10) as weighting factors on the impact ratings for each substance. For example, mercury received a "2" impact rating under *Cancer* and a "5" impact rating under *Noncancer*. If the priority weighting of *Cancer* was 8 and the priority weighting of *Noncancer* was 10, mercury would receive an overall *Health Impacts* rating of (8*2 + 10*5)/(8 + 10) = 3.67.

2. Calculate an overall 1 through 5 rating for the substance based on the 1 through 5 ratings of each primary substance criterion. This calculation is also performed as a weighted average of the primary criteria's priority weightings (0 through 10) as weighting factors on the 1 through 5 impact ratings of each primary criteria, as determined under Step 1 above.

3. Calculate an overall 1 through 5 rating for the product based on the key substance identified and the additional product-level ratings (quantities and poisonings). Note that the tool automatically seeks out and includes the worst substance rating assigned to that product.

The use of priority weightings as *weighting factors* means that criteria that receive higher priority weightings will have a greater impact on the composite impact rating. In an extreme example, if the *Health Impacts* criterion and its secondary criterion *Cancer* are both set to 10 (or any nonzero number 1 through 10) and all other health secondary criteria and all other primary criteria are set to zero, then the overall rating for that substance will be based solely on the *Cancer* rating.

g. Interpret Results

The product and substance interfaces of the Product Ranking Tool provide ranked output that can be used to help assess the relative priority of each substance or product. Although this ranked output and spreadsheet format of the tool may suggest that priorities can be taken directly from the numerical rankings, the large array of data and assumptions that are employed as well as the small differences between most overall ratings suggest combining the numerical output of the tool with a more cautious and qualitative approach.

In particular, the consultant recommends the following "common-sense" approach to formulating priorities from the product rating tool. This approach was used by the consultant to formulate the conclusions that follow in Section 3.2 and should be repeated by DEQ on an ongoing basis as it updates the tool with new information or as program priorities change.

1. **Review the rankings for general trends or surprises.** Assume that products that rate near the top do indeed bring more risk and those near the bottom carry less risk, but do not be concerned about the precise order of the rankings (e.g., if product A is ranked #10 and product B is ranked #11 rather than the other way around).

2. **For any surprises, look at the individual ratings** (e.g., health, environment, poisonings). What criteria appear to have caused the product to rate where it did? How big of a difference in overall rating was there between this product and other products? What substance was the "worst" rated substance for the product and does that substance seem to fit with the product? Looking at the "Products to Substances" tab in the Excel workbook, how many substances were rated for the product and what was the range of ratings for those substances? Are the substances contained within a product actually available to the environment or human exposure or does the product and management infrastructure adequately contain the risk? Considering these questions can help understand why a product rated as it did and inform decisions about what products should be DEQ priorities.

3. **Consider how similar products, or product categories, rate.** For example, a number of pesticides and cleaners cluster near the top of the rankings, based on different substances, suggesting that as a group pesticides should be one of the top priorities. In contrast, most adhesives and glues cluster near the bottom.

4. **Conduct sensitivity analyses** by experimenting with reasonable adjustments to the priority weightings. If, for example, the agency modified its view of the relative importance of human and environmental health, would the change dramatically affect the ratings?

5. **Develop conclusions about the relative priority of different products.** Although the Product Ranking Tool cannot be a perfect, definitive, or completely comprehensive assessment of each product, the goal has been to create a tool that increases the likelihood that DEQ is targeting the products with the highest risk. What products cluster near the top, and did experimental changes in the priority weightings affect the rankings? We recommend forming conclusions in tiers, such as high-priority, medium-priority, and lower-priority products.

6. **If a product ranking seems considerably out-of-line with professional experience or opinion, investigate further.** It may be that the substance or substances rated for that product are no longer appropriate, or that a particular rating is not accurate given the reviewer's (or the scientific or professional community's) current knowledge. Adjustments can be made to individual criteria ratings if new or more complete information warrants a change.

7. **Consider the substance interface on its own.** The ability of the product ranking tool to assess accurately the ranking of very highly toxic substances that are only present in moderate amounts in products is limited. Substances that rate near the top of the substance interface of the Product Ranking Tool, if they are known to be present in significant quantities in household products, should be considered as additional priorities even if their corresponding products did not rate highly on their own. This limitation underscores the future need to develop a comprehensive means of measuring product use quantitatively

8. **Pay close attention to any criterion with highest ratings (especially ratings of "5").** The use of quintiles or other systems of rating products and substances on a 1-5 scale tends to flatten results. For example, some substances with a "human health – cancer" rating of 5 are much more than five times as carcinogenic as many substances with a rating of 1 (many of which are not carcinogenic at all). Products or substances with individual criteria ratings of 5 (especially for human health – cancer, human health – noncancer, and ecotoxicity, all of which were assigned from TRACI using quintiles) may have potential impact disproportionate to that suggested by their overall product rating.

3.2 Results

The following table displays the output of the Product Ranking Tool, given equal priority weightings and the data included at the time of this report (May 2007). Since the Product Ranking Tool is meant to be used by DEQ on an ongoing basis, the results below are subject to revision.

Table 3. Product Results from the Product Ranking Tool

Oregon Department of Environmental Quality

Household Hazardous Waste Product Ranking Tool

May 24, 2007

Program Priorities

Criteria	Weighting Factor
Health Impacts	10
Environment Impacts	10
Hazard Potential	10
Generation	10
Poisonings/Availability	10

These three criteria comprise the "Substance Rating", below, which refers to the rating for the worst consitutuent substance in the product. All substance ratings are reported on the Substance Interface and the assignment of substances to products occurs on the "Products to Substances" worksheet.

Results

	Product	Product Category	Overall Rating	Substance Rating	Generation	Poisonings	Substance Rated for This Product	Substance Health Impacts	Substance Enviro Impacts	Substance Hazard Potential
1	Strong Acids	Cleaners	3.3	2.6	4	4.5	hydrochloric acid	1.5	3.0	3.3
2	Herbicides - residential	Pesticides	3.3	2.8	5	3.0	glyphosate	3.0	4.0	1.3
3	Strong Bases	Cleaners	3.1	2.4	4	4.5	sodium hydroxide	2.5	2.0	2.7
4	Insecticides - banned	Pesticides	3.1	4.0	1	2.5	DDT	5.0	5.0	2.0
4	Insecticides - residential	Pesticides	3.1	2.8	3	4.0	malathion	2.5	4.0	2.0
6	Auto Batteries	Batteries	3.0	2.8	3	3.5	lead	4.5	3.0	1.0
6	Rechargeable Batteries	Batteries	3.0	3.5	2	2.5	cadmium	4.5	4.0	2.0
8	Ammonia	Cleaners	2.9	2.6	4	3.0	ammonia	2.0	3.0	2.7
9	Other cleaners	Cleaners	2.9	2.2	4	4.0	tetrachloroethylene	3.5	1.0	2.0
9	Used Motor Oil	Automotive fluids	2.9	2.8	3	3.0	naphthalene	2.5	4.0	2.0
11	Fumigants	Pesticides	2.9	3.1	2	3.0	dichloropropene	3.0	3.0	3.3
12	Herbicides - banned	Pesticides	2.8	3.1	2	3.0	sodium cyanide	3.5	4.0	1.7
13	Polishes	Polishes	2.8	3.2	2	2.5	nitrobenzene	3.0	4.0	2.7
13	Detergents and surfactants	Cleaners	2.8	3.1	2	3.0	nonylphenol (and ethoxyl	2.5	4.0	2.7
15	Photographic fixer	Photographic Chemic	2.8	3.2	1	3.5	silver	3.5	5.0	1.0
16	Rodenticide	Pesticides	2.8	2.9	2	3.0	brodifacoum	3.5	4.0	1.3
17	Fungicides	Pesticides	2.7	2.8	2	3.0	copper	3.5	4.0	1.0
17	Liquid fuel	Fuels/gasses	2.7	2.2	3	4.0	benzene	2.5	1.0	3.0
17	Computers	Electronics	2.7	2.8	4	1.0	lead	4.5	3.0	1.0
17	Disinfectants	Cleaners	2.7	2.2	4	3.0	phenol	1.5	2.0	3.0
17	Bleach	Cleaners	2.7	1.8	4	4.0	sodium hypochlorite - ble	2.5	1.0	2.0
17	Pigment	Art supplies	2.7	3.5	1	2.0	cadmium	4.5	4.0	2.0
17	Ammunition	Ammunition/explosiv	2.7	2.8	2	3.0	lead	4.5	3.0	1.0
24	Pool/spa chemicals	Pool/spa chemicals	2.7	2.3	2	4.5	sodium hypochlorite - anl	2.5	1.0	3.3
24	Household fertilizer	Fertilizer	2.7	2.3	4	2.5	potassium nitrate	2.5	2.0	2.3
26	Lice medication	Pharmaceuticals	2.7	3.4	1	2.0	lindane	5.0	4.0	1.3
26	Latex paint	Paint	2.7	1.9	5	2.5	formaldehyde	1.5	3.0	1.3
26	Thermometers	Mercury-containing p	2.7	3.3	1	2.5	mercury	3.5	5.0	1.3
30	Oil-based paint	Paint	2.6	2.2	3	3.5	benzene	2.5	1.0	3.0
31	Thermostats	Mercury-containing p	2.6	3.3	1	2.0	mercury	3.5	5.0	1.3
32	Other solvents	Solvents	2.5	2.2	2	4.0	hexane	2.0	2.0	2.7
32	Moss killer	Pesticides	2.5	2.6	3	2.0	zinc	3.0	3.0	1.7
34	Solder	Solder	2.5	3.5	1	1.0	cadmium	4.5	4.0	2.0
34	Mothballs	Insect repellants	2.5	2.8	2	2.0	naphthalene	2.5	4.0	2.0
34	Inks/dyes	Inks/dyes	2.5	2.8	1	3.0	naphthalene	2.5	4.0	2.0
37	Banned solvents	Solvents	2.5	2.4	2	3.0	tetrachloromethane	5.0	1.0	1.3
38	Alkaline Batteries	Batteries	2.4	2.6	2	2.5	zinc	3.0	3.0	1.7
39	Arsenic pesticides	Pesticides	2.4	3.3	1	1.0	arsenic	5.0	4.0	1.0
40	CFLs	Mercury-containing p	2.4	3.3	1	1.0	mercury	3.5	5.0	1.3
40	Superglue	Adhesives/glues	2.4	2.4	1	3.5	cyanoacrylate	2.0	3.0	2.3
42	Mineral spirits	Solvents	2.3	2.1	2	3.5	petroleum distillates	2.5	1.0	2.7
42	Paint thinner	Paint	2.3	2.1	2	3.5	petroleum distillates	2.5	1.0	2.7
44	Propane	Fuels/gasses	2.3	1.8	2	4.0	propane	2.0	1.0	2.3
45	Rubber cement	Adhesives/glues	2.2	2.2	2	2.5	hexane	2.0	2.0	2.7
45	Spray adhesive	Adhesives/glues	2.2	2.2	2	2.5	hexane	2.0	2.0	2.7
47	Molluscicides	Pesticides	2.1	2.6	2	1.0	metaldehyde	3.0	2.0	2.7
47	Paint remover	Paint	2.1	1.7	2	3.5	methylene chloride	2.5	1.0	1.7
49	Wood filler	Wood filler	2.1	2.0	1	3.5	toluene	2.0	1.0	3.0
49	Oral contraceptives and estro	Pharmaceuticals	2.1	2.0	1	3.5	ethinylestradiol	3.0	2.0	1.0
49	DEET	Insect repellants	2.1	2.0	2	2.5	DEET	2.0	2.0	2.0
49	Antifreeze	Automotive fluids	2.1	1.5	2	4.0	ethylene glycol	1.5	1.0	2.0
53	Explosives	Ammunition/explosiv	2.1	2.3	2	1.5	potassium nitrate	2.5	2.0	2.3
54	Polycarbonates	Plastics	2.1	1.8	4	1.0	bisphenol a	2.0	2.0	1.3
55	Preservatives	Pesticides	2.0	2.2	2	1.5	pentachlorophenol	3.0	2.0	1.7
55	Rust-proofing	Paint	2.0	1.7	2	3.0	methylene chloride	2.5	1.0	1.7
57	Spot remover	Cleaners	1.8	1.6	1	3.0	acetone	1.5	1.0	2.3

Table 4. Substance Results from the Product Ranking Tool

Results

Rank	Substance	CAS #	Overall Rating	Health Impacts	Environment Impacts	Hazard Potential	Sample Product(s)
1	DDT	50-29-3	4.0	5.0	5.0	2.0	banned pesticide
2	PCB-1254	11097-69-1	3.7	4.0	5.0	2.0	fluorescent lamps/ballasts
3	Chlorpyrifos	2921-88-2	3.6	3.5	5.0	2.3	insecticide, nematicide
4	diazinon	333-41-5	3.5	3.5	5.0	2.0	insecticide
4	cadmium	7440-43-9	3.5	4.5	4.0	2.0	metal plating, pigments, batteries (heavy metal)
6	lindane	58-89-9	3.4	5.0	4.0	1.3	insecticide - lice treatment
7	arsenic	7440-38-2	3.3	5.0	4.0	1.0	banned lead arsenate pesticide (heavy metal)
8	permethrin	52645-53-1	3.3	3.5	5.0	1.3	insecticide - pyrethrin
8	mercury	7439-97-6	3.3	3.5	5.0	1.3	thermometers, switches, fluorescents (heavy metal)
10	chromium	7440-47-3	3.2	5.0	3.0	1.7	metal plating, pigments (heavy metal)
11	nitrobenzene	98-95-3	3.2	3.0	4.0	2.7	floor/furniture polish
12	silver	7440-22-4	3.2	3.5	5.0	1.0	photographic fixer
13	dichloropropene	542-75-6	3.1	3.0	3.0	3.3	fumigant
13	asbestos	1332-21-4	3.1	3.0	4.0	2.3	cement tile, thermal insulation
15	sodium cyanide	143-33-9	3.1	3.5	4.0	1.7	insecticide
16	nonylphenol (and ethoxylates)	25154-52-3	3.1	2.5	4.0	2.7	detergents and surfactants
16	vinyl chloride	75-01-4	3.1	4.5	1.0	3.7	PVC, pipe seal
18	nickel	7440-02-0	3.0	4.0	4.0	1.0	NiCad/NiMH batteries (heavy metal)
19	cobalt	7440-48-4	2.9	3.5	3.0	2.3	pigments (heavy metal)
20	brodifacoum	56073-10-0	2.9	3.5	4.0	1.3	rat poison
20	trifluralin	1582-09-8	2.9	2.5	5.0	1.3	herbicide
22	propoxur	114-26-1	2.9	2.0	5.0	1.7	insecticide/ant killer
22	diuron	330-54-1	2.9	3.0	4.0	1.7	herbicide
24	turpentine	8006-64-2	2.9	3.0	3.0	2.7	paint thinner
25	atrazine	1912-24-9	2.8	3.5	3.0	2.0	herbicide
25	Naphthalene	91-20-3	2.8	2.5	4.0	2.0	mothballs, insecticide, pigments, used motor oil
25	malathion	121-75-5	2.8	2.5	4.0	2.0	insecticide
25	copper	7440-50-8	2.8	3.5	4.0	1.0	fungicide (heavy metal)
25	lead	7439-92-1	2.8	4.5	3.0	1.0	batteries, ammunition, pipes, banned pesticides (hea
30	glyphosate	1071-83-6	2.8	3.0	4.0	1.3	herbicide - RoundUp
31	dimethoate	60-51-5	2.7	3.5	3.0	1.7	insecticide
31	methoxychlor	72-43-5	2.7	2.5	4.0	1.7	insecticide
33	para-dichlorobenzene	25321-22-6	2.7	3.0	2.0	3.0	mothballs
33	rotenone	83-79-4	2.7	2.0	4.0	2.0	insecticide
35	hydrochloric acid	7647-01-0	2.6	1.5	3.0	3.3	toilet cleaner
36	zinc	7440-66-6	2.6	3.0	3.0	1.7	herbicide - moss killer (heavy metal)
37	metaldehyde	9002-91-9	2.6	3.0	2.0	2.7	slug bait
37	ammonia	7664-41-7	2.6	2.0	3.0	2.7	glass cleaner
37	hydrofluoric acid	7664-39-3	2.6	2.0	3.0	2.7	metal cleaner/degreaser
40	octa-PBDE	32536-52-0	2.5	3.5	3.0	1.0	computer housings
40	sulfuric acid	7664-93-9	2.5	2.5	2.0	3.0	car batteries
42	cyanoacrylate	137-05-3	2.4	2.0	3.0	2.3	super glue
43	tetrachloromethane	56-23-5	2.4	5.0	1.0	1.3	cleaner/paint stripper
44	acephate	30560-19-1	2.4	2.5	3.0	1.7	insecticide
46	sodium hydroxide	1310-73-2	2.4	2.5	2.0	2.7	drain and oven cleaners
47	paraquat	4685-14-7	2.3	3.0	2.0	2.0	herbicides
47	carbaryl	63-25-2	2.3	2.0	3.0	2.0	insecticide
49	potassium nitrate	7757-79-1	2.3	2.5	2.0	2.3	fertilizer, explosives
49	methyl bromide	74-83-9	2.3	3.5	1.0	2.3	fumigant
49	muriatic acid (HCl)	7647-01-0	2.3	1.5	3.0	2.3	pool chemical
49	sodium hypochlorite - anhydrous/solid	7681-52-9	2.3	2.5	1.0	3.3	pool chemical
49	2,4-D	94-75-7	2.3	2.5	2.0	2.3	weed-n-feed
54	pentachlorophenol	87-86-5	2.2	3.0	2.0	1.7	wood preservative
55	hexane	110-54-3	2.2	2.0	2.0	2.7	adhesives
56	Potassium hydroxide	1310-58-3	2.2	2.5	2.0	2.0	alkaline batteries
56	phenol	108-95-2	2.2	1.5	2.0	3.0	disinfectant, antibacterial
56	tetrachloroethylene	127-18-4	2.2	3.5	1.0	2.0	cleaner/spot remover
56	benzene	71-43-2	2.2	2.5	1.0	3.0	fuels
60	trisodium phosphate	7601-54-9	2.1	2.0	2.0	2.3	cleaner
61	petroleum distillates	8052-41-3	2.1	2.5	1.0	2.7	paint thinner
61	xylene	1330-20-7	2.1	1.5	2.0	2.7	sealants, spray paint, particleboard, cleaners
63	ethinylestradiol	57-63-6	2.0	3.0	2.0	1.0	birth control pills and estrogen supplements
63	DEET	134-62-3	2.0	2.0	2.0	2.0	insect repellant
63	ammonium thiosulfate	7783-18-8	2.0	2.0	2.0	2.0	photographic fixer
63	trichloroethane	71-55-6	2.0	3.0	1.0	2.0	solvents
63	butane (isobutane)	75-28-5	2.0	2.0	1.0	3.0	cleaners
63	toluene	108-88-3	2.0	2.0	1.0	3.0	wood filler
69	methyl ethyl ketone	78-93-3	1.9	1.5	2.0	2.3	solvents
70	chlorothalonil	1897-45-6	1.9	1.5	3.0	1.3	fungicide
70	formaldehyde	50-00-0	1.9	1.5	3.0	1.3	preservative
72	sodium hypochlorite - bleach/liquid	7681-52-9	1.8	2.5	1.0	2.0	bleach
75	vinyl acetate	108-05-4	1.8	2.0	2.0	1.3	latex paint
77	methylene chloride	75-09-2	1.7	2.5	1.0	1.7	rust-proofing coatings, paint and varnish remover
78	methanol	67-56-1	1.7	1.5	1.0	2.7	solvents
79	acetone	67-64-1	1.6	1.5	1.0	2.3	nail polish remover
80	ethylene glycol	107-21-1	1.5	1.5	1.0	2.0	antifreeze
81	styrene	100-42-5	1.3	1.5	1.0	1.3	latex paint

Note that the project's expert advisory team expressed some concern regarding several of the results in the above table.[9] In particular, glyphosate is generally considered to be among the least toxic herbicides but TRACI rated it higher than 2,4-D for both human toxicity and ecotoxicity (glyphosate also rated higher than some insecticides, including methoxychlor and carbaryl). In addition, reviewers commented that benzene, formaldehyde, and hexane appeared to be rated too low given their professional experience and other scientific literature. Although the systematic, TRACI-based method used did not allow for adjustments based on professional opinion, the differences observed could perhaps relate to the different concentrations of these products in actual use and therefore expose an area for future enhancement (as already noted) in the methodology.

Discussion

Two products that rated very highly in the Product Ranking Tool (Table 3) are pesticides and strong cleaners. Even with small-to-moderate changes in priority weightings (for example, setting any of the five primary criteria to 5 instead of 10), these products consistently rate near the top.

- **Pesticides** dominated the top of the rankings. In particular, several **herbicides** and **insecticides** rated very highly due to high environmental impacts, high generation, and medium to high health impacts. **Fumigants, fungicides,** and **rodenticides** also rated highly for similar reasons but with lower generation.

- **Strong cleaners** also rated very highly, including cleaners that contain strong **acids** and **bases** as well as **other cleaners** such as tetrachloroethylene ("perc," a dry-cleaning fluid that may also be used in households for stain removal and degreasing). Strong cleaners rated highly due to high generation, high number of poison center calls, and high hazard potential (either due to the high corrosive/irritant properties of acids and bases or due to moderate corrosive/irritant properties combined with high human toxicity of chemicals like perc.)

- **Heavy metals consistently rated highly in the substance interface of the Product Ranking Tool** due to human and environmental impacts. Examples include cadmium, mercury, chromium, silver, nickel, cobalt, copper, and lead.

Several other products also rate very highly and warrant specific mention here. These are:

- **Used motor oil** rated highly due to its moderate to high ratings across all criteria. Used motor oil contains polycyclic aromatic hydrocarbons and related chemicals such as naphthalene and may in some cases contain significant quantities of heavy metals such as lead from engine wear.

- **Auto batteries** rate highly due to medium to high ratings for generation and poison center calls, as well as for high health and/or environmental impacts of sulfuric acid and lead.

- **Rechargeable batteries** rate highly due to medium to high ratings for generation and poison center calls, as well as for high health and environmental impacts of lead, nickel, and cadmium. However, note that these substances are not easily accessible due to the battery casings, that the probability of exposure is likely low, and therefore that rechargeable batteries may not pose as high a hazard as their product rating might otherwise suggest.

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[9] The consultant's review team included Dr. Philip Dickey of the Washington Toxics Coalition, Dr. Joan Rothlein of Oregon Health and Science University, and Annette Frahm of Sage Environmental.

- **Polishes** (including shoe, floor, and furniture polishes) are not nearly as ubiquitous as pesticides or cleaners, but they rated highly because some contain nitrobenzene, a substance that received moderate to high human, environment, and hazard scores. Further research may be needed to determine how common nitrobenzene is and whether the concentration of nitrobenzene in household polishes is significant.

The following common HHW products rated in the middle to lower half of the rankings:

- **Adhesives and glues.** The substances rated for adhesives and glues (hexane and cyanoacrylate) received lower high health, environment, or hazard ratings. Low quantities (despite moderate to high poison center calls) also helped keep adhesives and glues near the bottom of the ratings.

- **Antifreeze.** Despite a moderate to high rating for poison center calls, the relatively low quantities and low toxicity of ethylene glycol kept antifreeze near the bottom of the ratings.

- **Latex paint.** Latex paint rated in the middle of the pack overall. Latex paint received lower human and environmental impact ratings, but its very high quantity rating kept it from being rated much lower.

3.3 Limitations and Intended Uses of the Product Ranking Tool

As described above, the Product Ranking Tool is designed as a rational, systematic approach to informing product and substance priorities for DEQ's Household Hazardous Waste efforts. It is intended to assemble and provide information to support HHW funding and program decisions, though not to supplant the judgment that ultimately guides policies and programs. Given the data and resource constraints of this project, the tool contains several limitations and cannot be the single, definitive resource on product risk. Rather, the goal in creating it was *to increase the likelihood that DEQ is effectively targeting the products that pose the greatest risks*. Further improvements on this tool would increase the likelihood of accuracy and confidence in its results.

In particular, please keep in mind the following when using the Product Ranking Tool and reviewing its output:

- <u>The results of the tool should be reviewed and assessed qualitatively</u>, with consideration of trends and possible surprises, sensitivity of results to priority weighting inputs, possible new information about constituent materials of products, and assembly of the ranked results into high-, medium-, and low-priority tiers. Even though a numerical scoring system is used, the method is essentially qualitative in nature and the numerical output should not be interpreted as an absolute measure of risk. In addition, given the numerous assumptions made in assigning each rating, even relative comparisons contain uncertainty. Caution is particularly warranted given the very small differences among the numerical ratings for some products.

- <u>Substance concentration and availability in products has not been systematically assessed</u>. No comprehensive source of substance concentration or availability data was found to incorporate into the analysis, though we reviewed the federal Household Products Database and Source Ranking Database. The *Poisonings/Availability* criterion is intended to serve as a proxy for better information about concentration and availability, but it is not a direct measure of substance concentration or availability.

- <u>Substance degradation or breakdown products are not fully accounted for in the model</u>. Each product is rated for health, environment, and hazard impacts based on at least one constituent substance. But in some cases, substances can break down into other substances with either higher or lower toxicity. Although TRACI takes such breakdowns into

account when data are available, it is probable that not all breakdown products are included. Breakdown products were generally not considered for those substances not assessed in TRACI.

