Managing Household Hazardous Waste in Oregon

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

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Prepared by

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At **Cascadia Consulting Group**, Christy Shelton served as project manager; Peter Erickson led the development of the Product Ranking Tool, the Geography Ranking Tool, and this report; Jessica Branom-Zwick conducted literature reviews, interviews, and other research; and Marc Daudon provided strategic input at key junctures.

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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 consituuent 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 Chemi	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.

[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:

- The results of the tool should be reviewed and assessed qualitatively, 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.

- Substance concentration and availability in products has not been systematically assessed. 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.

- Substance degradation or breakdown products are not fully accounted for in the model. 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

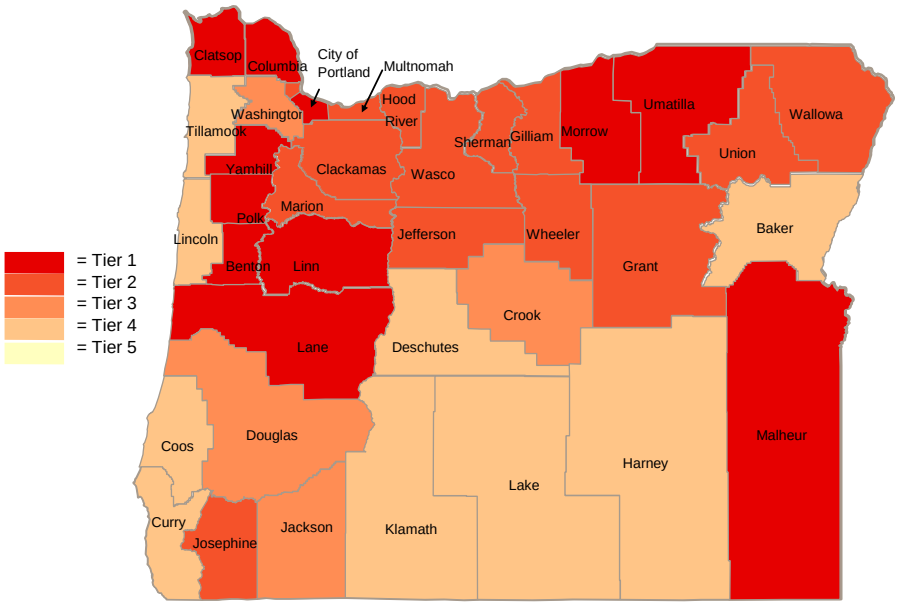
SECONDARY (SUB) CRITERIA

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



*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

[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.