Preliminary Evaluation of Pesticides Used by the City of Seattle

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The Approach in Context

These notes describe the approach taken for a preliminary assessment of pesticides used by the City of Seattle. The purpose of this assessment is to prioritize candidates for phaseout in order to meet the City's desire to reduce pesticide use. The tiered lists generated as a product of this assessment can only be correctly interpreted with an understanding of the approach and methodology that was used.

It has become clear after working with the list of pesticides provided by the City that a single step assessment will be insufficient. The list was too large for a highly detailed analysis at the beginning. While some elements of exposure analysis will likely have to come into play at some point, it would be prohibitively expensive to do that for all of the products on the list. Therefore, a second assessment step, as described in the recommendations at the end of this report, is suggested for some products.

This initial screeing is not, nor should it be, a risk assessment. Risk assessments require an enormous amount of information and analysis in order to estimate exposure and quantify risk. Risk assessments are only able to estimate risk subject to considerable uncertainties arising from incomplete toxicology data and current limitations in their ability to model the effect of exposures to many chemicals at one time. Thus, even though a risk assessment may be able to deliver a quantifiable result, there immediately arise valid questions about the precision, accuracy, and relevance of that number.

This report describes an initial cataloguing and hazard characterization. It identifies potential hazards of the products and may also characterize the degree of hazard (e.g. low, medium, or high) or the certainty of the hazard (possible, probable, or known). This hazard assessment identifies, for example, if a product contains a possible carcinogen (cancer-causing ingredient). A risk assessment would include cancer potency, estimated exposure levels, and other factors in order to estimate risk, i.e. number of cancers per million exposures. Whereas a risk assessment seeks to determine the likelihood of a given set of outcomes in a particular population, a hazard assessment can help decide if a chemical is appropriate for use under a given set of criteria. It is possible to decide as a matter of principle not to use any products containing known or probable carcinogens without seeking to determine exactly how many cancers might occur as a result of continuing to use the products.

It must be emphasized that this initial screening considered for the most part only active ingredients in the products. Active ingredients in pesticide products are those that are directly responsible for the pesticidal action. Active ingredients in the products were obtained from product labels. Other ingredients (so-called "inert" ingredients) are not

usually listed on labels and are frequently considered proprietary information despite the fact that they may be toxic or otherwise hazardous. Although some hazardous inert ingredients are listed on MSDSs, all inert ingredients could not be identified in most products. Although a court ruled in 1996[21] that the identity of inert ingredients in pesticide formulations must be available to the public, the information is not disclosed on product labels and a process for obtaining this information in a timely manner has not yet been established. Thus, while an assessment of inert ingredients would be desirable, it has not been possible at this time. For this reason, hazards of inert ingredients were not evaluated unless included in parameters that relate to the full product formulation, such as product toxicity category or signal word. Only the active ingredients could be screened against lists of carcinogens, reproductive toxicants, and endocrine disruptors. In addition, only active ingredients were evaluated for persistence and mobility in soil.

Procedure

A list of pesticides used was provided by the City. This list consisted of several parts containing a total of well over 200 products. Some of the product names were incomplete or duplicative. Apparent duplicate products were removed and additional information was requested on products with incomplete names. Some of the products were not pesticides, but rather pesticide adjuvants or fertilizers. Those products will not be covered in this report. A few products were added for evaluation as potential alternatives for some uses.

Whenever possible, a product label and Material Safety Data Sheet (MSDS) were obtained for each product. For many products, labels and MSDSs were downloaded from manufacturers' Internet web sites. If labels were not available electronically, they were obtained from the US EPA's Pesticide Product Label System CD-ROM[1]. Additional MSDSs were downloaded from various Internet sites. In many cases, more than one product is registered with a particular name. The US EPA's Office of Pesticide Programs registration database[2] was used to match product names and registration numbers in order to pinpoint the correct products to evaluate. In a few cases where exact product matches were not found, the evaluation was performed on similar products for which more complete information was available. In the end, some product registration numbers could not be identified and some product labels could not be found within the time available. If necessary, additional effort could be made later to resolve these issues if the products in question are used in quantities that would justify the effort.

A final list of approximately 220 products was entered into an Excel spreadsheet for analysis. A second spreadsheet was used to record properties of ingredients.