- Combined or compounded effects of substances are not accounted for. In some cases, products may contain substances that, when combined, pose higher or lower risks than the individual substances would on their own. These multiple, cumulative, and synergistic effects could not be accounted for in the Product Ranking Tool, which rates each product based only on the single worst substance it contains. A related limitation is that the Tool cannot rank a product that contains more than one toxic substance higher than a product that contains only a single toxic ingredient. For example, auto batteries contain both sulfuric acid (with a very high corrosiveness score) and lead (with a very high human health score), but the system can only use the composite score from one of these substances.

- The one through five (1-5) qualitative rating method limits the ability to distinguish extremely toxic substances. TRACI rates some substances as hundreds or thousands of times more toxic than other substances. However, to facilitate a standard system of substance and product assessment across a wide variety of criteria, the Product Ranking Tool uses 1 through 5 ratings for each criterion. As a result, the relative difference in potential impact between ratings is reduced. Note that this compression happens in all criteria, not just those criteria dependent on TRACI.

- Quantitative use or generation data are lacking. This assessment used an estimation approach to assessing product use or generation, but more detailed sales or use data would improve the reliability of the analysis.

- The Product Ranking Tool does not directly distinguish disposal versus use phase impacts. Quantities and exposure pathways may be very different in these two phases and warrant different management approaches.

4 Geographic Priorities: The Geography Ranking Tool

The risks posed by household hazardous waste are distributed unevenly across the state of Oregon. A variety of programmatic, demographic, cultural, and physical factors contribute to some areas having a higher presence of risk factors than others. DEQ is therefore interested in developing a method to identify geographic priorities in Oregon based on the relative presence of risk factors.

Much like the product ranking process, the consultant developed an analytical spreadsheet to organize the methodology, compile relevant data on risk factors in Oregon, and perform the assessment. This spreadsheet is termed the Geography Ranking Tool. Like the Product Ranking Tool, the geographic tool allows DEQ to choose priorities and interactively calculate and present results.

4.1 Methodology and Use of the Geography Ranking Tool

The development and use of the Geography Ranking Tool are similar to that of the Product Ranking Tool: identifying the geographies and criteria to be evaluated, assigning ratings, and calculating and presenting results. For the Geography Ranking Tool, these steps include:

1. **Identify what geographies are to be evaluated.** The consultant and DEQ selected counties as the basic geographic unit to be analyzed. Counties represent a reasonable geographic size and are a logical fit with DEQ's current approach to working with local governments, which focuses many of its efforts, such as HHW planning grants, at the county level. In addition, existing data are often available and compiled by county, facilitating the process of data collection. The only exception to the practice of using counties is that the City of Portland and the remainder of Multnomah County, excluding Portland, were both considered as their own geographies to provide greater detail in the most densely populated area of the state.

2. **Identify criteria for assessing geographies.** Three primary criteria were identified to characterize the relative risk level of Oregon counties: population and density, estimated level of HHW exposure, and estimated level of HHW susceptibility (both vulnerable populations and environments). A number of risk factors within the each of these criteria were identified. These factors are discussed below in more detail in Table 5.

3. **Weight criteria according to relative importance for DEQ efforts.** As a default assumption, each primary (*Population and Density*, *Exposure*, and *Vulnerability*) and secondary criterion was assigned the same priority. DEQ may wish to modify these initial assumptions as it uses the tool. As an example of how varying the criteria affect the output, three different scenarios will be presented below.

4. **Rate geographies against risk factors.** In the Product Ranking Tool, toxicity data varied tremendously (by many orders of magnitude), while in other cases no quantitative data were available. These substance rating factors necessitated a more qualitative rating system, and the consultant used the 1 through 5 rating approach. For the Geography Ranking Tool, however, quantitative data were generally more available and did not vary as widely. For this reason, a more direct means of rating geographies was used. More specifically, the rating for each risk factor was expressed as a decimal between 0 and 1, where each rating was assigned as a percentage of the maximum value in the state. For example, if 25% of one county's stream length is water-quality limited and the maximum fraction of water quality-limited streams found in any Oregon county was 100%, then the county with 25% would receive a rating of 0.25 (25/100).

Similarly, if 20% of one county's housing units were on septic systems and the maximum septic use in any Oregon county was 50%, the county with 20% septic use would receive a rating of 0.4 (20%/50%). Note that ESRI's ArcMap geographic information system (GIS) software and data was used to calculate the quantitative ratings for several of the risk factors.

5. **Perform calculations and rank geographies.** The composite rating for each county was calculated as a weighted average of risk factor ratings. As with the Product Ranking Tool, this geographic ranking process had two steps. First, calculate a rating for each primary criterion (population and density, exposure, and vulnerability) based on a weighted average of the risk factors (secondary criteria). This calculation uses the risk factors' 1 through 10 priority weightings as weighting factors on the 0 through 1 risk factor ratings. Second, calculate an overall rating for the geography by conducting a weighted average of each primary criterion's rating. The resulting composite rating is therefore also a decimal, on a scale of 0 through 1. For example, suppose that Jackson County received a population and density rating of 0.15, an exposure rating of 0.48, and a vulnerability rating of 0.65, and that population and density, exposure, and vulnerability received priority weightings of 5, 10, and 10, respectively. Jackson County's overall rating would then be (5*0.15 + 10*0.48 + 10*0.65)/(5+10+10) = 0.48. Note that if a county were to receive the top rating for every risk factor used, that county would receive a score of 1.0.

6. **Interpret results.** As with the Product Ranking Tool, the consultant recommends a qualitative approach to developing conclusions. Such an approach should include a review of the rankings to assess general trends or unexpected results; consideration of individual criteria ratings for any unexpected reulsts; experimentation with reasonable, modest adjustments to the priority weightings; and then development of informed conclusions that take into account the inherent uncertainty in the tool and its methods.

The Excel-based Geography Rating Tool presents results in two forms: a sorted numerical ranking and a color-coded geographic map of Oregon and its counties. Please note that the risk factors identified should be considered only as "indicators" of potential risk that inherently contain uncertainty. Therefore, the result ratings should be interpreted with caution: the composite ratings are not based on actual HHW generation or exposure because such data are not available. Accordingly, small differences in composite ratings are likely not meaningful. Nonetheless, the risk factors selected were judged by the consultant and DEQ project staff to have clear ties to HHW exposure or vulnerability, so counties that rank higher on the list can be interpreted to have a higher presence of risk factors than counties that appear lower on the list.

In addition, the Geography Rating Tool does not address the significant variability in risk that may exist between communities or locations at the level smaller than an individual county. The risk factors identified here are useful not only for populating the Geography Rating Tool, but also for targeting collection and outreach activities to specific areas and populations (hobby miners, families with young children, etc).

For mapping purposes, the composite ratings were placed into one of five tiers, or priority classes. The five tiers were determined relative to the maximum score assigned for any individual county. For example, if the maximum overall score was 0.48, counties that received composite scores of 0.38 or higher (i.e., 80% or more of the high score of 0.48) would be considered Tier 5 and colored the darkest color on the map; counties that received scores of 60%-80% of the maximum (cutoff: 0.29) would be assigned Tier 4, and so on. Again, please note that the difference between ratings may not be significant, particularly near the boundary between any two classes.

Figure 2. Interface of the Geography Ranking Tool

Oregon Department of Environmental Quality

Household Hazardous Waste Geography Ranking Tool

May 24, 2007

Program Priorities

PRIMARY CRITERIA

Criteria	Priority Rating (0 to 10)
Exposure	10
Vulnerability	10
Population and Density	10

SECONDARY (SUB) CRITERIA

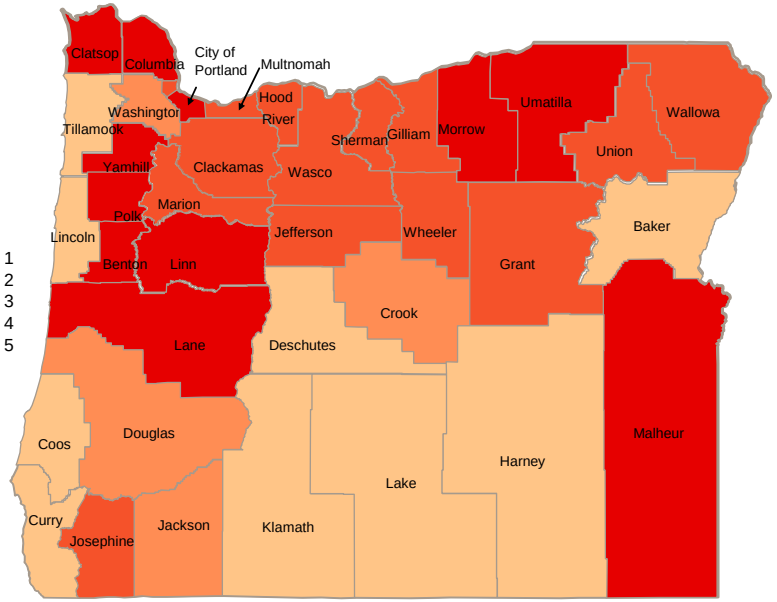
Primary Criteria	Sub-criteria	Priority Rating (0 to 10)
Exposure	Fraction living in surface water source a	10
	Fraction using individual wells	10
	Unlined landfill usage	10
	Incinerator throughput	10
	Fraction using septic systems	10
	Prevalence of CSOs	10
	Prevalance of outdoor burning	10
	Likely hobby mining	10
	Infrequent housing turnover	10
Vulnerability	Existing surface water quality concerns	10
	Existing groundwater concerns	10
	Young children	10
	Elderly	10
	Critical salmon/steelhead habitat	10
Population and Density	Population density	10
	Total Population	10
	Degree of Urbanization	10

ADJUSTMENT FOR EXISTING COLLECTION PROGRAMS

Effectiveness (% of HHW generation) of fixed facility collection:	0 %
Effectiveness (% of HHW generation) of event collection:	0 %

Map Results

= Tier 1
= Tier 2
= Tier 3
= Tier 4
= Tier 5



*Note this reduces the exposure-related impacts by the percentage entered

Table 5. Risk Factors Included in Geographic Assessment

Primary Criteria	Secondary Criteria (Risk Factor)	Units	Data Source	Rationale
Exposure	Unlined landfill usage	Annual tonnage received at unlined cells of MSW landfills	DEQ (2002)	The more tonnage of municipal solid waste (MSW) disposed in unlined landfill space in a county, the more disposed HHW is likely to enter into the environment
Exposure	Incinerator usage	Annual tons of criteria air pollutants released	DEQ (2002)	The more municipal solid waste (MSW) is treated by incineration in a county, the more heavy metals and potentially other toxins are likely to enter into the environment. Annual tons of criteria air pollutants was used instead of tons because those data were more available and using them helps to correct for the level of pollution control practices or equipment used at the facility
Exposure	Infrequent housing turnover	% of housing units with occupants who moved in pre-1980	Census 2000	Residents who have lived in their homes a long time have likely accumulated larger quantities of HHW. The consultant chose 1980 as the indicator year because several particularly toxic chemicals were banned in the late 1970s and may still be present in people's homes from that era.
Exposure	Septic system use	% of housing units not on public sewer	1990 Census (not available in 2000)	Residents may dispose of some HHW items down their home drains. If these residents use septic systems or other non-sewer disposal methods, HHW could be released directly to the environment.
Exposure	Prevalence of CSOs	Number of CSOs	DEQ (Date unknown)	Combined sewer overflows (CSOs) may, during storms or other high-flow events, discharge raw sewage to receiving water bodies. HHW products that were disposed in household drains could therefore be released directly to the environment without treatment and a wastewater treatment plant.
Exposure	Outdoor burning	Estimated % of housing units who burn outdoors	Survey data provided by DEQ	Households that burn are more likely to manage their solid waste outside the regular solid waste infrastructure, including burning it or potentially on-site dumping. This may also extend to household hazardous waste.
Exposure	Drinking Water Source Areas	% of population living in a DWSA	DEQ	Drinking Water Source Areas (DWSAs) are areas that drain to drinking water intakes of public water supplies. HHW released to the environment in a DWSA may be more likely to affect public health.
Exposure	Individual well users	% of population using individual wells	1990 Census (not available in 2000)	Residents who use untreated water from individual wells, rather than treated public drinking water supplies, may have higher risk of exposure to environmental toxins, including any from HHW.
Exposure	Likely hobby	Number of gold or mercury mineral	Oregon Dept. of Geology and	The intensity of gold and mercury mineral resources was used as a proxy for hobby mining activity of these minerals. Note that mercury often appears in

Primary Criteria	Secondary Criteria (Risk Factor)	Units	Data Source	Rationale
	mining	resources	Mineral Industries	conjunction with gold deposits and may be used in the processing of gold ore.
Vulnerability	Existing surface water quality concerns	% of stream miles included on the 303(d) list for pollutants	DEQ (2002)	Streams that are already impaired by pollutants may be particularly susceptible to further pollution from HHW releases. Note that a GIS layer of the more-recent Clean Water Act 303(d) list for 2004 was not available, nor was a GIS layer of TMDL-approved streams for 2002. The Oregon DEQ provided GIS layers of 303(d) listings for pollutants; criteria included in this data set included metal and chemical pollutants (e.g., mercury, lead, arsenic, ammonia) as well as biological pollutants (fecal coliform) as well as pH variances and low dissolved oxygen.
Vulnerability	Existing groundwater quality concerns	% of population living in a groundwater management area	DEQ	Groundwater that is already impaired by pollutants may be particularly susceptible to further pollution from HHW releases. Groundwater Management Areas have been identified to denote areas with significant groundwater concerns.
Vulnerability	Critical salmon and steelhead habitat	The presence of absence of critical salmon or steelhead habitat in the county	NOAA	Salmon and steelhead are anadromous fish very susceptible to chemical releases. Other fish and wildlife (including endangered species) may also be susceptible to chemical releases, but no feasible means to assess the distribution of these species could be identified for this project.
Vulnerability	Young children	% of population under age 6	Census 2000	Young children may be more prone to the effects of toxics, including HHW.
Vulnerability	Elderly	% of pop. over age 65	Census 2000	The elderly may be more prone to the effects of toxics, including HHW.
Population and Density	Population density	People per square mile	Census 2000	Greater cumulative impacts may be present if HHW is generated in an area with high population density, independent (or somewhat independent) of total population
Population and Density	Total population	People	Census 2000	More people in a region means more potential for HHW generation.
Population and Density	Degree of urbanization	% of population living in urban areas	Census 2000	Degree of urbanization is another means of assessing how densely populated in area is. Although similar in concept to population density, degree of urbanization measures what fraction of people live in an urban environment (including both “urbanized areas” and “urban clusters” as defined for Census 2000) whereas similar population density values could be obtained by having either a small area of very high density surrounded by an area of very low density or, in contrast, by the entire area having a moderate density.

4.2 Results

The following tables present sample results of the Geography Ranking Tool. Three possible results scenarios are presented to reflect the impact of different, reasonable choices of priority weightings for the primary and secondary criteria. The scenarios are as follows:

- **Equal priorities:** The first scenario presented will be the default assumption in which all primary and secondary criteria receive priority weightings of 10.

- **Exposure only:** The second scenario will focus only on the *Exposure* criterion – both the *Population and Density* and *Vulnerability* criteria will be set to zero.

- **Water-quality focus:** The third scenario will focus only on criteria that pertain to water quality. These include *Fraction living in surface water area*, *Fraction using individual wells, unlined landfill usage, Fraction using septic systems, Prevalence of CSOs* (all *Exposure* criteria) plus *Existing surface water quality concerns, Existing groundwater concerns,* and *Critical salmon/steelhead habitat* (all *Vulnerability* criteria).

Table 6. Results from the Geography Ranking Tool: Equal Priorities
(If all primary and secondary criteria receive priority weightings of 10)

Numerical Results *All ratings are out of 1.0 (1.0 would mean the county was tops in all criteria rated)*

Rank	Geography	Overall Rating	Ex-posure Rating	Vulner-ability Rating	Pop. & Density Rating	Fixed Facility	Only Local Events
1	City of Portland	0.61	0.22	0.63	1.00	Yes	No
2	Marion County	0.45	0.35	0.51	0.49	Yes	No
3	Lane County	0.42	0.30	0.47	0.48	Yes	No
4	Umatilla County	0.40	0.35	0.58	0.28	No	No
5	Washington County	0.40	0.10	0.45	0.65	Yes	No
6	Clackamas County	0.39	0.22	0.46	0.49	Yes	No
7	Linn County	0.38	0.36	0.50	0.28	No	Yes
8	Malheur County	0.38	0.42	0.49	0.22	No	No
9	Yamhill County	0.37	0.29	0.53	0.30	No	Yes
10	Morrow County	0.37	0.26	0.65	0.18	No	No
11	Benton County	0.36	0.29	0.47	0.33	No	Yes
12	Multnomah Excl. Portland	0.36	0.14	0.52	0.43	Yes	No
13	Polk County	0.36	0.26	0.52	0.30	Yes	No
14	Jackson County	0.35	0.36	0.31	0.38	No	Yes
15	Clatsop County	0.33	0.30	0.47	0.22	No	No
16	Baker County	0.33	0.49	0.30	0.20	No	No
17	Columbia County	0.33	0.31	0.46	0.21	Yes	No
18	Josephine County	0.32	0.44	0.29	0.23	No	No
19	Wasco County	0.32	0.22	0.49	0.24	Yes	No
20	Union County	0.31	0.26	0.47	0.21	No	No
21	Grant County	0.30	0.42	0.48	0.01	No	No
22	Douglas County	0.30	0.34	0.30	0.26	No	No
23	Wallowa County	0.29	0.41	0.46	0.00	No	No
24	Jefferson County	0.29	0.24	0.48	0.14	No	No
25	Hood River County	0.28	0.20	0.49	0.16	Yes	No
26	Coos County	0.28	0.28	0.30	0.25	No	No
27	Wheeler County	0.27	0.32	0.48	0.00	No	No
28	Sherman County	0.26	0.32	0.47	0.00	Yes	No
29	Klamath County	0.26	0.25	0.27	0.26	No	No
30	Deschutes County	0.26	0.21	0.28	0.29	No	Yes
31	Crook County	0.25	0.30	0.27	0.19	No	No
32	Gilliam County	0.25	0.29	0.44	0.00	Yes	No
33	Lincoln County	0.25	0.21	0.29	0.24	No	No
34	Lake County	0.24	0.32	0.26	0.15	No	No
35	Curry County	0.24	0.24	0.32	0.17	No	No
36	Harney County	0.24	0.27	0.26	0.19	No	No
37	Tillamook County	0.22	0.25	0.30	0.10	No	Yes

Table 7. Results from the Geography Ranking Tool: Exposure Only
(If *Exposure* is the only primary criteria considered and its secondary criteria receive equal priority weightings of 10)

Numerical Results *All ratings are out of 1.0 (1.0 would mean the county was tops in all criteria rated)*

Rank	Geography	Overall Rating	Ex-posure Rating	Vulner-ability Rating	Pop. & Density Rating	Fixed Facility	Only Local Events
1	Baker County	0.49	0.49	0.30	0.20	No	No
2	Josephine County	0.44	0.44	0.29	0.23	No	No
3	Malheur County	0.42	0.42	0.49	0.22	No	No
4	Grant County	0.42	0.42	0.48	0.01	No	No
5	Wallowa County	0.41	0.41	0.46	0.00	No	No
6	Jackson County	0.36	0.36	0.31	0.38	No	Yes
7	Linn County	0.36	0.36	0.50	0.28	No	Yes
8	Umatilla County	0.35	0.35	0.58	0.28	No	No
9	Marion County	0.35	0.35	0.51	0.49	Yes	No
10	Douglas County	0.34	0.34	0.30	0.26	No	No
11	Wheeler County	0.32	0.32	0.48	0.00	No	No
12	Sherman County	0.32	0.32	0.47	0.00	Yes	No
13	Lake County	0.32	0.32	0.26	0.15	No	No
14	Columbia County	0.31	0.31	0.46	0.21	Yes	No
15	Lane County	0.30	0.30	0.47	0.48	Yes	No
16	Clatsop County	0.30	0.30	0.47	0.22	No	No
17	Crook County	0.30	0.30	0.27	0.19	No	No
18	Gilliam County	0.29	0.29	0.44	0.00	Yes	No
19	Benton County	0.29	0.29	0.47	0.33	No	Yes
20	Yamhill County	0.29	0.29	0.53	0.30	No	Yes
21	Coos County	0.28	0.28	0.30	0.25	No	No
22	Harney County	0.27	0.27	0.26	0.19	No	No
23	Morrow County	0.26	0.26	0.65	0.18	No	No
24	Union County	0.26	0.26	0.47	0.21	No	No
25	Polk County	0.26	0.26	0.52	0.30	Yes	No
26	Tillamook County	0.25	0.25	0.30	0.10	No	Yes
27	Klamath County	0.25	0.25	0.27	0.26	No	No
28	Curry County	0.24	0.24	0.32	0.17	No	No
29	Jefferson County	0.24	0.24	0.48	0.14	No	No
30	Wasco County	0.22	0.22	0.49	0.24	Yes	No
31	Clackamas County	0.22	0.22	0.46	0.49	Yes	No
32	City of Portland	0.22	0.22	0.63	1.00	Yes	No
33	Deschutes County	0.21	0.21	0.28	0.29	No	Yes
34	Lincoln County	0.21	0.21	0.29	0.24	No	No
35	Hood River County	0.20	0.20	0.49	0.16	Yes	No
36	Multnomah Excl. Portland	0.14	0.14	0.52	0.43	Yes	No
37	Washington County	0.10	0.10	0.45	0.65	Yes	No

Table 8. Results from the Geography Ranking Tool: Water-Quality Focus
(If the only criteria used are those that pertain to water quality)

Numerical Results *All ratings are out of 1.0 (1.0 would mean the county was tops in all criteria rated)*

Rank	Geography	Overall Rating	Ex-posure Rating	Vulner-ability Rating	Pop. & Density Rating	Fixed Facility	Only Local Events
1	Umatilla County	0.47	0.41	0.53	0.28	No	No
2	City of Portland	0.45	0.24	0.67	1.00	Yes	No
3	Morrow County	0.45	0.27	0.62	0.18	No	No
4	Benton County	0.42	0.37	0.47	0.33	No	Yes
5	Linn County	0.42	0.44	0.39	0.28	No	Yes
6	Yamhill County	0.41	0.36	0.47	0.30	No	Yes
7	Malheur County	0.40	0.44	0.35	0.22	No	No
8	Lane County	0.37	0.34	0.40	0.48	Yes	No
9	Polk County	0.37	0.32	0.42	0.30	Yes	No
10	Clatsop County	0.36	0.34	0.38	0.22	No	No
11	Columbia County	0.35	0.34	0.37	0.21	Yes	No
12	Wallowa County	0.35	0.34	0.36	0.00	No	No
13	Marion County	0.34	0.28	0.39	0.49	Yes	No
14	Clackamas County	0.31	0.24	0.38	0.49	Yes	No
15	Wheeler County	0.31	0.28	0.34	0.00	No	No
16	Sherman County	0.29	0.24	0.35	0.00	Yes	No
17	Multnomah Excl. Portland	0.29	0.13	0.45	0.43	Yes	No
18	Grant County	0.28	0.22	0.35	0.01	No	No
19	Jefferson County	0.28	0.22	0.35	0.14	No	No
20	Union County	0.28	0.19	0.36	0.21	No	No
21	Gilliam County	0.27	0.21	0.34	0.00	Yes	No
22	Hood River County	0.27	0.18	0.37	0.16	Yes	No
23	Wasco County	0.27	0.18	0.35	0.24	Yes	No
24	Josephine County	0.24	0.45	0.03	0.23	No	No
25	Jackson County	0.22	0.37	0.07	0.38	No	Yes
26	Baker County	0.22	0.40	0.04	0.20	No	No
27	Douglas County	0.21	0.36	0.07	0.26	No	No
28	Washington County	0.20	0.07	0.33	0.65	Yes	No
29	Crook County	0.18	0.33	0.02	0.19	No	No
30	Lake County	0.17	0.33	0.01	0.15	No	No
31	Coos County	0.16	0.24	0.08	0.25	No	No
32	Deschutes County	0.15	0.23	0.07	0.29	No	Yes
33	Lincoln County	0.14	0.23	0.06	0.24	No	No
34	Curry County	0.14	0.24	0.04	0.17	No	No
35	Tillamook County	0.13	0.21	0.05	0.10	No	Yes
36	Klamath County	0.13	0.24	0.02	0.26	No	No
37	Harney County	0.12	0.23	0.00	0.19	No	No

The tables above all present results without considering any effect of collection services offered in each county (collection services could be expected to reduce HHW exposure). By reviewing the results above as well and conducting limited sensitivity analyses (especially to the population density criteria), the consultant developed the following conclusions.

- **No counties rank high in all (or even a majority) of the criteria used.** The top rating assigned for each individual criterion is 1.0. Therefore, if a county received top ratings in each criterion, its overall rating would also be 1.0. The top rating in the exposure category, however, was 0.49, indicating that no county dominated the exposure ratings. Likewise, the top rating in the vulnerability category was 0.65 (assuming all vulnerability criteria are weighted equally, as in Table 6).

- **The overall county ratings are very sensitive to the treatment of *Population and Density*.** The ratings for *Population and Density* are generally more variable than the ratings for *Vulnerability* or *Exposure*. Therefore, changes in the priority weightings for *Population and Density* or its secondary criteria can have large impacts on the final ratings. (Note that this finding does not apply if *Population and Density* is completely excluded, as it is in the maximum exposure and water-quality focus scenarios above.)

- **The City of Portland rates near the top if *vulnerability* is a criterion, even if *Population and Density* is not a criterion.** This high rating is due to its high vulnerability rating, primarily due to the fact that a very high percentage of its streams or rivers are water-quality-limited as well as due to the presence of critical salmon habitat. The fact that its *Population and Density* rating is so high only strengthens its position near the top of the ratings in any scenario except one focused narrowly on the exposure criteria, as presented in Table 7, above.

- **Multnomah, Washington, Clackamas, Lane, Marion, and Jackson counties rank near the top if *Population and Density* is a criterion.** These counties are the most populous counties in the state and also have higher population density and degree of urbanization than most others. These counties have high enough exposure and vulnerability ratings such that if *Population and Density* is even a small factor then they will rate near the top.

- **If both *vulnerability* and *exposure* are considered, Umatilla, Morrow, and Malheur counties tend to rank near the top regardless of whether *Population and Density* is a criterion or not.** All three of these counties have moderate ratings in both exposure and vulnerability, and small changes in the exposure and vulnerability ratings do not affect these results.

- **If both *vulnerability* and *exposure* are considered, several other counties consistently rank in the upper third regardless of whether population density is a criterion.** Linn, Yamhill, Benton, and Polk counties rate lower than the counties discussed above but still in the top third.

The Geography Ranking Tool also offers users the opportunity to experiment with collection system effectiveness rates and assess how the presence of existing collection systems might affect the ratings. Modeling by the consultant to explore the effect of collection on the ratings generated the following conclusion.

- **The presence or absence of existing collection systems does not dramatically affect the ratings**. Since collection systems capture only a portion of the HHW that is generated and therefore have only a modest impact on potential exposure, including them in the Geography Ranking Tool has only a small affect on the ratings. The county most affected is Marion County, with the highest exposure rating of all counties with fixed facilities, but it still remains well within the top half (without considering population density) and within the top third (considering population density) of the ratings.

4.3 Limitations and Intended Uses of the Geography Ranking Tool

The Geography Ranking Tool is designed to enable assessment and combination of several geographic variables to help inform, though not direct, DEQ's efforts to set geographic priorities for household hazardous waste programs. Given the data and resource constraints of this project, the Geographic Ranking Tool contains several limitations.

- Changes in priority weightings can have a substantial impact on results, as displayed by the variation among the three sample results scenarios presented above. DEQ may wish to refine these choices of priority weightings further before making priority decisions.

- Risk factors (sub-criteria) included in the tool are logically correlated to increased HHW exposure or vulnerability. However, scientific studies were not conducted to establish more definitive links or to establish the factors that correlate with highest risk; in most cases review of the literature found few well-documented relationships. For example, while it is logical that a higher fraction of residents living in a drinking water source area results in more potential HHW releases to drinking water, the consultant did not identify scientific studies examining this relationship.

- Significant gaps in data availability exist. For example, little information is available about levels of water-quality pollutants pertaining to possible household hazardous waste sources. Furthermore, groundwater quality was assessed based only on designated Groundwater Management Areas, which exist in only a small number of Oregon counties, but other areas may also be of concern.

- As with the Product Ranking Tool, the results of the tool should be reviewed and assessed qualitatively. Many counties differ in their overall ratings by very small amounts and may not face significantly different risks.

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5 Population Risk Factors: Exposure and Vulnerability

In addition to determining which HHW materials pose the greatest risks and where in the state the worst risks are found, Oregon DEQ's HHW Priority Assessment also sought to identify populations likely to experience higher-than-average risks from household hazardous waste. Some groups may face a greater risk from household hazardous products because they are more susceptible, more exposed, or both. Among Oregonians, some populations may generate or use greater amounts of hazardous products than average.

Where geographic data are available on the location of these subpopulations, such as demographic data from the U.S. Census, these population factors were incorporated into the geographic analysis described in the previous chapter. Data for geographic targeting for many of these populations, however, are not readily available. More research could be conducted around particular topics of interest, but this examination is intended to provide a screening-level analysis rather than exhaustive review of the topic. Thus, the population risk assessment by design and necessity (due to data gaps) does not have the same level of detail as the product and geographic assessments, nor does it lend itself to the development of an assessment "tool" at the current time. Other population factors are considered in the integration of findings across the Priority Assessment, including targeting particular populations regarding the use of certain products, such as lindane-containing lice treatments. The population risk factors may help DEQ in selecting among alternate management approaches for HHW in Oregon – including collection (e.g., promotions among sensitive populations or HHW user groups), education (e.g., Spanish-language materials), and market change (e.g., removing certain products from the shelves that may be harder to address by other means).

In the assessment of population risk factors, DEQ and the consultant developed an initial brainstorming list of potential populations and demographic categories of interest. The consultant then reviewed and summarized key literature regarding the following of subpopulations that may require special considerations:

- asthma sufferers;
- residents of particular housing types and locations;
- senior citizens;
- children;
- ritualistic users of mercury;
- mobility-impaired individuals;
- pets and pet owners;
- people who burn trash;
- people changing residences; and
- people with limited English proficiency.

Rough order-of-magnitude estimates for the number or people or households in these subpopulations were estimated and are summarized in Table 9. The remainder of this chapter describes these population risk factors and presents findings from the literature regarding HHW risks for each subpopulation. Note that exposures due to industrial pollutants (even if in the

home, such lead fallout from smelters or mercury accumulated in fish tissue) are generally excluded from this discussion, which focuses instead on exposures to household products.

Table 9. Approximate Order-of-Magnitude Estimates for Oregon Populations of Interest

Population	**Order-of-Magnitude Estimate of Number of Oregonians Affected**
Asthma sufferers	328,000 people (270,000 adults and 58,000 children)
Residents of particular housing types and locations	
Urban households	2.7 million people
Rural households	730,000 people
Single-family households	2.4 million people
Multi-family units	600,000 people
Senior citizens	450,000 adults age 65 or over
Children	750,000 children age 15 and under; 850,000 age 18 and under
Ritualistic users of mercury	10,000 – 35,000 people (very rough estimate)
Mobility-impaired individuals	180,000 – 275,000 people
Pet owners	2.2 million people
People who burn trash	1.2 million people
People changing residences	800,000 people (in 1999 to March 2000)
People who speak a language other than English at home	460,000 people

5.1 Asthma Sufferers

Household hazardous products pose a special risk to people with asthma because these individuals are more sensitive to respiratory irritants, including volatile organic compounds (VOCs) and other chemicals typically found in cleaning products, paints, adhesives, and other household hazardous products. Studies have shown that exposure to VOCs is significantly

influenced by personal activities and that VOC levels are elevated during and just after cleaning activities.[10] VOCs, especially in cleaning products, have long been linked to airway irritation and the exacerbation of asthma symptoms.[11] For example, the Sentinel Event Notification System for Occupational Risks (SENSOR) in California, Massachusetts, Michigan, and New Jersey has identified cases of occupational asthma and the cleaning products thought to be responsible.[12] Most cases in SENSOR listed a generic title (e.g., "cleaning compound"), but among identified cleaning products were bleach, disinfectants, carpet cleaners, floor strippers and waxes, and ammonia. In addition, the effect of cleaning products on asthma has typically been measured by comparing asthma prevalence among professional cleaners to prevalence among the general population, generally finding that the professionals have greater odds of having or developing asthma.[13] Although professional cleaners are exposed to stronger chemicals for a longer duration than the average person cleaning his or her own house, one may assume that typical household cleaners, or remaining residues from household cleaning services, also exacerbate asthma. Other household hazardous products that pose a risk to asthmatics because they emit VOCs include paints, solvents, and adhesives.[14]

According to the Behavioral Risk Factor Surveillance System (BRFSS), 10.1% of Oregon Adults had asthma in 2005.[15] The Oregon Asthma Surveillance Summary Report from Oregon's Department of Human Services (DHS) also cites BRFSS data but reports a rate of 9.9% among adults.[16] Oregon's adult population was roughly 2.7 million in 2005,[17] making the number of Oregon adults with asthma 268,000 to 274,000. According to Oregon DHS, asthma prevalence among children ages 0-17 is estimated to be 6.9% and prevalence among eighth graders is estimated at 10.5%.

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[10] Weisel, Clifford P. "Assessing Exposure to Air Toxics Relative to Asthma," *Environmental Health Perspectives* (August 2002) 110(S4):527-537. Wolkoff, Peder, Thomas Schneider, Jan Kildesø, et al. "Risk in Cleaning: Chemical and Physical Exposure." The Science of the Total Environment (1998) 215(102):135-156.

[11] Weisel, Clifford P. "Assessing Exposure to Air Toxics Relative to Asthma" Environmental Health Perspectives (August 2002) 110(S4):527-537.

Wolkoff, Peder, Thomas Schneider, Jan Kildesø, et al. "Risk in Cleaning: Chemical and Physical Exposure." The Science of the Total Environment (1998) 215(102):135-156

Delfino, Ralph J. "Epidemiologic Evidence for Asthma and Exposure to Air Toxics: Linkages between Occupational, Indoor, and Community Air Pollution Research." Environmental Health Perspectives (August 2002) 110(S4):573-589.

[12] Jaakkola, Jouni J. K. and Maritta S. Jaakkola. "Professional Cleaning and Asthma." Current Opinion in Allergy and Clinical Immunology. (April 2006) 6(2):85–90.

[13] Jaakkola, Jouni J. K. and Maritta S. Jaakkola. "Professional Cleaning and Asthma." Current Opinion in Allergy and Clinical Immunology. (April 2006) 6(2):85–90.

[14] Anderson, Melissa J., Shelly L. Miller, and Jana B. Milford. "Source Apportionment of Exposure to Toxic Volatile Organic Compounds Using Positive Matrix Factorization." Journal of Exposure Analysis and Environmental Epidemiology. (August 2001) 11(4):295–307.

[15] The Behavioral Risk Factor Surveillance System is available at http://apps.nccd.cdc.gov/brfss/.

[16] Oregon Asthma Program, Oregon Department of Human Services. *Oregon Asthma Surveillance Summary Report*. August 2006. Accessed online December 2006. (http://www.oregon.gov/DHS/ph/asthma/docs/report.pdf)

[17] Census Bureau. *American Community Survey 2005 table S0101: Age and Sex for Oregon.*

5.2 Residents of Particular Housing Types and Locations

The relationships between household hazardous products and residential dwelling type (multi-family vs. single-family) or location (urban vs. rural) are not definitive. A review of the literature did not locate studies on how general household hazardous material use or storage varies across multi-family versus single-family dwellings; however, several studies compared pesticide use and exposure, finding mixed results. Homes with gardens, primarily single-family dwellings, seem to store and use more pesticides than homes without gardens, primarily multi-family dwellings. However, low-income multi-family homes may be more likely to use indoor pesticides (e.g., roach sprays). Similarly, there does not seem to be a clear-cut distinction between urban and non-urban households. The evidence is described in the following paragraphs.

A study in Seattle found no significant difference in the level of organophosphate pesticides in children living in two different communities: one predominately lower- to middle-income with multi-family dwellings and the other predominately middle- to upper middle-income with single-family dwellings. On the other hand, whether the household used pesticides in its garden made a significant difference, and most homes with gardens were located in the single-family community.[18] In addition, unpublished data from education surveys at HHW collection events and facilities in King County, Washington, supports the hypothesis that single-family dwellings generate more HHW (or at least are more likely to use collection services): more than 95% of survey respondents in 2003-2004 lived in single-family or duplex residences.[19] While outdoor pesticide use is linked to having a garden, research suggests, however, that multi-family dwellings may have high rates of indoor pesticide use. Several studies have documented high rates of indoor pesticide use (e.g., roach sprays or ant traps) in multi-family dwellings in New York City among low-income households, although the studies did not make comparisons with single-family dwellings.[20]

In addition, it is unclear whether urban or rural households have higher rates of pesticide use, exposure, or both. For example, a study in Minnesota found that urban households were slightly more likely to have pesticides than non-urban households (defined by Census tract), although the difference was not statistically significant.[21] Urban and non-urban households were equally likely to have used pesticides in the previous year. The study also found that other socio-demographic factors, including income and household size, did not predict the presence or use of pesticides; dwelling type (multi-family or single-family) was not reported. Similarly, a study that reviewed several previous studies in Washington State found that children living in urban areas and in agricultural areas during the non-spray season had similar levels of organophosphate pesticides in their urine, though children in agricultural areas had higher pesticide levels during the active

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[18] Lu, Chensheng *et al.* "Biological Monitoring Survey of Organophosphorus Pesticide Exposure among Preschool Children in the Seattle Metropolitan Area." Environmental Health Perspectives (March 2001) 109(3):299-303.

[19] Unpublished data from the Household Hazardous Wastemobile On-site Education Program (2003 and 2004) run by the Local Hazardous Waste Management Program in King County. Permission to cite data has been requested but not yet granted.

[20] See Berkowitz, Gertrud S. et al. "Exposure to Indoor Pesticides during Pregnancy in a Multiethnic, Urban Cohort." Environmental Health Perspectives (January 2003) 111(1):79-84. and Whyatt, Robin M. et al. "Residential Pesticide Use during Pregnancy among a Cohort of Urban Minority Women" Environmental Health Perspectives (May 2002) 110(5):507-514.

[21] Adgate, John L. et al. "Pesticide Storage and use Patterns in Minnesota Households with Children." *Journal of Exposure Analysis and Environmental Epidemiology*. (2000) 10(2):159-167

spray season (and even higher levels if their parents were pesticide applicators).[22] Markers for these pesticides are short-lived, so measured levels reflect recent, not chronic, exposure. On the other hand, a review of reported pesticide use in Canada estimates that residential pesticide use is 1.97 to 3.65 times higher per hectare than agricultural use, so exposure quantities in urban areas may be higher than in rural farming areas (though the study did not address any differences in the toxicity levels between urban and agricultural pesticides).[23]

Statewide, roughly 2,400,000 of all residents live in single-family residences while 600,000 live in multi-family units.[24] Statewide, nearly 2.7 million Oregonians live in urban areas, of which nearly 720,000 live in urban clusters. By contrast, nearly 730,000 Oregonians live in rural areas, of which only 65,000 live on farms.[25]

5.3 Senior Citizens

Few studies have examined whether the elderly face additional risk from household hazardous materials compared to the general population; however, researchers have begun developing a research framework for studying the relationship between aging and toxics.[26] Researchers suggest that the elderly may have the following risk factors beyond risks faced by the general population:[27]

- **Different behavior and activity patterns that affect exposure to household hazardous materials.** Older adults tend to spend more time indoors, which could lead to greater exposure to VOCs from household cleaning products and other HHW.

- **Changes in how the aging body absorbs, metabolizes, and excretes toxics.** Older adults may absorb toxics more readily through the skin, present more adverse reactions at lower doses of exposure, and be less able to eliminate toxics from their bodies than younger adults. Older adults may also take more medications that have side-affects or unintended interactions with other medications or toxins.

- **Reduced ability to compensate for environmental stressors such as toxics.** Older adults who are frail may be less able to withstand or survive the adverse effects of acute exposure to hazardous household products. For example, although the elderly account

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[22] Fenske, Richard A. et al. "Biologic Monitoring to Characterize Organophosphorus Pesticide Exposure among Children and Workers: An Analysis of Recent Studies in Washington State." *Environmental Health Perspectives* (November 2005) 113(11):1651-1657.

[23] Pim, Linda, Kathleen Cooper, and Karyn Keenan. "Urban versus Agricultural: Pinning Down the Numbers on Pesticide Use" *Canadian Environmental Law Association*. (January - June 2002) 27(1-2). Accessed online November 2006 (http://www.cela.ca/newsletter/detail_art.shtml?x=1260).

[24] Census Bureau. *Census 2000 Summary File 3: H30 Units in Structure*. Accessed online December 2006.

[25] Census Bureau. *Census 2000 summary file 3, P5 Urban and Rural and H5 Urban and Rural.* Accessed online December 2006.

[26] U.S. Environmental Protection Agency. Aging and Toxic Response: Issues Relevant to Risk Assessment (Final). U.S. Environmental Protection Agency, Washington, D.C. November 2005

[27] Geller, Andrew M. and Harold Zenick. "Aging and the Environment: A Research Framework." *Environmental Health Perspectives* (September 2005) 113(9):1257-1262.

for 2.8% of all poisoning incidents, they account for 5.9% of incidents with moderate to major outcomes and 28% of all deaths.[28] Most exposure to HHW occurs in smaller doses, though sensitive populations such as the elderly may also be more vulnerable to adverse effects of chronic exposures.

In addition, older people may have a different sensitivity to household hazardous materials because they are likely to have had more exposure to toxics over their lifetime, not only because they have had more time to be exposed but also because they may have been exposed to very dangerous chemicals, such as DDT and PCBs, that are now banned or highly regulated. Although older adults appear likely to be more vulnerable to exposure to toxic products than the general population, more research is needed to confirm or refute this hypothesis and to determine which chemicals pose the greatest threats.

In 2005, 12.6% of Oregonians were age 65 and over, adding up to nearly 450,000 residents.[29] The percentage of each county's residents that are age 65 or over is considered as a variable in the Geography Ranking Tool described in Chapter 4.

5.4 Children

Children face a greater risk from household hazardous products than the general population for several reasons.[30] First they have more exposure to chemicals in the environment. Children drink more liquids, eat more food, and breathe more air per pound of body weight than do adults. For a given concentration of a contaminant, such as fumes from cleaning products in the home, children will absorb a proportionally greater amount of the contaminant per pound than will adults. Children are also more likely to ingest toxic residue because they tend to put their hands or items they find on the ground into their mouths. Also, because children play closer to the ground, they may have a higher exposure to toxins that are present in the air near the ground, such as pesticide vapor or chemical and heavy metal residues in dust.

Children are also uniquely vulnerable to toxics because their internal systems are still developing. Children are developing delicate systems such as the nervous system, reproductive organs, and the immune system that can all be permanently damaged by toxic chemicals. Children do not have fully developed metabolic systems, so they are less able to detoxify and excrete toxic chemicals than are adults, in most cases.

Roughly 24% of Oregonians were age 18 and under, or nearly 850,000 residents. Nearly 750,000 Oregonians are under the age of 16, or 21% of the population.

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[28] U.S. Environmental Protection Agency. "Effective Control of Household Pests Information for Older Adults and Family Caregivers" November 2006. Accessed online November 2006. (http://www.epa.gov/aging/resources/factsheets/index.htm)

[29] Census Bureau. *American Community Survey 2005 table S0101: Age and Sex for Oregon.* Accessed online December 2006.

[30] Summarized from: Landrigan, Philip J. and Anjali Garg. "Chronic Effects of Toxic Environmental Exposures on Children's Health." *Clinical Toxicology* (2002) 40(4):449–456; Landrigan, Philip J. "Children as a Vulnerable Population." *International Journal of Occupational Medicine and Environmental Health*. (2004) 17(1):175-177); Mazur, Lynnette J. "Pediatric Environmental Health." *Current Problems in Pediatric and Adolescent Health Care.* (January 2003) 33(1):6-25; Stein, Jill et al. "In Harm's Way: Toxic Threats to Child Development" *Journal of Developmental and Behavioral Pediatrics*. (Februarly 2002) 23(0):S13-S22.

5.5 Ritualistic Users of Mercury

Several Latino and Afro-Caribbean religious rituals and medicines involve mercury, which may be worn in amulets or carried in pockets, sprinkled on the floor, burned in candles, mixed into lotions and perfumes, used in spells, and ingested. Mercury is generally obtained in *botánicas*, religious supply stores or folk medicine pharmacies. Although several small, localized studies have attempted to gauge the extent of mercury use, accurate figures, especially for Oregon, are unknown. A study in New York found that 44% of Caribbean and 27% of Latin American survey respondents reported using mercury; whereas a study in Hartford, Connecticut found that only 8% of Latino and West Indian residents surveyed used mercury.[31]

Studies suggest that mercury users do not understand all the risks of mercury. A study that interviewed three users of mercury found that they understood that mercury is toxic and should not be touched or ingested but did not know about the dangers of volatization and inhalation. Also uncertain among the public health community is the fate and transport of mercury indoors and the resulting exposure level caused by the ritual use of mercury. Rough estimates of mercury exposure during ritual use suggest that certain uses may cause exposure levels below the level of health concern; however, other rituals, frequent use, or both may cause dangerously high levels of exposure.[32]

No direct evidence exists at this time that directly links ritual mercury use (aside from ingestion) to serious health effects. Nonetheless, mercury's toxicity, volatility, and persistence make it a significant health concern because mercury spills or deliberate releases can enter the environment as well as contaminate a living space even after the mercury-using residents have moved; mercury could also contaminate adjoining apartments in multi-family residences.

According to the 2000 census, roughly 275,000 Oregon residents were of Hispanic or Latino origin.[33] Also, according to the Census, over 125,000 Oregon residents are of Hispanic, Latino, or West Indian origin (primarily Hispanic/Latino) and were born outside the US.[34] If 8% of these residents use mercury ritually, then just over 10,000 Oregon residents would use mercury ritually. If the proportion is higher, say 27%, then nearly 35,000 residents may use mercury.

5.6 Mobility-impaired Individuals

Some persons, such as elderly, alter-abled, and infirm individuals, may have difficulty bringing household hazardous waste to disposal facilities or events because they are unable to drive or otherwise transport their hazardous materials. Without easy access to proper disposal methods, these individuals may stockpile or improperly dispose of hazardous wastes. Mobility-impaired individuals are also at higher risk from household fires, which HHW can cause and/or contribute

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[31] Primarily summarized from U.S. Environmental Protection Agency, "Task Force of Ritualistic Uses of Mercury Report," EPA/540-R-01-005, December 2002.

[32] Riley, Donna M. *et al.* "Assessing Elemental Mercury Vapor Exposure from Cultural and Religious Practices" *Environmental Health Perspectives* (August 2001) 109(8):779-784.

[33] Census Bureau. *Census 2000 Summary File 1. PCT11. Hispanic or Latino by Specific Origin.* Accessed online December 2006.

[34] Census Bureau. *Census 2000 Summary File 4, PCT 43. Sex by Place of Birth by Citizenship Status.* Accessed online December 2006.

to. Some HHW programs offer special mobile collection or curbside pick-up for household hazardous waste to help serve mobility-impaired populations.

According to the 2000 Census, over 275,000 Oregonians over age 5 had physical disabilities, and nearly 180,000 of Oregonians over age 16 had disabilities that limited their ability to go outside of their home independently.[35]

5.7 Pets and Pet Owners

Pets are at risk from household hazardous products and may also increase risk to their owners. Like young children, pets cannot read warning labels and may be prone to eating unfamiliar substances, even if they are toxic. According to the ASPCA, the top toxicants that cats are exposed to include canine pesticides, other topical insecticides, glow jewelry and sticks, liquid potpourri, human medicines, and rodenticides.[36] Dogs are most likely to be exposed to human medicines (e.g., ibuprofen, acetaminophen), ant and roach baits, rodenticides, bleach, fertilizer, and hydrocarbons (e.g., in paints, engine cleaners, furniture polish, lamp oils).[37] Slug baits made from metaldehyde are also attractive and available to dogs.

In addition, having pets may also increase human exposure to hazardous chemicals, such as pesticides. Children in a study in Seattle were more likely to test positive for pesticides if their household contained a pet, whether or not the family treated the pet with pesticides (no explanation was given).[38]

According to a secondary source, 891,000 households in Oregon owned pets in 2001. Of these, 511,000 owned dogs and 603,000 owned cats.[39] The average household size in Oregon is 2.51, so possibly 2,240,000 Oregonians live with pets.

5.8 People Who Burn Trash

Hazardous household waste does not seem to be a large problem for people who burn trash because many appear unlikely to deliberately burn hazardous waste; however, some hazardous waste may be burned, in addition to other materials that release toxic chemicals or produce toxic ash. In addition, people who manage their trash outside the regular solid waste infrastructure could also be expected to be more likely to manage their household hazardous waste in alternate

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[35] Census Bureau. *Census 2000 Summary File 3, P41 Age by Types of Disability for the Civilian Noninstitutuionalized Population 5 Years and Over with Disabilities*. Accessed online December 2006.

[36] Merola, Valentina and Eric Dunayer. "The 10 Most Common Toxicoses in Cats." Veterinary Medicine (June 2006) pp.339-342.

[37] Meadows, Irina and Sharon Gwaltney-Brant. "The 10 Most Common Toxicoses in Dogs." Veterinary Medicine (March 2006) pp.142-147

[38] Lu, Chensheng et al. "Biological Monitoring Survey of Organophosphorus Pesticide Exposure among Preschool Children in the Seattle Metropolitan Area." Environmental Health Perspectives (March 2001) 109(3):299-303.

[39] Michigan Veterinary Medical Association "Pet Ownership Statistics in the United States and in Michigan." Accessed online December 2006 (http://www.michvma.org/documents/site%20update%20docs/petownerstats.pdf)

means, including dumping. Recent research by students in the University of Oregon's Environmental Studies Program has documented the presence of potentially hazardous materials mixed with mundane household garbage at illegal dump sites on public lands in Western Oregon.[40]

An Oregon DEQ statewide study from 1996 estimates that 38% of households in Oregon burn some portion of their waste.[41] The percentage of household who burn trash outdoors is higher in rural counties (55%) than in suburban areas (15%) or urban areas (11%). The percentage of households who burn trash indoors is also higher outside city limits (26% of rural residents) than inside city limits (16% of residents in incorporated areas). A second statewide survey in 2001 estimated that the percentage of households that burn trash outdoors fell slightly, but the difference between the findings from the two studies was not statistically significant.