Parameters and Sources of Information

A variety of product and/or ingredient attributes were collected so that the City would be able to use the information against different screening criteria in the future. The parameters used in this analysis are as follows:

Hazard Category (full product):

Each pesticide product registered by EPA is assigned a hazard category I, II, III, or IV by the Agency based on characteristics of the full product formulation, including acute toxicity, and skin and eye irritation. In evaluating the acute data, EPA assigns the hazard category based on the greatest hazard, i.e. ingestion, inhalation, skin absorption, eye irritation, etc. A relatively non-toxic product (via ingestion, inhalation, or skin absorption) could be placed in the highest hazard category merely on the basis of extreme eye irritation. Products in category I are most hazardous and bear the signal word DANGER on their labels. Those in category II are labeled WARNING. Both category III and IV products are labeled with CAUTION. Product category was determined from label signal words, and category III and IV products were not distinguished from each other.

Restricted Use Pesticides:
Some pesticides are restricted to use only by certified pesticide applicators and are not available to the general public because of high toxicity, particularly hazardous ingredients, or environmental hazards. Pesticides designed as restricted use are indicated as such in this analysis. Sources of information included product labels and EPA's list of restricted use pesticides.[3]

Dioxin-containing Ingredients:
The City requested that the product list be screened for those that would pose disposal difficulty due to the presence of dioxin contamination. The criterion used for identifying potential dioxin-containing waste was the EPA waste designation F027: "Discarded unused formulations containing tri-, tetra-, or pentachlorophenol or discarded unused formulations containing compounds derived from these chlorophenols...does not include formulations containing hexachlorophene synthesized from prepurified 2,4,5-trichlorphenol as the sole component." No products on the list met this criterion.

Persistent, Bioaccumulative Toxic Chemicals (PBTs): (active ingredients only)
At the request of the City, the list of products was compared to two lists of chemicals designated as persistent, bioaccumulative, and toxic. The first is an initial list of 12 chemicals proposed by EPA as a priority list.[18] No products contained active ingredients on this list. The second list is the list of 27 PBTs proposed by the Washington State Department of Ecology as candidates for elimination in the state.[19] Two chemicals on this list (endosulfan and trifluralin) were found in a total of four products.

"P" Chemical Products on state Dangerous Waste List: (active ingredients only)
The product list was screened against the state of Washington Dangerous Waste Regulations list of "P" discarded chemical products list.[17] Products with a listed chemical as the sole active ingredient are indicated in the product tables. Only four ingredients in products on the list met this criterion: dimethoate, disulfoton, endosulfan, and oxamyl.

Carcinogens (active ingredients only):
Various state, federal, and international organizations evaluate or list chemicals for carcinogenicity. Due to the expense and difficulty of such evaluations, not all agencies have reviewed the same chemicals and not all reach the same conclusions on a given chemical. For this reason, we have presented the ratings of several agencies whenever possible. Those agencies and their categories are as follows:

US EPA[4]

Old system:

- Group A - Human carcinogen
- Group B - Probable human carcinogen
  - B1 - Indicates limited human evidence
  - B2 - Indicates sufficient evidence in animals, inadequate or no evidence in humans
- Group C - Possible human carcinogen
- Group D - Not classifiable
- Group E - Evidence of noncarcinogenicity for humans

New system (weight of evidence categories):

- Known/Likely
- Likely
- Cannot be Determined
- Not Likely

State of California[5]

No categories; single list of chemicals entitled “known to the State of California to cause cancer.”

National Toxicology Program (NTP)[6]

Known to be human carcinogens

Reasonably anticipated to be human carcinogens

International Agency for Research on Cancer (IARC)[7]

Group 1 - carcinogenic to humans

Group 2A - probably carcinogenic to humans

Group 2B - possibly carcinogenic to humans

Group 3 - not classifiable as to its carcinogenicity

Group 4 - probably not carcinogenic to humans

Carcinogenicity information was obtained by screening active ingredients against the above lists. Although MSDSs do indicate listing of ingredients by some of these agencies, the information may not be current or complete. In the tables that accompany these notes, a blank cell in the carcinogenicity columns indicates that the agency has no listing for the chemical. It does not mean that the agency has determined that the chemical is not carcinogenic. The case of conflicting results from different agencies could be a problem in principle, but for the chemicals considered here there were few such conflicts. There were cases where one agency found a chemical to be a possible carcinogen, while another found it to be not classifiable. In such a case, which is not really a conflict, the finding of possible carcinogenicity is the one that would trigger the tier rating as the criteria are written. In the one case of an actual conflict (piperonyl butoxide), the single product where that compound was the only suspected carcinogen was marked as conflicting evidence.