Organic materials, including paper, wood waste, yard debris, and cardboard, compose the bulk of waste that is burned, but households also burn some plastic (2%) and miscellaneous items (7%). The survey did not ask whether people burn hazardous waste. However, burning many wastes poses a health threat, whether or not the waste is generally considered hazardous. When garbage contains even trace amounts of chlorine (which most does), burning can release significant amounts of highly carcinogenic dioxins.[42] Dioxins are persistent, bioaccumulative, and toxic pollutants (PBTs) that build up in the food chain. Smoke from burning trash can also contain sulfur dioxide, lead, and mercury, as well as particulates. Ash from burning trash can contain lead, mercury, chromium, and arsenic and can contaminate garden vegetables, play areas for children, or even drinking water sources.

Using the estimate from 1996 that 38% of households in Oregon burn some portion of their waste and the Census's estimate of 1.3 million households (in 2000),[43] we can estimate that potentially 500,000 households in Oregon burn waste. This may be a high estimate, given that a subsequent survey in 2001 found that the proportion of households that burn waste fell slightly, though not significantly, and since several cityies and counties have recently adopted or tightened existing restrictions on burning. Taking the average household size in Oregon as 2.51 people, roughly 1,240,000 people may live in households that burn trash.

5.9 People Changing Residences

The literature review did not identify any studies on the effect of occupant turnover on household hazardous waste disposal; however, a conjectural examination of the issue suggests that people moving residences may face several challenges regarding household hazardous waste. First, people who move infrequently may have stockpiled a significant amount of household hazardous waste that they need to either take with them when they move, dispose, or leave for the new occupants. In some cases, this stockpile may exceed the allowable disposal amount, so previous owners may leave new owners with leftover wastes or may dispose of them improperly. Stockpiles of old HHW may include particularly toxic materials, such as banned pesticides.

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[40] For more details, see http://darkwing.uoregon.edu/~ecostudy/elp/illegaldumps/Overview.htm.

[41] Allaway, David. "Solid Waste Generation in Oregon: Composition and Causes of Change" Oregon DEQ. May 15, 2006

[42] U.S. Environmental Protection Agency. "The Hidden Hazards of Backyard Burning." EPA530-F-03-012. August 2003.

[43] Census Bureau. *Census 2000 summary file 1, P15 Households.* Accessed online December 2006.

Second, previous owners may face a similar dilemma if they do not have any access to a permanent HHW collection facility and a temporary event does not coincide with their move. At the same time, new owners may discover a cache of hazardous wastes they did not anticipate. On the other hand, people who move more frequently may either become accustomed to taking hazardous products with them or even acquire less over time (decreasing total hazardous waste generation), or they may dispose of hazardous wastes more often or cause new occupants to do so (increasing total hazardous waste generation). Empirical studies are needed to determine the actual effects of moving on household hazardous waste disposal.

According to the 2000 Census, median Oregon homeowners had lived in the same residence for 8 years (since 1992) while the median renter had moved in the past year (1999).[44] In March of 2000, 268,000 homeowners had moved in the previous 15 months, while 530,000 renters had moved.[45]

5.10 People with Limited English Proficiency

People with limited English proficiency may be more at risk for exposure due to inability to read warning labels on household products such as cleaners or pesticides. According to the Census Bureau's 2005 American Community Survey, 14% of Oregon residents speak a language other than English in the home, or approximately 460,000 people. Furthermore, an estimated 3.6% of Oregon households are "linguistically isolated," meaning that all members of the household age 14 and over have at least some difficulty with English.[46]

5.11 Other Populations

Other populations were considered but not included in the current analysis because insufficient data were found to support their inclusion. For example, immune-compromised individuals are commonly acknowledged for inclusion in lists of particularly susceptible or sensitive populations, though a brief review of the literature did not identify studies suggesting that people with impaired immune systems should take special precautions with HHW in particular.[47] Related to immune function, however, programs recommended that everyone take precautions with HHW because many toxic chemicals have been shown to damage immune function and endocrine functions. The risk is greatest for children and fetuses whose immune systems are still developing.

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[44] Census Bureau. *Census 2000 summary file 3, H39.Median Year Householder Moved into Unit by Tenure.* Accessed online December 2006.

[45] Census Bureau. *Census 2000 summary file 3,HCT9. Total Population in Occupied Housing Units by Tenure by Year Householder Moved into Structure.* Accessed online January 2007.

[46] Census Bureau, *2005 American Community Survey*. Accessed online May 2007.

[47] For example, a U.S. EPA website states *(emphasis added)*, "In addition, sensitive populations, such as children, the elderly, and *those with suppressed immune systems*, are typically more susceptible to many kinds of pollutants, including POPs." Accessed November 2006 (http://www.epa.gov/international/toxics/pop.htm)

6 Integration with HHW Management Plan

The previous chapters of this report have described the methodology and findings of the consultant's research and assessment of priority substances and products, geographies, and populations in Oregon. The Department of Environmental Quality intends to use these findings to help inform and guide the allocation of state resources for collection (including grants to local governments and DEQ-funded collection events, among other activities), waste prevention and education activities, and market change or product stewardship initiatives**. The Priority Assessment is intended to improve the likelihood that DEQ is targeting the correct set of products, geographies, populations, and behaviors related to HHW risks, and it is designed to supplement – not supplant – the professional judgment that guides these policies and programs.**

To help integrate results into the Department's HHW planning process, the consultant reviewed and analyzed the findings from this project to recommend possible priorities for DEQ's efforts. Possible priorities were suggested in each of the following categories, in accordance with the elements of the *Household Hazardous Waste Management Plan for the State of Oregon: 2005-2011.*[48]

- **Collection Services.** As reported in the *2005-2011 HHW Plan*, approximately two-thirds of Oregon's residents live in a county served by a fixed facility that accepts HHW, and an additional 14% of the population is served by locally sponsored HHW collection events. Given the growth in local HHW collection service in recent years, DEQ will not play as significant a role in collecting HHW in 2005-2011 as it has in the past but will instead focus on communities and residents with the greatest need for collection service. Suggested priorities for products and geographies will be presented below.

- **Waste Prevention and Education.** Under its updated HHW Plan, DEQ intends to increase the resources it devotes to preventing the use and generation of hazardous household products through education and other initiatives. Suggestions for priority products that may be particularly suited to waste prevention and education approaches are presented below.

- **Market Change, including Product Stewardship.** In the long term, the most cost-effective approach for DEQ to manage HHW is likely to be the elimination or minimization of hazardous materials in household products. Such a change is likely to take a long time and involve parties throughout the supply chain, from manufacturers to retailers to consumers. Findings from this Priority Assessment suggest that some products may be better suited to market change and/or product stewardship efforts than others.

The identification of priorities for each of these three categories involved assessing:

- Which products or substances rated particularly highly in the Product Ranking Tool and which criteria contributed to their high ratings;

- Which geographies and populations are especially susceptible to risks from certain highly rated products; and

[48] The plan element "Planning, Monitoring, and Evaluation" was not addressed explicitly here; rather, this Priority Assessment project is itself one component of that element.

- Which combinations of collection, waste prevention, and market change activities could best address the priorities identified. Some products may be best handled by a single category of options, but for most products a combination of strategies will be needed.

As described in Chapter 3, qualitative interpretation of results from the Product Ranking Tool is necessary; it is not possible to create a purely mechanistic means of identifying priorities directly from the spreadsheet output of the assessment tools. However, the consultant did create and follow a step-by-step process to identify priorities and options that integrate with DEQ's *2005-2011 HHW Plan.* This process is described below.

Note that the process and options presented in this chapter were developed assuming that the priority weightings within both the Product Ranking Tool and the Geography Ranking Tool are approximately equal (i.e., product and substance results as displayed in Table 3 and Table 4 and geography results as displayed in Table 6). Nevertheless, much of the approach is independent of priority weightings because the options are tied more closely to ratings of individual criteria than to the single, overall ranking of any given product. In addition, sensitivity analyses conducted by the consultant suggest that moderate changes to these priority weightings would not substantially alter the suitability of the process or options presented below. DEQ may wish to review the process and options below as it uses the spreadsheet tools and considers possibly alterations of the priority weightings.

6.1 Process for Identifying Priorities

The consultant used the following process for identifying options for priorities to correspond with the three major elements of the *2005-2011 HHW Plan.*

Identifying Collection Options

Collection services are particularly important for those products that pose significant end-of-life impacts or that pose moderate end-of-life impacts but for which few practical alternative products or disposal options exist. Collection services are also particularly important in geographic areas that are especially susceptible to HHW risks. To identify these options:

- **Scan the final product and substance ratings and identify products that are rated highly in part due to health and environmental impacts.** Since releases of these products are more likely to impact human health and the environment, collection is particularly appropriate. Note that pesticides are near the top of the ratings overall and generally received health and environmental impact ratings of 3.0 or greater. On the other hand, acids, though rated very highly overall, did not have as high of health and environmental impact ratings as pesticides and were instead rated highly due to hazard potential and poison center calls. Products and substances that rated highly overall and that received health and environmental impact ratings of 3.0 or greater include pesticides, polishes (at least those with nitrobenzene), auto batteries, heavy metals (and associated products, e.g, batteries, pigments, computers, photographic fixer, ammunition), and lindane (found in some lice medications).

- **Review the products identified to determine if disposal options exist.** Collection will be particularly important if private-sector or other safe means of disposing the product are not available. For example, pesticides have few if any alternative safe disposal options. On the other hand, some options do exist for batteries, with private-sector take-back for consumer batteries and modern landfill designs that in many cases may be adequate to contain these releases.

- **Review the products to determine if particular geographies could be more susceptible.** Pay particular attention to areas where disposal practices could not be adequate to contain releases (e.g., unlined landfills or incinerators) or in geographies with particularly high vulnerability ratings in the Geography Ranking Tool. For example, a more intense focus on heavy metals may be needed in areas with incinerators, whereas more focus on pesticides may be needed in areas with existing water quality problems and critical salmon habitat.

- **Consider other large-volume or commonly collected HHW products.** Further conclusions may be suggested by considering where other large-volume or common HHW products rate on the list. For example, motor oil ranks highly but may have some alternative collection systems available, and latex paint ranks in the middle and could potentially have safe alternative treatment (e.g., dry and dispose).

Note that collection of products that have higher hazard potential and/or poison center calls (e.g., acids) may help to reduce risks associated with those hazards, but strategies that more directly target safe use and storage of those items may be more appropriate and effective. Such options are discussed in the next section.

Identifying Waste Prevention and Education Options

Waste Prevention and Education are particularly suited to those products (or substances) with significant use-phase impacts and for which least-toxic alternatives exist. Waste Prevention and Education strategies also offer the ability to target specific populations that are at highest risk, are highly susceptible, or who use particular products at high rates. To identify possible priority products for education options:

- **Scan the final product and substance ratings and identify products that are rated highly in part due to poisonings, hazard potential, and health impacts.** These products are likely to have significant risks associated with product use and/or storage. Note that nearly all products near the top of the overall ratings received impact ratings of 3.0 or greater in poisonings, hazard potential, and/or health impacts. Noteworthy products include cleaners (especially acids), insecticides, fumigants, some herbicides, oil-based paint, and liquid fuels.

- **Review the products identified to assess whether least-toxic or preferred alternatives exist and are readily available.** Such products may be clear candidates for education and outreach about purchasing and use behaviors. For example, least-toxic alternatives clearly exist for cleaners, pesticides, and (in most applications) oil-based paint. On the other hand, fewer alternatives exist for liquid fuels, and so education for these products may focus on safe storage.

- **Review the products identified to assess whether certain populations may be at higher risk or use the products at higher rates.** In other words, is use of a particular product concentrated in a certain segment of the population? For example, certain Hispanic populations use mercury in rituals, and banned pesticides may be present in homes that have not had a new owner in 20 years.

- **Consider other large-volume or commonly collected HHW products.** Is there a role for education in promoting the preferred management method, even if that method is outside the HHW system? For example, any change in approach to collecting latex paint would require an education campaign, but education may also be needed to maintain awareness of other options, such as for household batteries.

Identifying Market Change and Product Stewardship Options

Market change or product stewardship is a particularly suitable strategy when firms involved in designing, manufacturing, distributing, or selling potential HHW products have tangible opportunities to reduce risks associated with consumer product use or disposal. These opportunities may arise because product designers have less-toxic substances available, because existing retailers are equipped (and possibly willing) to recycle used or leftover products, or because new technologies are available to replace older, more polluting products or practices. The Product Ranking Tool can help identify particularly toxic substances that could be strong candidates, but ultimately a detailed understanding of the marketplace and existing policy trends is needed to select appropriate options for market change. The process used by the consultant to identify and prioritize products and materials that are strong candidates for market change included:

- **Identify high-ranking substances** using the substance interface of the Product Ranking Tool. Focus on substances that are still in use in the marketplace, as some high-ranking substances have been, or are in the process of being, phased out of use. Note that heavy metals and pesticide ingredients (including lindane, found in some lice shampoos) dominated the top of the substance ratings. In addition, some other substances rated in this tool on a preliminary basis also made their way into the top half of the ratings: nonylphenol ethoxylates (used in some detergents) and octa-PBDE (which is common in electronics housings).

- **Identify products or substances where substitutions are feasible or where existing initiatives are underway.** For example, substitutions are available for mercury thermometers, lindane in lice shampoo, heavy metals in pigments, and the most toxic pesticide constituents. In addition, existing product stewardship initiatives are underway concerning paint and electronics, although these initiatives are focused more on end-of-life collection than on upstream changes to product design. Nevertheless, by taking such increased responsibility, manufacturers have more incentive to design products for ease and safety of end-of-life management.

- **Identify products for which existing private sector retailers or service centers could be partners in product recycling.** For example, numerous retail stores now take back rechargeable batteries due to past successes by the Rechargeable Battery Recycling Corporation. More recently, several office-supply chain stores have experimented with take-back of electronic products. Other opportunities may also exist for HHW products not currently recycled, or only recycled in limited quantities, at retail establishments (e.g., paint, motor oil, or antifreeze). Any exploration of an expanded private sector role would clearly need to involve retailers extensively.

- **Identify products with toxic components where consumers have little choice.** If consumers are not aware of toxic constituents or cannot in practice make least-toxic choices, then the only approach for the product may be a policy or market change strategy, such as a labeling or recycling requirement, disposal ban, or substance ban. An example is computers, where PBDE content is very common and is not generally known to consumers. Another example is nonylphenol ethoxylates, which are used as a surfactants in some detergents and cleaning products.

6.2 Options for Priorities

As discussed above, possible priorities were identified in accordance with the elements of the *Household Hazardous Waste Management Plan for the State of Oregon: 2005-2011*, including options for collection, waste prevention and education, and market change. This section of the report describes these findings.

These possible priorities are not definitive recommendations but rather the consultant's proposed options for DEQ consideration as the agency continues to implement its HHW Plan. The options presented below are by no means mutually exclusive. For example, options for pesticides are included in *Collection, Waste Prevention and Education,* and *Market Change*, and all of these options could support each other for maximum effectiveness. Market change and product stewardship approaches can, and frequently do, have components of collection (e.g., manufacturer-sponsored recycling of electronics), while waste prevention and education activities are clearly needed to support effective market change or collection. The options presented in this section could have positive outcomes on their own but in most cases would be most effective if combined with activities all along the lifecycle of the product.

As described above, the options below were assembled by considering product and geography ranking tools with equal priority weightings. The process used to select options is somewhat independent of the priority weightings used, and sensitivity analyses were conducted to demonstrate the validity of the following options even under moderate changes to priority weightings. Nevertheless, dramatically different choices of priority weightings could make some of the options presented below less appropriate. For example, if DEQ was to care only about products that pose immediate, acute risks (and not about long-term health and environmental effects), then options regarding carcinogens and heavy metals would be less relevant and options regarding safe use, storage, and collection of immediate hazards, such as acids and explosives, would be more immediately relevant.

Finally, note that although the priorities presented below are key options suggested by the assessment, they are not meant to address each and every product or substance included in the Product Ranking Tool.

Collection Options

Based on the assessment methodology discussed above and results from the Product Ranking Tool, the following options emerge.

- **Collection systems to place particular emphasis on pesticides and heavy metals.** These products and substances are rated highly for their health and environmental impacts. In particular:

  - Household **pesticides** are used statewide, and so collection is also needed statewide. However, an extra focus is warranted in vulnerable areas, such as counties with critical salmon or steelhead habitat (those that border the Columbia or Willamette rivers) – see Geography Ranking Tool for complete list. Collection of leftover quantities can help prevent pesticides from being disposed improperly, but education and market change options should also be considered. Several banned pesticides are of particular concern (e.g., DDT, diazinon), but many others still in use also merit significant attention, such as permethrin, dimethoate, and propoxur.

- **Heavy metals** and other high-risk (but often low quantity) substances. Heavy metals rate very highly for human health and environmental impacts but are present in low quantities. These materials should continue to be collected, but given the infrequent generation of these substances and potential lack of community awareness, special promotions may be needed to remove such items (such as thermometers, thermostats, and fluorescent light bulbs) from resident homes. Particular collection attention should focus on collection in areas where disposal facilities are less effective at controlling releases. Focus should be directed to Marion and Coos counties, which use incinerators, and any other jurisdictions that send waste to these facilities. Emissions data for the Marion and Coos county incinerators should be reviewed, but it is anticipated that special collection attention should focus on products with heavy metals such as thermostats, thermometers, electronics, and batteries, among others. Attention should also be directed to Baker and Umatilla counties, which have some unlined but active cells for municipal solid waste (MSW) at their landfills, as well as to other counties that send waste to these facilities. Malheur, Wallowa, Klamath, and Lake counties also have some unlined MSW cells that receive lower volumes than Baker and Umatilla.

- **Collection systems are also important for used motor oil, fuels, oil-based paints, and polishes.** Continued attention is warranted for products that pose definite risks but where few alternatives are available. For example, liquid **fuels** and **oil-based paints** rate in the top third of products due in part to hazard potential (e.g., flammability) and poison center call ratings. HHW collection programs should have a role statewide since few other end-of-life options exist, but education is also needed to help minimize use-phase risks through safe handling, use, and storage (see Education and Waste Prevention section, below). Many other products currently collected – even those that are not particularly hazardous – have few if any other safe options for disposal. As a result, some base level of collection for these should continue, even if DEQ chooses to begin developing and promoting alternative management methods.

- **Consider transitioning latex paint to alternative management methods.** Latex paint rates in the lower half of product ratings, and it would rate lower if not for its very high quantity. Due to its relatively low risk, consider shifting latex paint to reuse, recycling, or to the solid waste system (e.g., dry and dispose). Concurrent with the development of this report, DEQ and the consultant conducted an economic analysis of discontinuing latex collection at DEQ-funded events. A consultant report on this topic is included as Appendix C.

Recommendations Corresponding to the 2005-2011 HHW Plan

The table below presents initial recommendations about areas of focus for each of the three main types of collection addressed by the *2005-2011 HHW Plan*: fixed facilities, collection events, and high-hazard collection.

Please note that results of this Priority Assessment provide little guidance as to whether fixed facilities or collection events are more effective or appropriate for certain products or materials. In general, the main factors to consider in facility-type decisions include desired service level and cost-effectiveness. DEQ and local community experience may offer additional insight.

In addition, the level of collection services currently offered by local governments in Oregon varies widely. DEQ will likely gain efficiencies by working with existing programs where they exist (e.g., Metro, Marion County) to expand services or increase promotion while assisting the creation of new programs where only limited services are currently provided.

Table 10. Summary of Priority Assessment Recommendations by HHW Plan Category

	Product Recommendations	Geography or Population Recommendations
Fixed Facilities (DEQ Plan Elements 3.2.1, 3.2.3,)	Results of this Priority Assessment suggest the following priorities. ▪ 1. Focus most intently on pesticides and products containing heavy metals ▪ 2. Provide collection of other higher risk products (including fuels, oil-based paints and stains, polishes, used motor oil) ▪ 3. Consider shifting latex paint to solid waste system or other alternative collection system	Priorities should address areas that satisfy the following: ▪ Areas where end-of-life impacts are likely to be greatest. These may include areas with critical salmon habitat (e.g., counties bordering the Columbia and Willamette rivers); areas with existing groundwater quality concerns (e.g., Malheur, Morrow, and Umatilla counties); and areas with a high fraction of water-quality-limited surface waters (e.g., Portland).
Collection Events[49] (DEQ Plan Element 3.2.2, 3.2.4)	As for fixed facilities, results of this Priority Assessment suggest the following priorities: ▪ 1. Focus most intently on pesticides and products containing heavy metals ▪ 2. Provide collection of other higher risk products (including fuels, oil-based paints and stains, polishes, used motor oil) ▪ 3. Consider shifting latex paint to solid waste system or other alternative collection system	Priorities should address areas that satisfy both the following: ▪ Areas where end-of-life impacts are likely to be greatest: areas with critical salmon habitat (e.g., counties bordering the Columbia and Willamette rivers); areas with existing groundwater quality concerns (e.g., Malheur, Morrow, and Umatilla counties); and areas with a high fraction of water-quality-limited surface waters (e.g., Portland). ▪ Areas without any current local service or that rate highly in DEQ's queuing system Counties that have no local fixed or event service and that received high vulnerability and exposure ratings include (in *approximate* decreasing order of vulnerability and exposure): Umatilla, Morrow, Malheur, Grant, Wallowa, Wheeler, Clatsop, Union, Baker, Jackson, and Jefferson counties.
High-hazard Collection (DEQ Plan Elements 3.2.6 and 3.2.7)	Heavy metals and the worst pesticides (e.g., DDT, arsenic, chlorpyrifos, diazinon, dichloropropenene, permethrin, sodium cyanide)[50]	Areas with incinerators and unlined landfills (for heavy metals) and potentially other areas with high vulnerability or exposure ratings.

[49] Note the recommendations for fixed facilities and events are essentially identical. Results of the Priority Assessment provide little guidance as to whether fixed facilities or collection events are more effective or appropriate for certain products or materials. In general, the main factors to consider in facility-type decisions include desired service level and cost-effectiveness. DEQ experience may offer additional insight.

[50] These chemicals are those that rated most highly in the substance interface of the Product Ranking Tool.

Options for Waste Prevention and Education

The consultant's assessment identified several possible priorities for waste prevention and education efforts. These options generally target products (or substances) with significant use-phase impacts for which least-toxic alternatives exist.

- **Strong cleaners: promote least-toxic products**. Cleaners (including strong ones) received only moderate human toxicity and ecotoxicity ratings, but received significant corrosiveness/irritant and poison center call ratings. Alternatives exist for many of these products, and safer alternatives can be promoted. Particular attention should be paid to acid- or alkaline-based drain openers, tile cleaners, oven cleaners, and toilet-bowl cleaners.

- **Pesticides: promote least-toxic products**. Education campaigns could emphasize least-toxic options. Education could also focus on the practices in addition to the products: for example, integrated pest management (IPM) approaches, promoting tolerance of some weeds or moss, learning to distinguish beneficial insects from harmful pests, and choosing plantings that require fewer chemical inputs. Several local governments have programs in place that could be partners. Particular attention should be focused on areas with existing water quality concerns and critical salmon habitat. Counties with a particularly high fraction of streams listed on the 303(d) list for pollutants include Multnomah (including the City of Portland), Yamhill, Polk, and Coos counties. Counties that contain critical salmon or steelhead habitat include Clatsop, Columbia, Multnomah (including the City of Portland), Washington, Yamhill, Polk, Benton, Lane, Linn, Marion, Clackamas, Hood River, Wasco, Jefferson, Sherman, Gilliam, Wheeler, Morrow, Grant, Umatilla, Union, and Wallowa.

- **Conduct education on proper disposal practices**. Proper disposal practices are important everywhere, but particular attention should be focused on areas where common mishandling practices are more likely to result in exposure by humans or the environment: areas with Combined Sewer Overflows, or CSOs (Clatsop, Portland); high septic use (e.g., Wheeler, Crook, Jefferson, Josephine); or unlined landfills or incinerators.

- **Conduct education on safe use and storage**, with a particular focus on substances with high human health ratings, poisoning, or hazard ratings, including strong cleaners and other household maintenance products (such as polishes), pesticides, auto batteries, fuels, pool chemicals (due to high poisoning rating), and antifreeze (due to high poisoning rating).

- **Conduct specific, targeted education campaigns for certain populations or geographies** thought to be at higher risk of exposure to certain harmful substances. In particular:

  - *Used motor oil among those who change their own oil*, perhaps in association with automotive supply stores.

  - *Lead among hunting and fishing hobbyists.* Ammunition is often made from lead and is explosive. Reach gun owners through gun clubs or ammunition stores. Fishermen may make lead weights at home and come in regular, direct contact with lead.

  - *Banned pesticides in homes that have not turned over in a long time*: potential to target homes for sale or recently sold by tapping into the Multiple Listing Service or county records.

  - *Lice medication among parents of young children*: lindane is one of the most hazardous substances rated.

- *Molluscicides and fungicides in western Oregon*: possibly used more heavily in western Oregon due to wetter climate.

- *Pool chemicals among pool and spa owners*: these chemicals could potentially be targeted in association with supply stores.

- *Mercury among ritualistic users.* Practitioners of certain religions may use mercury or other toxics in ritualistic uses, as is more common among Spanish-speaking immigrants. Other immigrant groups may also use traditional medicines that contain toxics.

- *Photo chemicals among home photographers*: may be difficult to reach since many supplies are mail-ordered, but some potential may exist to do outreach at photography stores. The large-scale transition to digital photography has likely reduced the purchase of new chemicals, but stockpiles likely exist and may take a long time to reach collection centers.

- *Residents with limited English proficiency.* Conducting outreach and providing materials in other languages would help residents with difficulty reading English to understand product risks that they might otherwise learn from product labels or other English sources.

Options for Market Change

Policy or product stewardship approaches to market change can help the marketplace transition away from particularly toxic components. For example, past phase-outs or reductions for substances such as DDT or lead in paint significantly benefited public health. Following are several options for products that rated highly in the priority assessment for which a market change strategy could yield beneficial and likely cost-effective results.

- **Pesticides: phase out the worst.** Many of the highest-risk pesticides formerly in household use have been phased out. However, due to the high risks remaining there may be additional candidates for phase-out. This study compiled some data on several consumer pesticides, but a further, more detailed analysis would be needed to identify any other pesticides that would be good candidates for phasing out. Note that DEQ does not have the authority on its own to phase out pesticide use but would need to work in concert with other state agencies, especially the Department of Agriculture. Note that some pesticides have been banned within a certain distance of salmon-bearing streams; retail labeling laws concerning these pesticides should be enforced.

- **Fuels: promote electric products or transition to biofuels for home applications.** DEQ could encourage a market transformation to electric lawnmowers and related products, likely one of the biggest reasons liquid fuels are kept at the home. DEQ could also promote the use of biofuels, where practical for home applications, to minimize toxicity and flammability concerns.

- **Motor oil: foster private sector take-back.** Do-it-yourself changing of motor oil at home has decreased in recent years, but collection is still necessary. One possibility could be to work with private businesses to accept used oil from homeowners.

- **Latex paint: promote product stewardship.** An existing national dialogue is underway with retailers and manufacturers that could produce new collection opportunities. However, uncertainty remains about the marketability and environmental benefits of recycling latex paint back into paint. Product stewardship approaches may offer some potential to focus on reducing VOCs or other ingredients of concern (e.g., formaldehyde). Oregon has a small

existing network of retailers who will collect leftover paint, and efforts could be renewed to expand this network.

- **Detergents and surfactants: phase out reproductive toxins and endocrine disruptors.** Although ratings of these substances in this Priority Assessment were very preliminary, it appears as if they may have significant human health and ecotoxicity impacts (e.g., nonylphenol, a common breakdown product of nonylphenol ethoxylates used in some consumer cleaning products). Alternatives likely exist, and potential partners include Wal-Mart, which has listed nonylphenol as one of its first three priority chemicals of concern.

- **Heavy metals: continue pursuing policy or product stewardship approaches.** For example, sale of mercury thermometers are now banned in Oregon and contractors are not allowed to install mercury thermostats. Similar approaches may be applied to other traditional products (such as artistic pigments or auto switches) or emerging products (such as flat-panel displays) that can contain mercury or other heavy metals.

- **Electronics: promote product stewardship.** The high rating of electronics results from large quantities in use as well as the presence of heavy metals and brominated flame retardants (PBDEs). However, consumers have few options of products that do not contain these constituents. A product stewardship approach could help foster a market transformation to least-toxic materials.

- **Lindane: phase it out.** Lindane is an ingredient of some lice shampoos, is a potent carcinogen, is toxic, and also received a 5 rating for ecotoxicity. Alternatives exist, and lindane appears to be an apt candidate for policy solutions or product stewardship. California, for example, has banned use of lindane in lice shampoos.

6.3 Topics for Further Research and Improvement of This Assessment

This Priority Assessment has created a methodology for identifying substances and products, geographies, and populations that likely pose or face the biggest risks to human health and the environment. Although the consultant has sought to find strong data sources and introduce practical methodologies, room for growth and improvement certainly exist. Sections 3.3 and 4.3 of this report have described limitations in the product and geography ranking tools, respectively.

As DEQ moves forward with implementing its *2005-2011 HHW Plan* and using these priority assessment tools, the agency may wish to consider the following areas of further research to potentially strengthen this assessment.

- **Explore alternate means of assessing quantity, concentration, and availability.** Understanding how much of each substance is present in households is an important step in assessing likely exposure. However, no comprehensive data sets were identified to help assess likely exposure for the range of substances rated in this assessment. Instead, the consultant used limited research combined with logical assumptions to assess product quantity and used severity of outcomes of poison center calls as a means of assessing concentration and availability (since a substance cannot produce a serious outcome if it is not present in any significant concentration and is not available). However, further research into alternative data sources and methods of assessing exposure could help strengthen the analysis.

- **Explore adding additional substance criteria: global warming potential, smog potential, and eutrophication effects.** These environmental and health affects were not

assessed in the existing model. In addition, endocrine-disrupting effects were also not fully accounted for.

- **Explore alternate means of assigning priority weightings.** Priority weightings were all set to 10 for simplicity. In addition, a method was briefly explored to assign priority weightings for human toxicity and cancer ratings relative to each other based on "cost to society" dollar-value metrics. While such an approach could not be easily applied to this assessment given the 1 through 5 rating scheme, the possibility remains to use this or other data- or policy-driven approaches to assigning these ratings.

- **Explore alternate means of assigning human health and ecotoxicity ratings.** Data from the EPA's 2002 TRACI model was used, where available, to assign human health and ecotoxicity ratings using quintiles. Quintiles were used because they enable combination of data from TRACI with other types of data using a simple, easy to explain, and transparent method. However, the use of quintiles significantly compresses the range of values in TRACI into a 1 through 5 scale, severely limiting the tool's ability to distinguish the most severely toxic chemicals, which, on a pound for pound basis may be hundreds or thousands of times more toxic than other substances. Alternate methods or data sources could be investigated further, including a yet-to-be-released, updated version of TRACI which may include more substances.

- **Assess additional products or substances.** This project did not assess all products or substances that are collected at Oregon's HHW collection centers nor could it assess all products or substances that could pose risks in use or disposal. DEQ may wish to add additional products or substances to this assessment in the future.

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Appendix A. Product Ranking Tool: Additional Details on the Rating Process

This appendix provides further detail on the rules used to assign 1 through 5 ratings to the secondary substance criteria and the primary criteria of Generation and Poisoning/Availability in the Product Ranking Tool. As described in the main body of this report, the steps were:

1. **Rate each substance for human health and ecotoxicity impacts based on data in TRACI**, if TRACI rated the substance. If TRACI did not rate the substance, consult the Hazardous Substances Data Bank (HSDB) or other sources.

2. **Rate each substance for reactivity and flammability based on the National Fire Protection Association's "Code 704" ratings.**

3. **Rate each substance as a corrosive/irritant based on qualitative information in the HSDB.**

4. **Rate each product for poisonings based on Poison Center call data.**

5. **Rate each product for generation based on limited available data or logical assumptions.**

Human Health and Ecotoxicity

The EPA's 2002 TRACI model includes separate factors for the impacts it tracks (e.g., Human health – Cancer, Human health – Noncancer, and Ecotoxicity) for releases to air and water. To develop the 1 through 5 ratings, we calculated the 20th, 40th, 60th, 80th, and 100th percentile of ratings in each category and then took the maximum across the two different media (exposure pathways).

For example, suppose that TRACI assigned human health – cancer toxicity ratings for lead that were to fall in the 79th percentile for releases to air and 88th percentile for releases to water. It therefore would receive scores of 4 and 5, respectively in our Product Ranking Tool for the two media. Given that the precise exposure pathway of each chemical is not known and cannot be individually assessed given the resources available for this project, we simply take the maximum of the 1-5 ratings for each media: in this case we therefore would use a rating of 5 to represent the human health – cancer impact of lead.

TRACI does not rate all substances for all impacts or media, however. Most significantly, human health – cancer ratings have not been developed for several chemicals. In such cases, we use qualitative information from the National Library of Medicines' Hazardous Substances Data Bank, which reports carcinogenicity classifications such as those used by the International Agency for Research on Cancer (IARC) and U.S. Environmental Protection Agency (EPA). The table below shows IARC and EPA equivalencies and the rating assigned in the Product Ranking Tool if the specific ratings or terminologies were reported in the HSDB but not in TRACI. Note that use of this alternative, qualitative system may not result in ratings that are identical to those in TRACI. In part to minimize potential differences between TRACI and this alternative method, we did not assign a human health – cancer rating of 4 or 5 based on qualitative information, preferring instead to reserve these ratings for substances with known high carcinogenic potency as indicated by TRACI. The rating scheme displayed in Table 11 therefore assigns any known or likely carcinogen to a rating of 3, possible or unclassifiable carcinogens to a rating of 2, and non-carcinogens to a rating of 1, although this rating was never encountered.

Table 11. Basis for Assigning Carcinogen Ratings if Substance Not in TRACI

IARC Rating	IARC Terminology	EPA Terminology	DEQ Priority Assessment
1	Carcinogenic	Carcinogenic	3
2A	Probably carcinogenic	Likely to be carcinogenic	3
2B	Possibly carcinogenic	Suggestive evidence of carcinogenic potential	2
3	Not classifiable	Inadequate evidence to assess carcinogenic potential	2
4	Probably not carcinogenic	Not likely to be carcinogenic	1

Unfortunately, no such existing systems were available to help assign ratings for human health – noncancer or ecotoxicity, although lack of data in TRACI is less common for these criteria. When not included in TRACI, we reviewed the qualitative summaries of toxicity and ecotoxicity studies reported in the HSDB and assigned a rating using professional judgment. In such cases, a description of why the rating was assigned was inserted in the tool. In some cases, particularly for pesticides, we also consulted pesticideinfo.org which gives qualitative assessments of chemicals used in pesticides.

Reactivity and Flammability

The National Fire Protection Association rates substances separately on their reactivity and flammability potential. The following table describes these ratings and provides a translation to the ratings uses in the Product Ranking Tool. Note that although both the flammability and reactivity codes are described in the same row, these codes are assigned separately. All NFPA ratings used were obtained from the Hazardous Substances Data Bank (HSDB) via an XML version of the HSDB supplied by the National Library of Medicine.

Table 12. NFPA Code 704 Ratings

NFPA Code	Flammability Code Description	Reactivity Code Description	DEQ Priority Assessment
4	Will rapidly or completely vaporize at normal atmospheric pressure and temperature, or is readily dispersed in air and will burn readily.	Readily capable of detonation or explosive decomposition at normal temperatures and pressures (e.g., nitroglycerin).	5
3	Liquids and solids that can be ignited under almost all ambient temperature conditions (e.g., gasoline). Flash point below 38°C (100°F) but above 23°C (73°F).	Capable of detonation or explosive decomposition but requires a strong initiating source, must be heated under confinement before initiation, reacts explosively with water, or will detonate if severely shocked (e.g., fluorine).	4
2	Must be moderately heated or exposed to relatively high ambient temperature before ignition can occur (e.g. diesel fuel). Flash point between 38°C (100°F) and 93°C (200°F).	Undergoes violent chemical change at elevated temperatures and pressures, reacts violently with water, or may form explosive mixtures with water (e.g., calcium).	3
1	Must be pre-heated before ignition can occur (e.g., canola oil). Flash point over 93°C (200°F).	Normally stable, but can become unstable at elevated temperatures and pressures (e.g., phosphorus).	2
0	Will not burn (e.g., water).	Normally stable, even under fire exposure conditions, and is not reactive with water (e.g., liquid nitrogen).	1

Substances not rated by the NFPA were assigned 1 through 5 ratings based on a review of the studies included in the Hazardous Substances Data Bank. Flammability was generally assessed considering the HSDB field *fire potential*. Most substances that were not given an NFPA rating were described as nonflammable (such as most pesticides). Reactivity was generally assessed by considering the fields *explosive limits and potential* as well as *hazardous reactivities and incompatibilities*.

Corrosive/Irritant

Unlike the previous criteria, no ready-made data sets were identified to assess the corrosive or irritant potential of substances. Instead, qualitative information in the Hazardous Substances Data Bank (HSDB) was used to assign these ratings. The following table summarizes the method used to assign ratings.

Table 13. Rating Categories Based on HSDB Qualitative Descriptions

Rating Assigned	Information in HSDB	Sample substance
5	Described in HSDB as an "extreme," "severe," or a "corrosive irritant" for more than one type of exposure (e.g., skin, eyes, or mucous membrane)	Hydrochloric acid
4	Described in HSDB as a "pronounced" irritant or if effects are mixed (e.g., severe for eyes but moderate for skin)[51]	Sodium hypochlorite (bleach)
3	Described in HSDB as a "moderate" irritant or corrosive or if effects are mixed but generally moderate	Trichloroethylene ("perc")
2	Described in HSDB as a "mild" or "slight" irritant or if description says it "may" or "can" irritate	Glyphosate (e.g., RoundUp)
1	No corrosive or irritant properties reported in HSDB	Nickel

Poisonings

Data on poisonings are included to help gauge how prevalent the products are in homes, how likely people are to be exposed to them, and how severe those exposures are. This criterion is therefore a proxy for concentration and availability metrics that were not otherwise available.

To develop these ratings, we obtained the 2004 Annual Report of the American Association of Poison Control Centers Toxic Exposure Surveillance System from the AAPCC web site (www.aapcc.org) and imported data table 22a into an Excel spreadsheet. This data table includes data on total number of exposures for numerous products as well as survey data for a portion of those exposures to determine severity of outcome. Note that we were not able to obtain an Oregon-specific data source but assumed that the benefit of access to the much greater size of the national dataset outweighed any drawback from not using local data.

Two metrics were devised for each product based on the AAPCC data: number of exposures and severity of exposures. Both metrics involved identifying what product (or group of products) in the

[51] Note that if the substance is described as "severe" for more than one type of exposure, it receives a 5 rating, regardless of whether it is less severe for other types of exposure.

AAPC database most closely matched each product in the Product Ranking Tool. In some cases, the product of interest could not be found in the AAPCC data and so data from a similar product was substituted. In such cases, a note was inserted in the Product Ranking Tool spreadsheet noting how the product was rated.

The method for calculating the two poisoning metrics were as follows.

- **Number of exposures.** For each product assessed in the Product Ranking Tool, the number of exposures was estimated by identifying what product (or group of products) in the AAPC database that most closely matched the product of interest. Once the number of exposures was estimated for every product, quintiles were calculated and 1 through 5 ratings were assigned to each product.

- **Severity of exposures.** For each of the products (or groups of products) used in the *number of exposures* metric, *severity of exposures* was calculated by dividing the number of outcomes that were “moderate,” “major,” or “death” (according to AAPCC terminology) into the total number of exposures with known outcomes (the sum of “None,” “Minor,” “Moderate,” “Major,” and “Death”). Once the severity of exposures was estimated for every product, quintiles were calculated, and 1 through 5 ratings were assigned to each product.

These two metrics were then averaged to produce an overall *Poisonings* rating. Note that the tool provides users the opportunity to adjust the *Poisonings* rating to be a different blend of the above two criteria, but caution should be used if adjustments are to be made. In particular, basing the rating only or primarily on "severity of exposures" would cause the rating to be based only on the severity of exposures, regardless of how many exposures there were. This is not advisable, as it would (in theory) rate a product that had only 1 exposure that was fatal higher than a substance with thousands of exposures (and hundreds of fatalities). The current setting (equal weighting to both metrics) attempts to strike a balance and is essentially the same as having this poisoning rating be based solely on the number (not percentage) of moderate to severe exposures.

Generation

As for other criteria, quantity ratings were assigned using a 1 through 5 scale. However, no single data set (or even a small number of data sets) could be identified that would provide the quantities of each product sold to or in use in Oregon's households. Therefore, benchmark quantities were estimated for several iconic HHW products and other products were rated by logically considering whether there was likely more or less of each product than the benchmark for each numerical rating.

The following table summarizes benchmark quantities used, followed by a description of the calculations for the iconic products.

Table 14. Quantity Rating Categories and Iconic Products

Rating	Minimum Quantity	Iconic Product
5	25,000 tons	Latex paint, herbicides
4	12,000 tons	Cleaners, disinfectants
3	6,000 tons	Insecticides, oil-based paint
2	3,000 tons	Antifreeze
1	More than 0 tons	Thermometers

Pesticides

Two primary data sources were used to estimate pesticide sales to home application: The California Air Resources Board's 1997 Consumer and Commercial Products Survey included data on pesticide sales (by total weight) to non-agricultural uses. In addition, the U.S. EPA published a report *Pesticides Industry Sales and Usage: 2000 and 2001 Market Estimates*. The methodology to estimate pesticide sales in Oregon to households was to start with the sales in California (which were both household and commercial) from the California Air Resources Board (CARB) and multiply by the fraction of pesticide sales nationally that were by households (excluding agricultural sales) from the U.S. EPA study.[52] Results were then converted to Oregon on a per-person basis. Following are the data used.

Table 15. Estimated Household Pesticide Use Tonnages in Oregon

Pesticide	1997 CA Total Product Sales (Tons per day, CARB)	Fraction Home and Garden (National, EPA)	Estimated Household CA Tons, Annual	Estimated Household OR Tons, Annual
Herbicides	3162	59%	682,860	68,976
Insecticides	397	53%	76,981	7,776
Fungicides	63	39%	8,901	899

[52] One complication is that the California data were based on the weight of the entire product whereas the EPA data were based on active ingredients only. If consumer pesticide concentrations were significantly higher or lower on average than commercial and agricultural uses then results could be skewed.

Latex and Oil-Based Paint

Based on data from the Product Stewardship Institute's Paint Product Stewardship Initiative, an estimated 2.3 gallons of paint are sold per person annually, 80% of which is latex, and each gallon of paint weighs 10 pounds. Given Oregon's 3.4 million people, this translates into 7.7 million gallons of paint annually, or 39,000 tons: 31,000 tons of which are latex and 8,000 tons of which are oil-based.

Cleaners

California Air Resources Board estimates were also used to generate ballpark estimates of cleaners. CARB Consumer and Commercial Product Survey data from 1997 showed 1,325 tons of disinfectants per day and 1,235 tons per day of carpet and upholstery cleaners. Assuming half of each of these quantities is for household use (as opposed to commercial), these quantities, when translated to Oregon on a per-person basis, imply about 24,000 and 23,000 tons of these two cleaners, respectively.

Antifreeze

An estimated quantity for antifreeze was calculated as follows. Assume 1 car per person in Oregon, or 3.4 million cars. Each car uses approximately 1.7 gallons of antifreeze which is recommended to be changed on a 2-year cycle (these figures are according to the LHWMP in King County, Washington). This results in an annual antifreeze generation of nearly 3 million gallons. At 9 pounds per gallon, the result is an estimated 13,000 tons. However, unlike most other consumer products, a large fraction of antifreeze is never handled by the consumer. If 75% of radiator maintenance is performed by service stations, then the quantity controlled directly by the consumer (and therefore available for exposure or generation as HHW) would be an estimated 3,200 tons.

Appendix B. Household Hazardous Waste Prevention and Behavior Change Literature Review

This appendix presents a summary of Cascadia's review of relevant literature relating to harmful HHW-related behaviors for DEQ to target, intervention strategies for implementing behavior change efforts, and evaluation methods for assessing the impacts of HHW waste prevention efforts. The scope of this research focused narrowly on behavior change specific to household hazardous waste and particularly on efforts for reducing HHW use, rather than the large body of literature regarding behavior change related to a range of environmental topics, such as recycling.

The appendix consists of six sections:

1. Introduction
2. Summary Findings: Behaviors, Intervention Strategies, and Evaluation Methods
3. Search Methodology
4. Behaviors to Target – Relevant Literature and Programs
5. Intervention Strategies – Relevant Literature and Programs
6. Evaluation Methods – Relevant Literature and Programs

1. Introduction

Since 1991, Oregon's Department of Environmental Quality has offered Household Hazardous Waste (HHW) collection services to residents in communities around the state. The primary purpose of DEQ's HHW Program is to **minimize risks from HHW to Oregonians and the environment**. In keeping with this overall mission, the primary goals for the 2005-2011 HHW Plan are to **reduce the generation of household hazardous waste** and to **ensure the provision of HHW services addressing the highest risks first**.

As part of the newly adopted six-year HHW Plan, DEQ is developing a comprehensive behavior change education campaign to reduce the generation and improper use of HHW. To guide its resource allocation decisions and help design an effective behavior change campaign, the HHW Program is investigating the following issues:

- Which **behaviors** regarding household hazardous waste should DEQ target?
- Which **intervention strategies** (e.g., mailings, workshops, regulations) should DEQ use in implementing HHW behavior change programs?
- Which **evaluation methods** should DEQ use to assess the impacts of household hazardous waste prevention programs?

Cascadia Consulting Group reviewed existing literature on HHW education and outreach programs to address these three key questions, which form the outline for this summary. (Other elements of the HHW Priority Assessment will also contribute information to the development of this campaign, particularly regarding high-risk behaviors to target.)

Peer-reviewed literature evaluating household hazardous waste programs was relatively sparse, but some clear patterns regarding intervention methods emerged. Less information was available on which behaviors DEQ should target, and few programs provided detailed information on evaluation methods for measuring outcomes rather than tracking activities.

The scope of this research effort was defined narrowly, to focus on behavior change specific to HHW and particularly on efforts for reducing its use. According to the guidance from DEQ, we did not explore the general literature regarding behavior change and environmental topics. (Many of the practices and lessons drawn from this broader environmental behavior change literature are likely transferable to household hazardous waste prevention, but DEQ already has a strong working knowledge of this field, including community-based social marketing techniques.)

2. Summary Findings

While a large body of literature exists relating to changing and improving behavior regarding environmental issues, the literature review found that few studies relate specifically to changing behavior with respect to household hazardous waste. Even fewer studies relate specifically to preventing HHW or reducing the *use* of hazardous household products. Many jurisdictions have HHW programs, but these programs typically track such activity measures as number of participants and pounds collected. Program evaluation studies are also difficult to find, as many HHW programs do not publish written evaluations, and few evaluations focus on measures of impact, outcomes, or actual behavior change, in addition to activity measures.

Most programs are not designed, implemented or evaluated using rigorous standards that would allow publication in academic literature. Additionally, program evaluations are also more likely to focus on efforts related to waste *management* behaviors (e.g., improper end-of-life disposal), rather than efforts to reduce the purchase and/or inappropriate use by households of hazardous substances. Rather than conducting scientific studies related to behavior change and HHW, many programs appear to draw from the experiences of working on similar environmental problems (e.g., recycling) and apply those principles to behavior change programs related to hazardous household products.

This summary provides a brief overview of findings organized around the three key topic areas below: **behaviors**, **intervention strategies**, and **evaluation methods**. Following those sections, this document briefly describes the methodology for the literature review and then provides more details, including relevant literature references, on each of the three major topics.

2.1 Behaviors

In selecting behaviors to target for change, DEQ should consider first what behaviors have the greatest impacts, and then which of those behaviors are most amenable to change through education or other interventions. For the most part, however, the literature does not specifically address these points. Most programs that Cascadia identified in the literature focus primarily on outdoor pesticide and fertilizer use or cleaning products. These materials ranked highly as products of concerns in the Priority Assessment study, though the literature does not generally specify why these products were chosen as the focus of their respective studies. Cascadia did not identify studies that explicitly compare HHW purchase and use behaviors against each other in terms of either their hazard potential or their potential for change.

Results from the Product and Substance Ranking Tools developed in another portion of the Priority Assessment project will be useful in deciding which products, and related behaviors, DEQ should target. Similarly, DEQ's planned work under the Baseline Study should help to identify the prevalence of certain behaviors and likely barriers to change.

2.2 Intervention Strategies

Successful projects to change people's environmental behavior generally:

- Have clear, **realistic objectives**;
- Select an **appropriate audience**;
- **Research the target audience**, in particular, the barriers to changing the specific behaviors and potential motivations for behavior change; and
- Use a **variety of tools and methods** that research has shown to be effective. Tools could include, for example, changes in technologies or products, laws and regulations, economic or other incentives, and education and outreach. A combination of methods is generally more effective than relying on one method.

The literature review showed that although education and outreach have an impact on behavior, **changing the framework within which people act has a much greater impact**. Changing the framework can include passing regulations to ban certain products (but should be supported by education and outreach) or, for example, creating low-impact developments wherein the built environment itself reduces HHW impacts (primarily fertilizer and pesticide use).

At the same time, while regulations supported by education are more effective than education and outreach alone, **it can be difficult to pass regulations without first generating political and community support through education** and outreach campaigns.

Behavior change campaigns appear **most effective when they use intensive interactive outreaches**, such as one-on-one meetings or presentations and workshops for small groups; however, **intensive outreach is expensive and inefficient for reaching larger populations**. Other options include media advertisements, mailings, and booths at community events.

One caveat is that even when participants in education and outreach programs report that they have changed their behavior, there may not be a significant effect on the environment or on independently assessed variables, such as water quality or the total quantity of hazardous products sold. Programs that evaluated both behavior change and downstream effects on the environment (primarily regarding yard care and water quality) found that **even when residents report making changes, there may be little discernable effect on the environment**. In one study, participants who reported increasing their use of non-toxic alternatives did not concurrently reduce their use of toxic cleaners.

Finally, a couple of programs focused on providing **outreach to minority populations**. Outreach seems to be more effective when it takes into account the target population's cultural context and forms partnerships with community organizations or uses outreach workers from the target population. For example, a program in Massachusetts to reduce the use of toxic cleaning products among Latinos hired outreach workers from the community who were familiar with common cultural issues and attitudes regarding cleaning.

2.3 Evaluation Methods

Evaluation is more effective when:

- Programs have **clear goals**;
- A **baseline evaluation** occurs;
- The **evaluation instrument is tested**; and
- **Sufficient budget and priority** are allocated to evaluation.

Activity measures (e.g., brochures distributed, website hits, events held, quantities of HHW collected) are the most common evaluation metrics for HHW programs, but they provide little information about behavior change regarding the use or prevention of hazardous household products. Programs seeking to address the latter topic can evaluate results based on self-reported behavior change (e.g., surveys that ask participants whether they have reduced pesticide use), independently assessed behavior change (e.g., performing inventories of the quantity of pesticides that households store and use, regional pesticide sales data), and/or impacts on the environment or human health (e.g., pesticide contamination of streams and lakes, number of accidental poisonings).

Evaluation based on self-reported behavior change may be easier to perform but tends to overestimate the impacts of programs because people often either believe that they are or want to portray themselves as doing "the right thing." Self-reported behavior change is usually measured through surveys, including telephone surveys to the general population, questionnaires placed in outreach kits, or evaluation surveys administered as part of workshops. Having households track their purchasing behavior may produce more credible, quantitative information, though it remains self-reported.

Behavior change can be assessed independently by actually measuring the quantity of hazardous products stored in homes or by tracking retail sales of products of concerns. These methods are more likely to reduce or eliminate the self-reporting bias.

Impacts on the population as a whole could be evaluated by comparing regional sales data for hazardous products before and after the program; however, sales data are expensive and can be difficult to acquire. Measures of environmental change, such as water quality parameters, could help show program impacts, though producing measurable change is difficult and demonstrating cause-and-effect is also problematic.[1]

[1] Especially see Dave Galvin's paper "Measuring results from outreach and education programs – Can we see improvements downstream?" for an excellent discussion of evaluation issues.

3. Search Methodology

During the literature review we searched publication databases including Pubmed (http://www.ncbi.nih.gov/entrez/query.fcgi), Proquest, Expanded Academic ASAP, Blackwell-Synergy, and Science Direct. Cascadia also searched Doug McKenzie-Mohr's CBSM.org (community-based social marketing) website, ToolsOfChange.org, and the web in general using Google and Google Scholar. Search terms included permutations of the following words: household, hazardous, waste, material, substance, chemical, pesticide, cleaner, education, outreach, behavior, prevent* (e.g., prevention, prevents), reduc* (e.g., reduction, reduce). Finally, Cascadia contacted several programs directly for information. We also obtained input from members of our expert advisory team, including Annette Frahm (formerly of the Local Hazardous Waste Management Program in King County, Washington) and Philip Dickey (of the Washington Toxics Coalition).

4. Behaviors to Target – Relevant Literature and Programs

The literature review found few studies that suggest which household hazardous waste behaviors DEQ should consider targeting. Four studies that were found primarily highlight the need for additional research, such as statewide surveys, to determine how Oregonians actually use, misuse, dispose, and decide to purchase various hazardous products. One relevant study is a survey in Maine that found that consumers rarely measure the area to be painted in order to calculate how much paint they need and that they deliberately purchase excess paint. A survey in King County, Washington, found that 28% of respondents reported using pesticides. Accordingly, the majority are not using pesticides, though pesticide use remains a key behavior of concern.

DEQ's HHW Priority Assessment is currently reviewing the risks associated with different hazardous products in the home. This effort will produce rankings to help DEQ prioritize the materials and behaviors to target, such as pesticide use.

Some surveys on household hazardous waste attitudes and behaviors have been periodically performed in various jurisdictions in Oregon. For example, a Metro Hazardous Waste Disposal Study in 1998 conducted phone surveys and found that 38% of respondents disposed of hazardous waste in the regular trash.[2] Several surveys have also asked about pesticide use. However, most of these surveys are several years old, limited in geography, and did not ask questions that would help identify which behaviors to target.

Marine and Coastal Policy Research Group (University of Plymouth). 2005. *Barriers to Green Buying: Household Chemicals*. United Kingdom: Clean Water Initiative.

Researchers in the United Kingdom performed a national survey of U.K. consumers and conducted interviews with retailers to determine attitudes and barriers regarding purchasing environmentally friendly products. Although consumers are generally environmentally aware and inclined, a large percentage do not consider the environmental impact on water quality of the cleaning and toiletry products they purchase or the impact of what they put down the drain. At the same time, most consumers also believe that sewage treatment plants do not remove all of the harmful chemicals. Identified barriers to purchasing environmentally-preferable products include:

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[2] See David Allaway's DEQ report, *Draft Background Research – Baseline A: Other HHW Data Sources* (June 13, 2006).

- Lack of awareness of environmental problems associated with household chemicals;
- Perception that “green” products do not work as well and are too expensive;
- Brand loyalty or inertia to choosing a new brand; and
- Difficulty in finding and identifying less-toxic alternatives.

Half of the survey respondents reported that reading labels does not help them choose which cleaning products and toiletries to buy.

Key lessons: Consumers may need more education about environmental problems associated with, and non-toxic alternatives to, conventional cleaning products and toiletries. They may also need demonstrations that these alternatives are high-quality and provide satisfactory results.

Evans/McDonough Company, *King County Pesticide Survey Summary Report*, prepared for Local Hazardous Waste Management Program in King County, March 2000.

A professional telephone survey conducted in early 2000 asked 400 King County residents about their use of and attitudes towards pesticides. Findings include:

- Only 28% of residents reported using pesticides or chemical fertilizers, including weed-and-feed products, “regularly” or “sometimes.” Pesticide users are more likely to be men and to be homeowners.
- Most residents are concerned about the health impacts (77%) and the environmental impacts (66%) of pesticides.
- Whereas roughly 60% of all residents believe that you can have the same quality of lawn without pesticides and that it does not take too much time and effort to maintain a lawn without them, roughly the same percentage of pesticide users felt the opposite.
- Pesticide users report being concerned about the impacts of their pesticide use on the health of their family (67%), water quality (61%), salmon (57%), and birds/pets/wildlife (55%).
- Pesticide users report that they would be more likely to reduce their pesticide use if there were better/safer/more effective alternative products (26%) or if they had more scientific evidence of the harm caused by pesticides (22%). However, 25% say that nothing would make them reduce pesticide use.

Key lessons: Most people surveyed do not use pesticides. Those who do use pesticides would be more likely to reduce pesticide use if safer, effective alternatives were available or if they had more scientific evidence of the harm caused by pesticides. A jurisdiction-wide survey can be used to tailor an outreach program by revealing attitudes/beliefs held by pesticide users (or users of other hazardous products) and can provide a pre-program baseline to use when evaluating that outreach program.

McKenzie-Mohr and Associates, *Residential Paint Survey: Report and Recommendations*, Prepared for the Product Stewardship Institute, November 2005. Accessed online November 2006 (http://www.productstewardship.us/supportingdocs/Paint_FinalResSurvey.pdf).

A survey regarding how people purchase paint for residential projects found that most people purchase more paint than the project requires when they first go to the store. Roughly a third purchased either the right amount of paint or up to 10% more than they eventually needed, but 47% purchased more than 10% more paint than they ultimately needed for the project. Most people reported that they would rather buy too much paint than have to go back to the store; most also wanted to have paint left over for touch-ups.

Measuring the area to be painted can help people determine the proper amount of paint to purchase, but this survey found that a significant percentage of participants reported that they were not at all likely to either measure the area with a measuring tape (46%) or roughly estimate the area by pacing or a similar method (41%). Only 22% and 16%, respectively, of participants reported that they were very likely to use those methods. On the other hand, although measuring could reduce over-purchasing, the survey also found that pre-purchase measuring was only weakly related to having paint leftover. Nonetheless, this report recommends putting kiosks in hardware and paint stores to help homeowners estimate the amount of paint they need.

The survey did not find strong potential motivators to encourage people to purchase less paint: only 39% of survey participants reported that it is important to purchase only the amount of paint they need in order to protect the environment, and only 17% reported that they purchase only what they need in order to save money.

Key lessons: Any program to reduce the over-purchase of paint should keep in mind that people deliberately purchase more paint than they need because they want leftover paint for touch-ups and do not want to have to return to the store to buy additional paint. A behavior change program could include tools for calculating the amount of paint required and education on the reasons to purchase the right amount of paint; however, at this time people do not seem to feel that the additional environmental harms, additional costs, or storage requirements caused by having leftover paint are burdensome enough to purchase less paint.

McEvoy, John W., and Annette Mackay Rossignol, "Household Hazardous Waste Disposal in Benton County, Oregon," *Journal of Environmental Health* (October 1993) 56(3):11-16.

A survey of Benton County, Oregon, residents in 1993 found at that time residents disposed of most household hazardous wastes improperly. Non-automotive wastes, such as cleaners, paints, and pesticides, were frequently put in the garbage can, while antifreeze was either put in the garbage or buried or poured on the ground. Only motor oil (55%) and lead-acid batteries (86%) were primarily properly disposed of by recycling; no one reported using a household hazardous waste collection day. Approximately half of residents had heard about household hazardous waste disposal in the previous year, primarily via the newspaper (42%), pamphlets or mailers (21%), or television (17%).

Key lessons: This study could be used as a baseline to evaluate the disposal-related impact of subsequent Benton County household hazardous waste programs.

5. Intervention Strategies – Relevant Literature and Programs

The **Intervention Strategies** section is divided into two parts, addressing:

- **pesticide**-related activities, which represent a significant portion of the focus of HHW programs as well as the relevant studies reviewed; and

- **general household toxics** more broadly.

5.1 Pesticides – Potential Intervention Strategies

King County, *Local Hazardous Waste Management Program in King County: 2004 Annual Report* (September 8, 2005).

King County has a long history of hazardous waste management programs, including programs relating to waste prevention. The program website, the Household Hazardous Waste Hotline, and educators at the Wastemobile (a mobile household hazardous waste collection facility) answer questions about proper disposal and provide information about how to reduce the use of toxic and hazardous products. Several additional programs are targeted towards reducing pesticide use. Residents in Natural Yard Care Neighborhoods work together and with the program to learn how to avoid pest problems to reduce the need for pesticides. The Natural Lawn and Garden Hotline answers questions from residents around the county. Finally, the Green Gardening Program holds workshops and presentations to teach yard care professionals and interested groups about natural gardening techniques. The following sections discuss these program elements in more detail.

Wastemobile Pledges

The Wastemobile, part of the Local Hazardous Waste Management Program in King County, successfully used pledges to change some behaviors of those who dropped off household hazardous waste. This involved a combination of an incentive and a commitment. In 1999-2000, Wastemobile staff offered a free weed puller if people signed a pledge to use the puller instead of weed killers. The Wastemobile distributed 150 weed pullers and did a follow-up survey with 56 visitors. The survey found that:

- 82% had used the weed puller;
- 53% found it easy to use and used it frequently (at least once a month); and
- 79% changed their behavior and stopped using pesticides.

The Wastemobile did a similar effort in 2003 involving slug traps. Staff distributed 60 traps and surveyed 47 visitors. This tool appeared somewhat less successful than the weed puller. The survey found that:

- 74% used the trap;
- 74% thought the trap was somewhat or very effective in reducing slugs; and
- 40% reported that they still use slug bait in addition to traps, despite signing a pledge to the contrary.

[Source: Internal summary report from Cascadia Consulting Group]

Natural Lawn Care Program

The Natural Lawn Care Program was an ambitious, multi-year, multi-agency effort in King County, Washington, to reduce water and pesticides used on lawns, particularly weed-and-feed, and to promote grasscycling, or leaving grass clippings on the lawn. To develop strategies, the project interviewed landscapers about barriers to changes in lawn care practices. It also held focus groups with its target audience of male, middle-aged, middle-income homeowners.

Among the strategies used by the project were advertising on radio and cable television, media events and other news media outreach, brochures (both general and focused on specific practices), and a model neighborhood that received equipment and classes to help them adopt new practices.

Some of the self-reported results are as follows:

	1997	1999	2001	2002	2003
Don't use weed & feed	47%	51%	61%	58%	58%
Don't care about lawn weeds	23%	28%	32%	28%	34%
Prefer environmentally friendly landscaper	9%	16%	47%	50%	44%

Source: SoundStats monthly random telephone survey of 400 King County residents.

Survey questions were repeated every year during the project. They showed a significant improvement in people's use of weed-and-feed (decrease) and tolerance of weeds in the lawn (increase). Self-reported behavior can be unreliable, however, as respondents may be guilty of over-reporting positive behaviors and under-reporting negative behaviors. Examining trends over time may yield more meaningful results than the absolute number and percentage of particular responses reported.

[Source: The Frause Group, King County Natural Yard Care and Associated Environmental Practices 1997-2003, Behavior Trends Analysis, 2003.]

Pesticides sales data from home and garden warehouse stores (Home Depot and Lowe's) paint a somewhat less rosy picture. During the program, there were small decreases in the sales of most pesticides, including weed-and-feed, and sales of pesticides found in local streams declined by 32%. On the other hand, sales of carbaryl, an alternative to two organophosphate insecticides that were phased out during the project, increased by 1100%. Also, less-toxic pesticides compose a small fraction of sales in those stores.

[Source: Philip Dickey, Pesticide Sales at King County "Home Improvement Centers" in 2000, 2001, and 2002.]

Natural Yard Care Neighborhoods

Budget reductions and changing agency priorities ended the Natural Lawn Care Program after 2002. It was replaced by Natural Yard Care Neighborhoods. This program uses a community-based social marketing model to help residents learn about and implement more natural methods to maintain their yards. The ongoing program has been a cooperative effort of King County and several suburban cities. The program recruits and involves specific neighborhoods in three free workshops "designed to help participants adopt, increase, or continue 25 environmentally responsible outdoor behaviors, from reducing water use to eliminating pesticides.

A 22-month follow-up effort found that participants in the workshops were not "the converted"; in other words, their pre-workshop yard care behaviors did not differ significantly from non-participants in the program. Three-quarters (78%) signed pledges to adopt Natural Yard Care practices, and according to the evaluation, 22% to 35% have adopted or increased the top-five behaviors, which included avoiding weed-and-feed products.

Participants had a strong, sustained knowledge increase. Those who knew about building healthy soil increased from 11% to 53%. Those who knew about controlling pests without pesticides increased from 7% to 34%. Those who knew how to practice natural lawn care increased from 10% to 54%. They had a high confidence in their knowledge; 79% to 91% were very or somewhat informed for each topic.

The program has aimed to change social norms by getting neighbors talking to neighbors about natural yard care. Three-quarters of participants (75%) said the classes were "important" to building a sense of community, and 40% said they were "very important." On average, people told five friends, neighbors, or family members about what they had learned in the sessions. If participants attended all three workshops, the average number of contacts went up to seven.

[Source: Linda Dethman, Draft 2003 Natural Yard Care Neighborhood Program Evaluation, Phase 2: Long Term Effects.]

Pesticide Postcards

A King County project done in cooperation with several suburban cities aimed to increase concern about pesticide risks and provide simple gardening actions to perform instead of using pesticides. Since research showed that women were more concerned about the health and environmental effects of pesticides, the project focused on female suburban homeowners. In the first year, the project mailed three postcards during the gardening season. The second year, three to five postcards were mailed. The results showed that those who remembered the postcards were more likely to make positive behavior changes.

[Source: Annette Frahm]

Green Gardening Program

In 2004, the Green Gardening Program held two integrated pest management (IPM) workshops to train public groundskeepers and private landscapers, offered more than 50 presentations to interested groups, and also conducted presentations for non-English-speaking audiences.

Green Gardening regularly conducts surveys to evaluate presentations and classes. Participants from a training for nursery employees reported that they saw fellow staff members sharing information they had learned with customers and fellow staff. Most participants in the integrated pest management workshop who responded to the follow-up survey said that they already used little or no pesticides (78%), and 17% reported that they were not able to make any reductions. Participants who attended presentations reported that they changed behavior more often by selecting plants suited to the local climate than by switching to non-toxic methods of pest control; however, of those who planned to reduce chemical use, over 60% report that they actually did so.

[Source: King County, Local Hazardous Waste Management Program in King County: 2004 Annual Report, September 8, 2005.]

Key lessons: King County uses a variety of approaches to reduce pesticide use, including media and mailing campaigns, community presentations for the public, and education for yard care professionals. Most approaches have yielded some results, but they involved significant resources and likely work best in combination.

Kassirer, Jay, and Chris Wolnik. 2004. *The Impact of By-laws and Public Education Programs in Reducing the Cosmetic/Non-Essential, Residential Use of Pesticides: A Best Practices Review*. Canadian Centre for Pollution Prevention and Cullbridge Marketing and Communications. Accessed online (http://www.cullbridge.com/Projects/Pesticides.htm**).**

Canadian researchers looked at communities in North America and Europe that passed by-laws restricting pesticide use, conducted education campaigns, or both. The study found that communities that did both were more successful than communities that used only education. Communities with a regulation supported by education reduced pesticide use by 51-90%, while communities that used only education reduced pesticide use by only 10-24%. Programs including by-laws generally cost $0.50-$1.00 (Canadian) per capita while education-only programs cost C$0.13-$0.24 per capita. By-laws are most successful when supported by public education and enforcement.

This study also includes nine case studies with descriptions of campaigns and results. Several bans allow some application of pesticides, but only with permits. By requiring that homeowners apply for permits themselves, rather than letting professional sprayers apply, jurisdictions can reduce permit requests and create an opportunity for one-on-one education of homeowners.

Public outreach campaigns that include other sustainable landscaping practices alongside pesticide reduction can be more cost-effective and attractive to potential retail partners. It can be important to enlist retailer support for pesticide reduction programs, especially where education is the only tool, because they can provide information at the point of sale. A broader education program that also includes promoting native plants and other alternative products can help offset lost revenues resulting from decreased pesticide sales.

Program tools to reduce pesticide use included:

- Emphasizing sustainable gardening and offering training and support;
- Building community pride in being pesticide-free through a logo on signs at the town border, on city paperwork, and on items for home display (e.g., yard sign, sticker for lawnmower);
- One-on-one education through home patrols and permit applications;
- Informational phone lines and websites;
- Gardening talks, hands-on workshops, programs in public schools, and natural garden tours;
- Articles, pamphlets, booklets, and information packages;
- Sustainable landscape maintenance calendars, recipe cards, posters, and seed packets;
- Homeowner pledges to reduce or eliminate pesticide use;
- Discount cards for alternative products;
- Directory of organic yard care companies;
- Media advertising including print, radio, and television ads as well as postcard mailers;
- Working with local garden clubs, retailers, and community organizations; and

- Connecting related issues that people care about to pesticide use. For example, when the U.S. Environmental Protection Agency added salmon to the endangered species list, King County used the publicity to connect pesticide use to declining salmon populations.

Evaluation of pesticide reduction programs was done through tracking pesticide sales, interviews of yard care providers at trade shows, interviews of garden product retailers, and telephone surveys of residents.

Key lessons: While education and outreach alone can have an impact on the use of hazardous products, regulations supported by education appear to be more effective, although at a higher cost.

Dietz, Michael E. "Impacts of Extension Education on Improving Residential Stormwater Quality: Monitoring Results." *Journal of Extension* (December 2002) 40(6).
http://www.joe.org/joe/2002december/rb5.shtml

Dietz, Michael, John Clausen, and Karen Filchak. 2004. "Education and Changes in Residential Nonpoint Source Pollution." *Environmental Management* 34 (5): 684-690.

This study compared paired watersheds. Residents in the treatment watershed received education from trained volunteers who offered on-site assessments, soil testing, and information on best practices. Residents in the control watershed received no education. Evaluation was performed via stormwater sampling as well as two surveys mailed to residents, one before and one after the site assessments. After two years, results were mixed. After receiving the intensive education, residents adopted some general best management practices and stormwater runoff improved, but specific surveyed behaviors (e.g., fertilizer application) did not change. In a private communication (Galvin, 2005), the study author suggests that although the results were promising, a low-impact development (LID) subdivision may produce better results in terms of measurable impact on water quality. Such LID projects change the environment in which people act without needing to change their behavior directly.

Key lessons: Intensive education, through trained volunteers, can somewhat influence how people behave. However, a program that changes the environment in which people act, rather than trying to change their behavior, may be more effective in reaching the ultimate goal (e.g., improving water quality).

Nelson, John Olaf. 1987. "Water Conserving Landscapes Show Impressive Savings." *Journal of the American Water Works Association* (March 1987) 35-42.

Researchers compared the use of water, fertilizer, and herbicide (among other variables) between housing developments that had traditional landscaping and ones that had water-conserving landscaping. Water-conserving landscaping was defined by the total area, perimeter, and layout of lawns as well as by the use of water-conserving plants in non-lawn areas. Water-conserving landscapes in the study had roughly 55% less lawn area and 10% less total landscape area than the traditional landscapes, on average. Landscape contractors in the water-conserving landscapes used 54% less water, 61% less fertilizer, and 22% less herbicide per dwelling unit. These landscapers also used 24% less fertilizer per square foot of lawn, although the author did not identify a good reason for this difference and noted that it is likely an artifact of a small sample size. Interestingly, the water-conserving landscapes also used 95% less herbicide on the lawn.

Key lessons: The environment in which people act, in this case the design of the landscape in a housing development, has a strong influence over their routine decisions, such as water or chemical use. Water-conserving landscapes in this study also used less fertilizer and herbicide per square foot of lawn, though the author suggested such differences could disappear with a

larger sample size. It could be that the water-conserving landscapes themselves are somehow healthier and do not need additional chemicals. On the other hand, it could be that homeowners with water-conserving landscapes or the landscaper contractors who serve those landscapes are predisposed to reduce chemical use.

Jackson, Caroline. North and West Vancouver, British Columbia: GardenSmart Program, 2003-Present.

Vancouver's GardenSmart program, initiated in 2003, has the twin goals of reducing pesticide use in lawn and garden care and reducing the volume of organics going to the landfill. In 2003 and 2004, the program conducted three initial telephone surveys to examine residents' use of and attitudes towards pesticides. These surveys found that pesticides were commonly used to deal with lawn maintenance issues. The 2004 surveys found that reported pesticide use had increased since the previous year, although increased recognition of pesticide use (e.g., educating residents that weed-and-feed contains pesticide) may have contributed to this change.

Intervention methods beyond advertising include a public education campaign, public workshops, school workshops, a natural gardens tour, and home workshops in the form of "Natural Garden Parties." The Natural Garden Parties draw on existing social relationships and social capital; program staff considers this model more effective than regular public workshops. The program also considers the garden parties cost-effective because the program does not need to recruit all the participants or provide a venue or refreshments. Instead, the program recruits only the hosts and supplies a speaker on a particular topic, invitations, handouts, and door prizes.[3] In 2006, the program held 12 parties and reached 170 participants, of whom approximately 50% reported using pesticides, according the pre-workshop questionnaires. The program does not appear to have conducted post-workshop questionnaires but is planning to do so in the future. The program is also scheduled to conduct a follow-up telephone survey in October 2007 to evaluate further results of the five-year program.

Key lessons: Telephone surveys may not register small differences in behavior and may be subject to self-reporting biases. Programs can leverage existing social networks to reduce recruitment time (and potentially also increase behavior change among participants) by having Natural Garden Party hosts organize workshops in their homes for groups of friends.

City of Austin's Grow Green Program

Grow Green is a natural landscaping program focused on protecting water quality. The program includes natural gardening classes for nursery professionals and a weed-and-feed outreach campaign, as well as fact sheets and other information. In the fall 2006 post-class survey, nursery managers reported that the Grow Green program had affected their sales. Managers were more likely to report that sales of natural fertilizers and less-toxic pesticides had increased, rather than that sales of chemical pesticides and fertilizers had decreased; however, some decrease in yard chemical sales was noted. The weed-and-feed campaign includes both a media campaign and targeted outreach efforts in selected pilot neighborhoods. The pilot neighborhoods were chosen because atrazine, an ingredient in weed-and-feed, was repeatedly detected in nearby springs. The Grow Green program surveyed neighborhood residents on their fertilizing and weeding habits before the campaign (March 2007) and plans to conduct a follow-up survey in the future. Although the survey captures only self-reported behavior, water quality testing of the springs can provide an objective evaluation.

[3] Although the 2006 annual report suggests that the cost per participant is higher for the GardenSmart Workshops than the Natural Garden Party Workshops, the GardenSmart costs do not include registration.

Key lessons: Objective measures, such as water quality testing, can be used both to direct and evaluate behavior change programs, in addition to self-reported surveys.

Quebec's Coalition for Alternatives to Pesticides

In 2001, the Coalition for Alternatives to Pesticides launched a behavior change campaign involving:

- Mass media coverage including press releases, newspaper articles, and interviews on radio and television;
- A website with information for adults and children;
- Children's activities at day camp and school;
- Free workshops to train partner organizations on sustainable lawn care and how best to share the information;
- Kiosks at events;
- 10,000 Action Kits for distribution. Action kits included information on biodiversity, pesticide poisoning, how to have a beautiful lawn without pesticides, activities for children, a lawn sign, and a horticultural calendar.

The Action Kits included a questionnaire. Of people who returned the questionnaire, roughly two-thirds reported that they reduced pesticide use, although fewer than 30% placed the lawn sign included in the kit in their yard. Self-reporting bias may mean that mainly people who made changes returned the survey, while people who received the kits but did not use them are not counted because they did not return the survey. The Coalition for Alternative to Pesticides also credits their campaign with encouraging municipalities to consider regulating the cosmetic use of pesticides and with helping induce a major grocery chain to stop selling pesticides.

Key lessons: A broad-based informational campaign can help change social thinking about pesticides, making natural yard care and pesticide regulation more acceptable to the public. Only a small percentage of questionnaires included in the Action Kits were returned, so more active methods may be necessary to obtain sufficient participant responses for conducting an effective evaluation.

Aceti Associates. 2002. *Reducing Pesticide Use in Lawn Care: Barriers and Opportunities*. Massachusetts: Department of Environmental Protection.

This fact sheet describes the barriers and motivations to reduce pesticides in lawn care, which can inform an outreach campaign based on a community-based social marketing approach. Barriers include a lack of awareness of the environmental and health risks, a narrow standard for lawn appearance (e.g., a green carpet), the belief that pesticides are necessary to produce an attractive lawn, limited sources of information on lawn care, social pressure to maintain a green lawn, the connection between property values and a lawn, and the perceived difficulties of transitioning to organic lawn care. Motivations to reduce pesticide use include concerns about health risks, water and other environmental contamination, and lower costs in the long run.

Key lessons: It is important to understand the barriers and motivations of the target population in order to design an effective behavior-change program that addresses their specific issues. A pre-program survey may be useful to choose which messages and interventions will resonate best with the target audience

5.2 General Household Toxics – Potential Intervention Strategies

Allaway, David. 2006. *Draft Background Research – Baseline A: Other HHW Data Sources*. Oregon: Department of Environmental Quality.

This summary of household hazardous waste data in Oregon primarily presents data from prior surveys. Most of the studies are either several years old or limited in geography (primarily Metro, as well as several individual counties). A few of the evaluation projects may be useful as potential models. *The Pollution Prevention Outreach Team – Motor Oil Project* (1995-1997) sent educational mailers and offers of free oil recycling containers to 4,000 households in the Portland area. A small survey of residents who received containers found that the percentage of households that recycle oil increased while improper disposal decreased; however, the survey had limited statistical validity.

Annual project reports from the *Garden of Natural Delights* contain surveys of participants who toured private yards and gardens to learn about natural gardening techniques. The post-tour survey report includes statistics on the number of participants (self-selected) reporting that they planned to adopt natural gardening practices as a result of the tour.

The *"Healthy Lawns, Healthy Families" Evaluation Survey* consists of a pre- and a post-campaign survey regarding weed-and-feed product use and awareness of a direct mail postcard and newspaper add. No further details were found in the summary.

Central Oregon's "From the Ground Up" Canvassing campaign also used pre- and post-intervention surveys. The surveys were designed to evaluate the impact of a behavior change program using community-based social marketing to encourage residents to reduce their outdoor water use and use of chemical pesticides and fertilizers.

Key lessons: Several household hazardous waste prevention projects, primarily addressing residential pesticide use, have been implemented around Oregon and could be used as models for future programs.

City of Peterborough, "We're Toxic Free" Campaign (Tools of Change website)

The City of Peterborough (east of Toronto) hired two students to canvass door-to-door in the summer of 1996 to encourage residents to participate in the "We're Toxic Free" campaign. Participants signed a pledge and received a kit with information on reducing and properly disposing of toxic products. The kits included fact sheets on alternatives, related health issues, potential environmental impacts, waste reduction, safer disposal methods, and contact names and numbers. Participating households also received "We're Toxic Free" stickers to display.

Participating households received follow-up phone calls one week and two months after receiving the kits. The program reached roughly 100 households, of which 50 agreed to participate. The campaign appear to result in little change in the purchase and disposal of lawn care, laundry, and cleaning products; however, participants were much more likely to dispose of their lawn care products at the hazardous waste depot. Participants also reported more favorable attitudes towards alternative cleaning products.

Key lessons: The program resulted in few changes in the purchase of hazardous household products. Program organizers felt that the vagueness of the program's pledge may have reduced results because it did not specify what behaviors to change. Other reasons may be that the households were approached "cold" by door-to-door canvassers and that contact between outreach workers and participants may have been limited.

Toronto Environmental Alliance, "The Toxic Challenge" (Tools of Change website)

The Toronto Environmental Alliance hired students to canvass door-to-door to tell residents about the health and environmental impacts of toxics, have residents score themselves on a toxics report card, and invite residents to participate in the Toxic Challenge by reducing or eliminating their use of toxics. Participating households received kits with information on the impacts of toxics and on non-toxic alternatives. Of the 5,809 households approached with this outreach strategy, 22 percent signed up for the Toxic Challenge.

Three months after signing up for the Toxic Challenge, one third of the 1,154 participating households were surveyed. Among those surveyed, respondents showed a sizeable decrease from their reported past use of toxic products to their expected future use of toxics, with an overall drop of 18 percent. Many participants reported having tried one or more alternative products:

- 72% had tried non-chlorine-based cleaners;
- 52% had tried alternatives to chemical herbicides; and
- 20% had tried alternative to insecticides.

Of those who had tried alternatives, 73% did not plan to return to using their toxic counterparts. The program also conducted a second follow-up survey two years later, which found disappointing results. In the long term, program participants did not purchase significantly fewer toxic products than did the control group. Of participants who had agreed to make changes, 40% did not remember their agreements. Those that remembered their pledges reported significantly greater use of alternatives, but without a corresponding decrease in the purchase of toxics. The program cost $37,000 (Canadian) in direct costs, with additional time and materials donated by volunteers from partner organizations.

Key lessons: The intervention, which involved cold calling, personal contact, an information kit, and a pledge, seems to have had a small effect in the short term. These results were not sustained over the long term, however, perhaps because no further contact or promotional efforts occurred.

Werner, Carol M. and Dorothy Adams. 2001. "Changing Homeowners' Behaviors Involving Toxic Household Chemicals: A Psychological, Multilevel Approach." *Analyses of Social Issues and Public Policy*. Pages 1-32.

Salt Lake County's education program used presentations and small group discussions to encourage proper storage and disposal of household chemicals as well as the use of non-toxic alternatives and chemical sharing to decrease purchases of toxic products. Program organizers used a psychological approach to developing their program and deliberately incorporated the following six components:

- "Address the individual's thoughts and memory processes with persuasive and memorable messages.
- "Include information about the behavior – how to be successful at it, and how to ground it in its physical and behavioral setting (the natural flow of events).
- "Suggest ways of making the physical environment more supportive of the new behavior.
- "Target or involve the local social milieu in which the individual and behavior are embedded.

- "Change the broader societal pressures and public information that informs the individual and social group.

- "Be sensitive to temporal qualities, such as short- and long-term aspects of change."

The presentations were run by trained leaders for roughly 25-person social groups. Church groups were a common audience, and other groups included high-school home economics classes, garden clubs, senior centers, and neighborhood centers. Each presentation began with a video from the health department providing basic information on HHW, the county's new disposal facility, and preventing HHW. The video was followed by a group discussion – rather than a formal presentation – about such topics as using nontoxic alternatives first, storing chemicals properly, protecting children, sharing leftover toxic products, and proper disposal. The goal of the group discussion was to encourage group members (friends and neighbors) to talk about their use of and successes with non-toxic products, in order to help other group members to feel that they could also use non-toxic alternatives successfully. The most popular parts of the program were the nontoxic cleaning recipes, the handouts, and the presenters.

Evaluation was conducted using an anonymous survey mailed to the primary contact in each social group after the presentation. Program organizers estimated that 33% of program participants changed their behavior, compared to 12% of the general population from publicity and general promotion alone. The evaluation did not include a "before" questionnaire for comparison with a pre-intervention baseline or any independently reported measures of behavior change. For example, the evaluation may not have considered the effect of the previous years of general promotion in laying the groundwork for the presentations. According to the authors, many people attended the presentations in order to obtain nontoxic cleaning recipes, which suggests that they were already interested in reducing their use of hazardous products.

Key lessons: Interactive programs with discussions for small groups seem to have yielded better results than traditional publicity and promotion activities. The preceding five years of advertising may have set the stage for behavior change.

Clark County, *"My Can is Hazard Free" Garbage Can Stickers* (Jim Mansfield, Clark County Public Works, personal communication November 28, 2006)

Five to seven years ago, Clark County distributed 85,000 stickers that read, "My can is hazard free" to residential garbage customers to encourage them to dispose of household hazardous waste properly. The stickers had a phone numbers that residents could call for information on hazardous waste disposal methods, and they came with a small card describing proper disposal methods. The stickers were mailed to all residential garbage customers in their garbage bills, reducing program costs. The project manager performed an informal evaluation by counting the number of garbage cans with stickers on them in selected areas, estimating that 25%-30% of households had put the stickers on their garbage can lids. Even five years after the program, some stickers appear to still be in use because the phone number is still receiving calls.

Key lessons: Using existing mailing systems (e.g., garbage bills) to distribute information and materials (e.g., stickers) can reduce program costs. Stickers appear to be durable and can remind customers not to dispose of hazardous waste in their garbage cans. Stickers can only convey a short message, however, and in this case they do not address the issue of HHW generation.

Blackmann, Anne Berlin and Jack Luskin. 2006. "A Community-based Initiative to Reduce Children's Exposure to Toxics in Household Products." *Health Education* 106(2):98-113.

Community health workers in Worcester, Massachusetts, received customized training regarding the impact of toxic household chemicals on children as well as strategies to reduce exposure.

The community health workers then performed outreach to Latino households through one-on-one home visits, group presentations, and booths at local events.

Successful aspects of the program were the messengers (community members), free product samples, and the messages used (e.g., health risks to children). Outreach workers felt that they could communicate their message effectively by discussing adverse reactions to toxic household products, risks to children, the cost and availability of alternatives, and personal experiences with using alternatives.

Challenges to behavior change included:

- Outreach workers had limited time to repeat the non-toxic message;
- The target audience had cultural expectations about what "clean" smells like, and many generally felt that "more is better" when using cleaning products; and
- Most clients did not generally read product labels.

A pre- and post-intervention survey suggests that the campaign had a modest effect on behavior, including reading labels, opening windows, and (somewhat) on using non-toxic or less-toxic alternatives. However, the program faced evaluation challenges, primarily because outreach workers did not fully understand the importance of data collection and did not like the original survey form. The program found that while home visits were very effective, they were not an efficient method to effect large-scale change. Accordingly, partway through the program, the community health workers shifted from home visits to group presentations.

Key lessons: First, one-on-one contact can be very effective at changing behavior, but is also highly time-consuming and expensive. The program organizers concluded that home visits are not appropriate for trying to implement large-scale change, hence the switch to presentations halfway through the program. Second, because the program was aimed at a minority population, a key aspect was using outreach workers from the same cultural affinity group as the target audience.

Tootelian, Dennis H. 2005. "A Local Jurisdiction Tool Kit: Outreach to Minority Communities on Used Oil and Household Hazardous Waste Programs." California State University Sacramento Foundation for California: California Integrated Waste Management Board (CIWMB).

Minority communities may need their own specifically tailored outreach efforts. This report discusses tools used by HHW programs in minority communities in California. Much of the information is specific to California, but results from a survey of HHW program staff could be relevant in Oregon as well. Survey respondents reported that the programs that work best (though it did not define this term or its supporting criteria) for minority communities are permanent collection facilities (28%), periodic collection facilities (24%), direct-mail pieces (22%), materials for the media (16%), non-sports promotions to the community (16%), and partnerships with others in the community (16%). Respondents also reported that the best communication methods are advertising (80%), printed materials in non-English languages (80%), and the telephone (60%). The paper also contains suggestions on creating marketing strategies, conducting community surveys, working with minority community groups, and performing evaluations, including sample questionnaires.

Key lessons: Outreach should include communication in non-English languages (as needed), partnering with community-based organizations, and otherwise tailoring programs to minority communities.

6. Evaluation Methods – Relevant Literature and Programs

Galvin, Dave. 2005. *Measuring Results from Outreach and Education Programs: A Critical Look at Case Studies.* Hazardous Waste Program Manager, King County Department of Natural Resources and Parks, Seattle, Wash. At the "Fourth National U.S. EPA Conference on Nonpoint Source and Stormwater Pollution Education Programs," held in Chicago, October 17-20, 2005.

A brief and unscientific review of nonpoint source education and outreach programs found that most programs do not measure results and impacts effectively, if at all. Programs that do measure behavior change rarely also measure the actual impact on the environment. For example, a pesticide reduction program may survey participants before and after intervention, finding that some percentage reduce or eliminate their use of pesticides, but the program may not measure (or be able to measure and link to behavior change) whether the local watershed is improved. Many outreach programs also do not use current theories or social marketing (summarized in the paper) to inform their strategies. This review suggests ways to improve both programs and evaluations and summarizes several case studies.

The most complete case study, by *Michael Dietz et al.*, is reviewed elsewhere in this literature review. An interesting finding is that the author said that although the educational intervention seemed somewhat promising, a Low-Impact Development (LID) subdivision is yielding better results even though those residents received no education or outreach. In the LID subdivision, resident behavior is not actively changed; rather, the environment in which they act is changed.

The *Stillhouse Spring Cleaning* project in Austin, Texas, has been encouraging residents to change their lawn care practices to reduce nitrate levels in the water, including by giving away slow-release fertilizer. Although 54% of residents say they have changed some aspect of their lawn care practices, nitrate levels have not been reduced.

In the *Twin Cities* area of Minnesota, outreach efforts to convince homeowners to use low- or non-phosphorus fertilizer had little effect on the watershed, while a subsequent ban on phosphorus-containing fertilizers yielded significant results. The ban likely would not have occurred, however, without the previous education efforts.

King County, Washington, saw a similar pattern in its efforts to reduce homeowner use of diazinon. Residents reported increased awareness and reductions in use (self-reported data, which may be biased toward over-reporting), but no real change in the watershed was evident until a federal ban took effect.

Useful general findings from this study include:

- "Increased awareness does not necessarily translate into behavior change";
- "Self-reported behavior change often does not translate on-the-ground";
- "Experiential programs appear to be more powerful than information campaigns"; and
- "Where education and outreach programs were not successful alone, they were essential to set the stage for regulations."

Key lessons: Outreach programs should develop a clear, coherent understanding of target audiences, behaviors, and desired outcomes. Programs should do pilot studies and gather data to document and measure the impacts of behavior change programs.

Bekarian, Nyree, Devon Payne-Sturges, *et al*. 2006. "Use of Point-of-Sale Data to Track Usage Patterns of Residential Pesticides: Methodology Development." *Environmental Health Journal* 5:15.

Researchers tracked the nationwide sales of products containing permethrin using a database that combined sales data, product codes, and U.S. Environmental Protection Agency data. This method offers a potential evaluation method that would not be subject, like a survey, to self-reporting bias. The study authors concluded that the method had potential as a tool to detect anomaliesin pesticide sales and to compare trends in sales between different active ingredients. However, this method also has several drawbacks. Sales data do not include all sales channels or retailers. For example, the data used for this study did not include lawn and garden stores or veterinary clinics. When a major mass merchant stopped reporting sales data midway through the study, the reported volume of sales decreased fourteen-fold. Although trends in total sales can be extrapolated, an extrapolation to total volume sold is not necessarily reliable. Sales data are also frequently reported on a regional or national level, making it difficult to track sales in an individual city or state. This study tracked sales of permethrin only, and obtaining sales data can be costly. A comprehensive pesticide-tracking database would need to track several active ingredients. It should also be updated regularly as new products enter the market and as consumer purchases shift from one ingredient to another due to regulations and restrictions.

Key lessons: Tracking the sales of products containing certain chemicals offers a clear, measurable (as opposed to self-reported) metric for evaluating behavior-change programs. Limitations of this methods include the cost of obtaining sales data as well as data gaps resulting from non-reporting retailers, changes in product formulations, and chemicals of concern listed as inactive (rather than active) ingredients.

Appendix C. Latex Paint Collection Analysis

This appendix presents the results of Cascadia's assessment of the potential tradeoffs associated with discontinuing the practice of accepting latex paint at DEQ-funded HHW collection events. As part of its HHW Priority Assessment project, DEQ contracted with Cascadia to research HHW programs conducted elsewhere and to develop a spreadsheet model to estimate program performance and costs associated with the practice of accepting or not accepting latex paint.

The appendix consists of seven sections and one attachment:

1. Overview of Key Findings
2. Introduction and Problem Statement
3. Methodology
4. General Findings from Program Reviews
5. Market Segmentation
6. Spreadsheet Model Analysis
7. Summary and Conclusions

Attachment 1: Review of Programs

1. Overview of Key Findings

The key findings that emerged from this study of latex paint collection at HHW programs within Oregon and elsewhere are as follows:

- Few programs were identified that do not accept latex paint.
- No programs were identified that allow for an "apples-to-apples" comparison of costs and performance of collection events that accept and do not accept latex paint.
- Among the programs that were identified where collection of latex paint had been discontinued, the change in participation and recovery varied widely from year to year and from event to event. This suggests that other variables, such as the frequency of events, maturity of the program, advertising, weather, location, and demographics were more important in affecting performance than whether or not latex paint was accepted.
- Limited data are available on how many people bring latex paint to events. These data, tracked by King County, Washington, and Portland's Metro, reveal that approximately 40% of participants (ranging from 23% to 42%) do not bring latex paint at all. About 10% (ranging from 6% to 19%) bring latex paint only, and 50% (ranging from 42% to 61%) bring both latex paint and non-latex HHW materials.
- Drawing on the available data and our experience with HHW programs, Cascadia's best estimate is that participation is likely to decline by 10% to 50% due to discontinuing latex collection, all other factors being equal.

- Our spreadsheet modeling analysis of DEQ's collection program suggests that if DEQ eliminates the collection of latex paint it could save up to 14% in program costs per pound of non-latex HHW collected, depending upon assumptions related to the decline in participation and operating cost savings. In the high loss leader (pessimistic) scenario, the estimated program cost per pound of non-latex HHW is roughly equal to the current cost.

- If these savings were reinvested in additional collection events, the net impact on collection of non-latex HHW would likely be minimal, with the possibility of an overall increase. In the low loss leader (optimistic) scenario, total HHW collection increased by 16%, when savings were reinvested in additional events. In the moderate loss leader scenario, total HHW collection increased by 11%. In the high loss leader scenario, collection remained roughly constant.[1]

2. Introduction and Problem Statement

Although most household hazardous waste (HHW) programs in Oregon and elsewhere collect latex paint, this type of paint is not particularly hazardous, and other options for safe disposal or reuse exist. It is expensive to collect latex paint through HHW programs, as the cost structure of those programs is designed to handle more hazardous materials such as pesticides and caustic household chemicals. The opportunity cost of collecting latex paint at these events is high: savings resulting from discontinuing its collection could be used to expand collection opportunities for more hazardous materials, for example. Consequently, DEQ is considering a change in its program to discontinue accepting latex paint.

There are, however, tradeoffs associated with making such a program change. Many HHW program managers believe that latex paint acts as a "loss leader," meaning that participation is greater and more HHW is collected at events that accept latex paint than at those that do not. The concern is that if DEQ stops accepting latex paint, then fewer people will come to collection events, less HHW will be collected and thus safely disposed, and the efficiency and performance of the collection events will decline. Other possible tradeoffs include an increase in the illegal dumping of paint in storm drains, improper disposal of liquid paint in the garbage, and, over the long term, increased risks to human health and the environment from HHW.

This assessment focuses primarily on the issue of HHW program performance in relation to latex paint collection. By examining experiences elsewhere and developing a spreadsheet model to analyze Oregon's collection program, this study seeks to answer four key questions:

1. If paint is no longer accepted at DEQ events, will participation at these events decline, and, if so, by how much? How much less non-latex HHW would likely be collected?

2. How much money could DEQ potentially save by not accepting latex paint?

3. If those savings were reinvested in additional events, how much new HHW could be collected?

4. What is the estimated net impact of stopping collection of latex paint and reinvesting in new events? Overall what is the likelihood that total pounds of HHW materials (excluding latex paint) collected annually would increase, decrease, or stay about the same?

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[1] Cascadia estimated three scenarios in which latex paint is considered to be a low, moderate, or high loss leader. If latex paint is a high loss leader, participation among people who bring both latex paint and other HHW will decline significantly – by 80% in our assumptions. If latex paint is a low loss leader, participation among this population will decline by a smaller percentage – 20% in our assumptions.

3. Methodology

The approach to conducting this study and answering the questions surrounding discontinuing latex paint collection consisted of three main activities:

1. **Examining programs in Oregon and elsewhere to obtain data on program performance and costs, both with and without latex paint collection.** Cascadia identified candidate programs through an internet search, using the Earth 911 database, and reviewing a previous study of HHW programs conducted for Metro. Few programs were found that do not accept latex paint. No programs were found that have a comparable "before" and "after" situation – that is, where programs stopped collecting latex paint; all other program elements remained the same; and authorities tracked all major aspects of program cost and performance. However, some before and after data are available from New York State, and the performance of programs in King and Pierce counties in Washington State were compared, where King County collects latex paint and Pierce County does not.[2] Also data exist from Oregon, where DEQ sponsored several events that did not accept latex. The performances of these events have been compared to the majority of DEQ's HHW collection events that do accept latex.

2. **Collecting and analyzing data from Oregon and programs elsewhere regarding participants and cost structures, including the portion of participants who bring latex paint and the costs associated with handling latex paint.** Data were obtained from DEQ on costs, quantities, and performance of the state-funded collection program for the last five years. Data were obtained from Metro and King County, Washington, on the percentage of participants who bring latex paint only, who bring both latex and non-latex HHW, and who bring only non-latex HHW.

3. **Developing a spreadsheet model to analyze Oregon's program and estimate program performance and costs with and without latex paint collection, using Oregon data and assumptions derived from the research.** This model used data from DEQ-funded events in 2005 and 2006 and evaluated three scenarios of the likely change in quantities collected, participation, and costs if latex paint were no longer accepted.

The lack of definitive data on comparable program performance with and without latex paint collection greatly affected the assessment, results, and conclusions of this study. This paper presents the findings from the program research, though many of these findings are inconclusive. The spreadsheet model consists of scenarios that provide a range of possible outcomes.

4. General Findings from Program Reviews

Cascadia conducted an extensive search for programs throughout the United States that might have useful data comparing performance with and without latex paint collection. We found few programs nationally that do not accept latex paint. There is some experience in Oregon and New York, as well as some comparative data from King and Pierce counties in Washington, that are informative but not directly relevant to this study. The overall finding from reviewing these programs is that participation and collection quantities vary significantly from year to year and program to program for a variety of reasons. Although collecting latex paint may affect participation and collection quantities, other factors seem to have an equal or greater influence.

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[2] King County is planning to discontinue accepting latex paint through its HHW programs effective 2008.

These factors include program service level (frequency and locations of events, other materials accepted), advertising, weather, program maturity, and the type of population served. See Attachment 1 for more details on the programs reviewed.

5. Market Segmentation – Participants Bringing Latex Paint

Cascadia's program reviews yielded one potential data source for estimating changes in participation: market segmentation data on the percentage of participants bringing latex paint. In determining the significance of discontinuing latex paint collection, it is important to understand how many of the customers who bring HHW to a collection event bring latex only, bring latex and other HHW, as well as how many do not bring latex at all. Accordingly, Cascadia examined data from King County, Washington (King County Wastemobile) and Metro in the Portland area (personal communications from Jim Quinn and David Allaway) to estimate these percentages, which might be similar to the participant behavior in Oregon (DEQ does not compile this information). These data which reveal that:

- An average of 38% (range: 23%-43%) of HHW participants in Metro and King County do not bring any latex paint.
- An average of 12% (range: 6%-19%) bring only latex paint.
- An average of 50% (range: 42%-61%) bring latex paint plus other materials.

The share of participants who bring latex is somewhat higher in Metro than in King County, likely because Metro actively advertises its latex paint recycling program. Consequently, events in other parts of Oregon may have a participant profile more similar to King County (which does not promote latex paint collection) than Metro.

Table 1. Percentage of Participants Bringing Latex Paint[3]

Program Location	Date	No Latex	Latex only	Latex + HHW
Metro South	July 2006	39%	19%	42%
Metro Central	July 2006	23%	16%	61%
Metro Satellite Events	2002-2004	43%	6%	50%
King County	2003	41%	9%	50%
King County	2004	42%	9%	49%
Average		**38%**	**12%**	**50%**

[3] Educators at the King County Wastemobile (which travels around the county to collect HHW) administered an on-site survey to participants in 2003 and 2004. Among other questions, the survey asked participants which materials they had brought to dispose at the Wastemobile. The survey was administered during a randomly-selected one-hour period on each day of operation. Although the survey collected self-reported information, self-reporting bias is not a concern for this data because the question is not value-laden and the answer could easily have been verified by Wastemobile staff. In 2003, 2356 visitors were surveyed. In 2004, 1860 visitors were surveyed.

Data for Metro South was collected by tracking waste deliveries by all 108 customers in a single day (July 18, 2006). Data for Metro Central was collected by tracking waste deliveries among the first 50 customers for each of two days. Data for Metro Satellite Events was collected through the Metro "long form" survey, completed by 558 participants at satellite collection events. Long form survey data may include some self-reporting problems.

6. Spreadsheet Model Analysis

Cascadia created a spreadsheet model to estimate the potential effects of discontinuing latex paint collection on the performance and cost of Oregon's HHW program. We used the model to develop three scenarios that differ primarily based on whether latex paint is considered to be a high, moderate, or low "loss leader." The high loss leader scenario assumes that latex paint is a very significant "loss leader" and that eliminating latex paint from DEQ collection events will lead to a steep drop in participation. The low loss leader scenario assumes that latex paint is a very limited "loss leader" and that eliminating latex paint from collection events will result in a much smaller drop in participation. The moderate scenario uses a mid-range assumption regarding the decline in participation.

The model does not assign probabilities to the scenarios but does allow us to understand the range of possible outcomes and to test the sensitivity of these outcomes to key variables. The model uses the "average event" as the primary unit of analysis and has been structured to allow for flexibility in incorporating the cost inputs and assumptions found during the program review phase.

The model uses data from Oregon's collection program as the reference point for the analysis. The participation levels, quantities recovered, and costs per event from 2005 and 2006 form the base of the analysis, although the "non-latex" event in Roseburg (2005) is excluded. Excluding Roseburg, DEQ sponsored eight events in 2005 and 2006. On average, 274 participants attended each event, bringing 26,269 pounds of non-latex HHW per event (95.8 lbs per participant), at a per-event cost of $34,621 (including latex collection). Latex paint was accepted at all these events. DEQ collected an average of 10,168 lbs of latex paint per event, or 28% of the total. Under DEQ's contract with MSE/Clean Harbors, the HHW event service provider, the cost to dispose of latex was $0.28/lb. The cost to dispose of all other HHW was calculated to be $0.59/lb.

The model calculates participation levels, cost, and the performance of DEQ's program with and without latex paint collection, based on a series of assumptions. The model estimates how much is saved by not collecting paint and then calculates how many additional events could be offered for the same budget with those savings reinvested and how much additional non-latex HHW could be collected as a result. The "before" and "after" estimates are then compared to see if the scenarios leave Oregon better off, worse off, or about the same, in terms of how much non-latex HHW is collected, relative to baseline quantities.

Model Inputs and Assumptions

The key inputs and assumptions modeled in this analysis are:

- The change in participation, as reflected by a percentage – how many fewer people will come to the average event (all other things equal) if DEQ discontinues latex paint collection?
- The disposal costs associated with latex paint and with non-latex HHW – what will be the disposal savings associated with not accepting latex paint?
- The operating costs (labor and equipment) associated with latex paint and non-latex HHW collection that would be saved if latex were not accepted.

Table 2 summarizes the model inputs and the assumptions used in the low loss leader, moderate loss leader, and high loss leader scenarios. A brief discussion of several of the key assumptions and how Cascadia derived values for each case is provided below.

Table 2. Model Inputs and Assumptions

	Input/Assumption	Low Loss Leader	Moderate Loss Leader	High Loss Leader
1	Baseline participants per event w/ latex		274	
2	Total % reduction in participants	20%	35%	50%
3	Pounds of non-latex HHW per HHW participant		106	
4	Baseline pounds of non-latex HHW per event		26,269	
5	Pounds of latex paint per event w/ latex		10,168	
6	Total cost per average event		$34,621	
7	Total average disposal cost per event		$18,399	
8	Average disposal cost for latex per lb		$0.28	
9	latex disposal costs		$2,847	
10	Average disposal cost for HHW per lb		$0.59	
11	non-latex HHW disposal costs		$15,552	
12	Total operating cost per average event		$16,222	
13	% of operating cost = labor cost		83%	
14	% labor cost associated with latex	16%	16%	16%
15	% reduction in non-latex labor cost	9%	18%	24%
16	% reduction in equipment cost	6%	10%	11%

Percent reduction in participants attending events where latex is not accepted (line 2)

Our assumptions for this key variable are derived from the King County and Metro information on 1) the percentage of customers who bring latex paint only, 2) the percentage who bring paint and HHW, and 3) the percentage who bring no latex. We used this information as a reference point, given that the data on comparable programs with and without latex collection were inconclusive.

- For all cases we assumed that in Oregon, 40% of participants bring no latex, 10% bring latex only, and 50% bring both. These numbers are slightly different from the actual averages: Cascadia weighted the King County data more heavily because events in other parts of Oregon may have a participant profile more like King County (which does not promote latex paint collection) than like Metro (which promotes latex collection).

- For all cases, we assumed that 100% of participants who historically brought only latex paint do not come to future “no-latex” events. We also assumed that participants who historically brought no latex paint would not be impacted by this possible change, but would continue to participate as before.

- For the low loss leader scenario, we assume that 20% of people who brought both latex and non-latex HHW would stop participating. This yields an overall decline in participation of 20%. For the moderate and high loss leader scenarios, we assume that 50% and 80% of them, respectively, would stop participating. This yields an overall decline in participation of 35% for the moderate scenario and 50% for the high loss leader scenario.

Pounds of non-latex HHW brought by participants (line 3)

The information from program reviews reflected a wide range in the pounds of HHW brought to an event per participant. However, it was not feasible to ascribe a change in non-latex quantities per participant as a function of whether or not latex paint is accepted. Therefore, we assumed no change in quantities brought per participant in any of the scenarios.

Labor as a percent of operating costs (line 15)

Oregon's data on the costs of its collection program are divided into two categories: "disposal" cost and "labor and equipment" cost. For this analysis, we needed to determine labor costs separate from equipment costs. A review of invoices for the eight DEQ events held in 2005 and 2006 found that labor costs (including travel time, mileage and per-diem) averaged 83% of this category. This assumption is applied to all three scenarios.

Percent of labor costs that are specific to handling latex paint (line 16)

Another key cost variable is the percent of labor costs that are specific to handling latex paint and that, therefore, would be eliminated if the paint were not accepted. Again, there is a high level of uncertainty around this assumption, and as a result, several ways to derive an estimate. For this analysis we assume that 16% of labor costs are associated with managing latex paint. Put differently, the model assumes that discontinuing acceptance of latex paint will reduce total labor costs by 16%.

This result is derived by assuming that the labor cost per pound for latex paint is half of the labor cost for other HHW. Labor costs for managing latex paint at DEQ events include unloading the paint from vehicles, identifying it, and packing it into larger containers. This work is primarily conducted by lower-paid hazardous waste technicians. Higher-paid staff (event supervisor, chemist, specialists) are not as involved. Further, paint tends to be delivered in larger quantities per package. Also, latex paint is not "bulked" at DEQ events, and so the amount of time required to manage latex may be less than for other wastes. All of these factors combine to suggest that the labor cost per pound of latex paint will be less than other wastes. Assuming that the labor cost per pound is 50% as much as other wastes results in a modeling assumption that 16% of labor costs are associated with managing latex paint. By comparison, latex paint comprises 28% of the total mass of materials shipped from DEQ events.

It is important to note that accurate data on this variable do not exist, so this modeling assumption must be understood to be only an estimate that might be verified through additional research, an RFP process, or field testing and would, in any case, vary from event to event.

Reduction in labor costs due to decreased participation (line 17)

A key assumption built into the modeling is the extent to which DEQ can reduce labor costs if events have a smaller number of participants (and less waste) resulting from discontinuing the collection of latex paint. We have already accounted for the estimate of labor cost savings specifically associated with handling latex paint (line 16). But, in addition, DEQ may be able to scale back operating costs because fewer people participate in the events and less non-latex HHW is being collected.

- In the low loss leader scenario, it is assumed that non-latex HHW labor costs are reduced by 9%. A savings of 16% is already attributed to latex, so the total labor savings is 25%. This compares to a 20% reduction in the number of vehicles and a 36% reduction in the total mass of HHW handled.

- In the moderate scenario, it is assumed that non-latex HHW labor costs are reduced by 18% for a total labor savings of 34%. This compares to a 35% reduction in vehicles and a 48% reduction in total mass of HHW handled.

- In the high loss leader scenario, it is assumed that non-latex HHW labor costs are reduced by 24% for a total labor savings of 40%. This compares to a 50% reduction in vehicles and a 60% reduction in total mass of HHW handled.

These assumed labor savings were derived using several different methods and sets of assumptions. Uncertainty in this modeling assumption is incorporated into the three scenarios. To keep the discussion simple and limit the number of modeling outputs, Cascadia has assigned to the low loss leader scenario modeling assumptions that maximize potential savings. This can be thought of as an "optimistic" approach, where relatively little loss of non-latex HHW is coupled with relatively large labor savings. Similarly modeling assumptions that minimize potential savings have been assigned to the high loss leader scenario. This corresponds to a "pessimistic" approach, where significant quantities of non-latex HHW are lost and less optimistic labor savings (relative to reduced participation and HHW) are modeled. Intermediate assumptions regarding potential savings have been assigned to the moderate case. This approach widens the range of modeled cost per pound of HHW collected.

Reduction in equipment costs due to decreased participation

A final assumption is the extent to which DEQ can reduce equipment costs if events have a smaller number of participants. To estimate this factor, invoiced equipment costs for events in 2005 and 2006 were reviewed. Costs in two categories – set-up charges and tents – were adjusted downward based on modeled changes in vehicle counts. For each scenario, the new assumed costs for all eight events (with reduced participation) were compared against actual invoiced costs for actual events. Equipment cost savings are estimated to range from 6% for the low loss leader scenario to 11% for the high loss leader scenario. Cost savings in this category are much lower than reductions in vehicle counts or quantity of waste collected, as costs are dominated by set-up charges (under the current contract, savings are only realized if projected participation falls below 700, 500, or 100 participants, with no savings for other reductions) and the supply delivery truck (which is billed as a function of miles traveled).

Spreadsheet Model Results

Table 3 and Table 4 summarize the results of the analysis of the impact of discontinuing collection of latex paint on cost and performance. Table 3 presents results for the low loss leader, moderate, and high loss leader scenarios in which no latex is accepted compared to the 2005-2006 actual program averages. Results include the estimated number of participants per event, pounds of non-latex HHW and of latex paint collected per event, and the average costs per event and per pound of non-latex HHW. Note that although the average savings per event is much higher in the high loss leader scenario, that result is due to the steeper decline in participation than in the low loss leader scenario and is accompanied by a similarly steep decline in the quantity of non-latex HHW collected.

A better way to compare the different scenarios is to compare the total cost (including disposal, labor, and equipment) per pound of non-latex HHW collected. In 2005-2006, the average cost was $1.32 per pound. The cost is lower in each of the scenarios where latex is not collected. The average cost per pound is $1.13 in the low loss leader scenario, $1.19 in the moderate scenario, and $1.31 in the high loss leader scenario.

Another way to compare results to estimate how many pounds of non-latex HHW could be collected for DEQ's available budget. According to Oregon's HHW management plan for 2005-

2011, DEQ expects to spend an average of $200,000 in each of the next two biennia.[4] Starting with this hypothetical budget, we can estimate how many events could be held over two years and how many pounds of HHW could be collected. If DEQ were to continue collecting latex, it could hold roughly six events and collect 152,000 pounds of non-latex HHW. If DEQ were to stop collecting latex, it could hold roughly eight events in the low loss leader scenario and collect 177,000 pounds of HHW. In the high loss leader scenario DEQ could hold ten events but would collect only 152,000 pounds of HHW. In all three scenarios, DEQ could collect the same or more non-latex HHW for a given budget if it did not collect latex.

Table 4 shows this before and after comparison in more detail. In the high loss leader scenario, DEQ could collect roughly the same amount of HHW, while in the low loss leader scenario DEQ could collect 16% more non-latex HHW.

Table 3. Results for the Average Event with Latex Paint Collection Discontinued

	2005-2006 Average*	Low Loss Leader	Moderate Loss Leader	High Loss Leader
# of participants per event	274	219	178	137
Pounds of non-latex HHW per event	26,269	23,350	18,972	14,594
Pounds of latex paint accepted	10,168	0	0	0
Total cost savings per event		$8,192	$11,996	$15,468
Average cost per event	$34,621	$26,428	$22,625	$19,153
Total cost per lb of HHW	$1.32	$1.13	$1.19	$1.31
# of events per $200,000	6	8	9	10
Total lbs of HHW collected for $200,000	151,753	176,707	167,711	152,395

*Excluding Roseburg, which was promoted as a “no-latex” event.

Table 4. Before/After Comparison Table

	Pounds of HHW collected for $200,000	Difference	%
No Program Change	151,753		
Low Loss Leader	176,707	24,954	16%
Moderate Loss Leader	167,711	15,958	11%
High Loss Leader	152,395	642	0%

[4] Note that this budget is hypothetical; actual funds available for events are a function of spending on other activities, some of which is not known with certainty at this point in time.

7. Summary and Conclusions

The review of HHW programs and scenario analysis suggest that if DEQ were to stop collecting latex at collection events:

- Each collection event could experience an estimated 10% to 50% drop in attendance; however, total program participation could actually increase if the savings in the cost per event were used to hold additional events.

- The overall cost to collect non-latex HHW could decrease from $1.32 per pound to between $1.13 and $1.31, depending on input assumptions.

- The average cost per event could decrease by $8,200 to $15,500 for a total biannual program savings of $50,000 to $90,000 (assuming an event budget of $200,000 per biennium and no additional events held).

- Total non-latex HHW collection could increase by 16% in the low loss leader scenario, increase by 11% in the moderate scenario, or remain roughly constant in the high loss leader scenario, if the program savings were reinvested in additional events.

The review of other HHW programs found the effects of not collecting latex are uncertain and that other variables (e.g., maturity of HHW program, advertising, weather) may have as much or more impact on program participation and collection quantities.

Our conclusion from this analysis and a review of programs elsewhere is that **the downside risks of discontinuing collection are limited and that these risks are outweighed by the potential upside benefits**. Our analysis shows that the impact on program performance could be fairly minor, with the strong possibility that DEQ could increase collection by holding more events with the dollars saved by not collecting latex paint. This would improve service in areas without locally-funded events by reducing the time between events. Alternatively, DEQ could use the savings to promote its existing events more effectively or better educate Oregon citizens about alternatives, proper use, and safe handling of products containing HHW.

One final caveat is that this assessment did not address the response of DEQ's customers if DEQ stops accepting latex paint. Some citizens will likely be disgruntled and may complain to their elected officials or improperly dispose of latex paint. Alternative disposal methods will need to be offered and promoted. Given political considerations, these alternatives might need to be comparable or better in terms of cost and convenience – and so some investment by DEQ will likely be required in managing latex paint, even if it is not handled through the HHW collection program infrastructure.

The bottom line is that discontinuing latex collection is likely to have limited, if any, negative long-term consequences on DEQ's HHW program. Doing so could provide benefits, by allowing DEQ to collect more non-latex HHW at more events and focus its resources on materials that pose greater risks to human health and environmental quality.

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Attachment 1: Review of Program Performance with and without Latex Paint Collection

Cascadia conducted an extensive search for programs throughout the United States that might have useful data comparing performance with and without latex paint collection. We found few programs nationally that do not accept latex paint. There is some experience in Oregon and New York, as well as some comparative data from King and Pierce counties in Washington. The overall finding from reviewing these programs is that participation and collection quantities vary significantly from year to year and program to program for a variety of reasons. Although collecting latex paint may affect participation and collection quantities, other factors seem to have an equal or greater influence. These factors include program service level (frequency and locations of events, other materials accepted), advertising, weather, program maturity, and the type of population served. The programs reviewed are discussed in more detail below.

Oregon DEQ

DEQ has held four events since 1999 that did not collect latex: Salem in 1999, Lincoln City in 2004 and Roseburg in 2003 and 2005. According to an analysis by David Allaway (Oregon DEQ, 2005), while participation was lower at the "no latex" events, it is likely that only a portion of this decline was due to not collecting latex. Three of the "no latex" events were held in the autumn, when events tend to have lower participation rates independent of the inclusion or exclusion of latex paint.

Data from the Salem and Lincoln City events are inconclusive, although for different reasons. The 1999 event in Salem was the only event in that city funded by DEQ, and so there are no data from events including latex to compare it against. In Lincoln City, the 2004 event had much lower participation (134 vehicles) than DEQ's one other event held in Lincoln City (382 vehicles in 1994, plus an additional 208 vehicles at a "paint only" event), however the 2004 event was marked by a severe rainstorm which is believed to have significantly depressed participation.

The two "no-latex" events in Roseburg averaged 315 participants, while the three previous HHW events in Roseburg (1994, 1999, and 2001) averaged 488 participants. Thus, the two "no-latex" events experienced 35% lower participation than the three "all waste" events held in Roseburg to date.

Wasco, Hood River, and Sherman Counties, OR

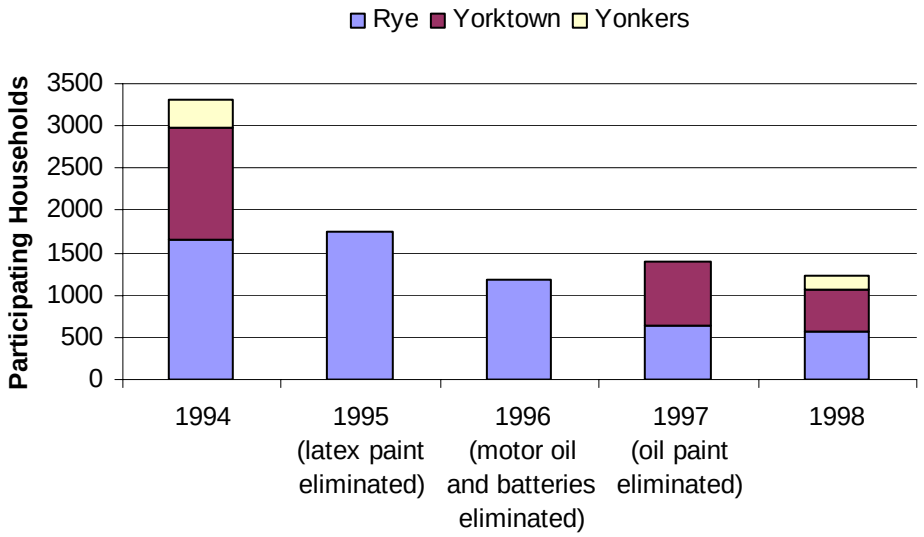
In the last six months of 2006, Wasco, Hood River, and Sherman Counties began offering locally-sponsored HHW collection events. These events do not accept latex paint, in contrast to 17 events provided by DEQ in these counties between 1991 and 2002. Because of differences in how the events were scheduled and promoted, a direct comparison of participation rates between DEQ- and locally-sponsored events is inappropriate. However, it is useful to note that over its first eight events, which served a combined total of 443 vehicles, compliance with the "no-latex" instructions has been quite good. Staff report having turned away no more than 60 cans of latex paint (or about 360 pounds, assuming the cans average half-full; this equates to 1% of all waste, compared to historic DEQ events in this area where latex represented 26% of all waste). Collections of non-latex HHW have not significantly changed, averaging 65 pounds per vehicle for DEQ's events in the tri-county area, and 74 pounds per vehicle during the locally-sponsored events.

Westchester County, NY

Westchester County, New York, has had a Household Chemical Clean-up Day program since 1985. Originally, Westchester collected both hazardous and non-hazardous materials, but in 1994, it began eliminating several materials from the program (personal communication Marianne Petronella and Peter Costa, 2006). In 1995, Westchester ceased accepting latex paint. While this would seem to offer a valuable test case, the program underwent many other changes at the same time. In 1995, the management of the program changed hands, and the program was downsized from three events (one small and two large ones) annually to a single large event. Then in subsequent years the program was expanded again, increasing to at least three events annually. At the same time, Westchester County began to reduce the number of other materials accepted (by excluding oil paint, motor oil, and car and non-rechargeable batteries), introducing yet another variable into the picture.

As one might expect, data from 1994 and 1995 provide an unclear picture of the impact of discontinuing the collection of latex paint. The total program participation dropped from 3,304 households to 1,757, but much of that may be due to the elimination of two of the three events, both a large and a small one. Examining only the one event that was continued, participation increased slightly from 1,646 to 1,757; however, some of those participants may have previously attended the canceled large event (held 30 miles away) or the small event (held 20 miles away). In 1998, all three events were again held, serving 1,224 participants, many fewer than in 1994. Participation that year may have been lower because oil-based paint, car and non-rechargeable batteries, and motor oil were also not accepted in addition to paint. See Figure 1.

Figure 1. Participation at Westchester County, NY HHW Events, 1994-1998



New York State

A New York State HHW program report (New York State Department of Environmental Conservation, 2000) that contains participation and collection quantity data from collection events and permanent facilities between 1995 and 1999 provide another opportunity to compare programs with and without latex paint collection. This report compared participation levels and

quantities collected at events that reported collecting latex and at events that reported collecting no latex. Analysis of these data shows great variability across years, however, making it difficult to draw definitive conclusions about the impact of latex paint collection on program performance.

Table 5 summarizes the relevant participation data from the New York study. We use the participation rate rather than the number of participant to remove bias that would be caused if one type of event served a greater population. For example, in 1996 and 1998, the potential population served by events not accepting latex was roughly equal to the potential population served by events accepting latex. In 1997 the non-latex events served a population more than two times larger than the latex events did, while in 1999 non-latex events served a population that was one third smaller.

As shown in Table 5, the average participation rate at events that did not accept latex was lower than the participation rate at events accepting latex for four of the five years studied. Nonetheless, it fluctuated widely from year to year ranging from between 0.55% to 0.81% for events that accept latex and from between 0.23% to 0.59% for events that did not accept latex. This variability in participation is difficult to explain – the low participation levels overall may be an important factor – but it suggests that whether or not latex paint is accepted may be less important than other factors, such as location, weather, marketing, and the type of population served.

Table 5. HHW Program Participation Rates in New York State

New York State	1995	1996	1997	1998	1999
Programs that collect latex	0.55%	0.61%	0.67%	0.81%	0.73%
Programs that do not collect latex	0.59%	0.37%	0.41%	0.23%	0.44%
Percentage difference	**7%**	**-66%**	**-63%**	**-272%**	**-67%**

Comparing program quantities in New York is complicated by the fact that New York programs do not report a single number for the total amount of HHW they collect. Rather, they report a weight in pounds for the solid materials and a volume in gallons for the liquids, which have been extrapolated from reports on the number of drums (of varying sizes) that were filled at the events. Nonetheless, variation can also be seen in the quantities of non-latex HHW materials collected per person (Table 6 and Table 7).

Events that did not accept latex collected anywhere from 37% more to 43% less liquid non-latex HHW per participant than events that accepted latex. Estimated gallons per participant ranged from 5.5 to 8.4 for events that collected latex and from 5.0 to 11.8 for events that did not. (See Table 6.) Although events that did not accept latex consistently collected more solid HHW per participant than events that accepted latex (ranging from 4% to 24% more), the total number of pounds collected per person fluctuated from year to year from a low of 5.9 pounds in 1996 to a high of 15.1 pounds in 1998 at no-latex events. (See Table 7.)

Table 6. Gallons of Liquid Non-Latex HHW Collected Per Participant in New York State

New York State	1995	1996	1997	1998	1999
Programs that collect latex	5.5	7.1	8.4	7.5	8.0
Programs that do not collect latex	8.4	5.0	7.3	11.8	10.6
Percentage difference	**34%**	**-43%**	**-15%**	**37%**	**24%**

Table 7. Pounds of Solid HHW Collected Per Participant in New York State

New York State	1995	1996	1997	1998	1999
Programs that collect latex	5.0	5.0	6.2	14.6	9.3
Programs that do not collect latex	6.6	5.9	6.8	15.1	10.9
Percentage difference	**24%**	**16%**	**9%**	**4%**	**15%**

According to Gus Ravera at the New York State Department of Environmental Conservation, Division of Solid and Hazardous Materials, participation and collection quantities can vary significantly with maturity (mature programs tend to have lower participation and collection rates), financial ability (e.g., in advertising, holding bigger events), proximity to paint recyclers (mainly located in Canada), and hazardous waste awareness levels of residents and solid waste haulers.

King and Pierce Counties, Washington

Similar data on participation and quantities collected are available from two counties in Washington State: King County, which currently collects latex paint, and Pierce County, which does not. Pierce County's participation rate is roughly 65-70% lower than King County's (City of Tacoma Public Works; King County LHWMP, 2003, 2004, and 2005). However, King County has a significantly larger collection program, which usually results in increased participation. Pierce County has one permanent facility and two to five collection events per year, ranging from three to six days each in length. King County has three permanent sites, the Wastemobile (which provides approximately 95 collection days per year), and approximately 45 city-sponsored events annually. Thus the difference in participation is most likely explained by varying levels of service than by differing policies on latex paint collection.

Looking at the data on materials per participant, it is not clear that there is a difference between Pierce and King County residents; however, for two out of the three years compared, Pierce County residents brought significantly more materials per person than King County residents. The differences could be explained if Pierce County residents wait longer to dispose HHW than King County residents because of the decreased level of service: they would, thus, be expected to store more materials (increasing quantities collected per participant) but dispose less frequently (reducing participation rates).

Table 8. Participation Rates and Non-Latex HHW Quantities Collected in King and Pierce Counties, Washington

Pierce County	**2003**	**2004**	**2005**
Number of Participants	8,772	10,336	9,889
Total materials collected (lbs)	723,059	756,927	425,869
Population served (OFM)	733,700	744,000	755,900
Participation Rate	1.20%	1.39%	1.31%
Materials per participant (pounds)	82	73	43
King County			
Number of Participants	69,500	72,000	76,761
Pounds collected*	3,900,000	3,660,000	5,641,400
Population served (OFM)	1,779,300	1,788,300	1,808,300
Participation rate	3.9%	4.0%	4.2%
Materials per participant (pounds)	38	38	73
Comparison			
Decline in participation rate	**69%**	**65%**	**69%**
Decline in materials per participant	**-117%**	**-93%**	**41%**