Reproductive/Developmental Toxicants (active ingredients only):
Active ingredients in the products were screened against the State of California lists of reproductive and developmental toxicants[5]. Blank cells indicate that the compound is not listed.

Neuro-acting Pesticides: (active ingredients only):
Chemicals that act primarily via the central nervous system are indicated in this column by type of chemical. The fact that a chemical has this mode of action does not mean that products containing it should be considered neurotoxic in the sense that any exposure would cause nerve damage or even nervous system effects. The usual dose and threshold concepts would apply. However, these groups of chemicals should be considered carefully in terms of worker exposure and exposure of the general public, particularly children, pregnant women, the elderly, the chemically sensitive, and other highly susceptible populations.

The main chemical classes identified as neuro-acting are organophosphates, carbamates, pyrethroids (synthetic pyrethrins), and pyrethrins. In addition there were several organochlorines, one chlorinated nicotinyl, and metaldehyde, which affects the nervous system but not as its principal mode of action. Although this information was collected, it was not used in the sample set of criteria provided for screening products into tiers. As it happens, most products with neuro-acting active ingredients were placed in Tier 1 because of at least one other sample criterion. This class of pesticides tends to have fairly broad ecotoxicity, being generally non-selective with respect to beneficial insects and often being quite toxic to birds and aquatic species as well. This lack of selectivity is perhaps the strongest reason to phase out or curtail the use of as many of these products as possible and to substitute more selective control methods where they are appropriate and available. It should be noted that the pyrethrins have the advantage (from a toxicology point of view) of very short residual life, a factor which helps to reduce both human and wildlife exposure.

Endocrine Disruptors: (active ingredients only)
Considerable attention has focused in recent years on the ability of certain chemicals to mimic or block the effects of hormones in humans and other wildlife. Because of the similarity of the endocrine system across many species, its critical role in development and reproduction, and its extreme sensitivity to very low levels of hormone-like compounds, there is the potential for endocrine disrupting substances in the environment to adversely affect wildlife and humans. Although the science is relatively new and in many cases highly controversial, considerable evidence of effects in wildlife and some evidence in humans has caused many scientists to warn of potential dangers from exposure to endocrine disrupting chemicals. Under the Food Quality Protection Act, the EPA is required to screen pesticide ingredients for endocrine system effects. Until that screening is done, a comprehensive list of endocrine disruptors will not be available. For purposes of this analysis, we used the list of endocrine disruptors compiled by the State of Illinois Environmental Protection Agency. Chemicals on this list are classified as known, probable, or suspected of causing endocrine system effects[8].

Ecotoxicity: (active ingredients only)
For purposes of this initial review, information on toxicity to non-target wildlife species was deduced primarily from required precautionary statements on product labels.[9] While these statements were not specifically designed for making comparisons between products, there are several reasons why this approach was taken:
1) As described below, the label warning language follows a hierarchy that is based on the toxicity of the active ingredient and field observations.
2) The product label is the primary document that describes the precautions required to use the product in a legal manner. It is the document that every product user should have in their possession and read before using the product.
3) The product label is the quickest source of information based on a uniform standard.
4) This screening does not consider chronic exposures. While it would be desirable to obtain additional ecotoxicity information in the form of appropriate LD50s, LC50s, and NOELs (no effect levels) or LOELs (lowest observed effect levels), not all Material Safety Data Sheets contain this information, and not all documents that offer some of this

information present data for the same species. In addition, the information available may be for active ingredients only and not the full product formulation. Therefore, to pursue the approach of gathering and comparing detailed toxicity values was judged to be beyond the scope of what could be done within the time and budget limits of this evaluation. This level of investigation should occur in the level two toxicology assessment for a reduced number of products.

Toxicity to Birds:

According to EPA regulations,[9] the required label warnings for avian toxicity are derived in the following manner:

* Products labeled as "**toxic to birds**" contain an active ingredient with an avian acute oral LD50 of 100 mg/kg or less or a subacute dietary LC50 of 500 ppm or less.
* Products labeled as "**extremely toxic to birds**" have been shown by accident history or field studies that they may result in fatality to birds**.**

Additional data for active ingredients was taken from *the Farm Chemicals Handbook* [10] and EXTOXNET[11], an Internet web site maintained by cooperative extension in a number of states. Ingredients were classified according to the following scale:

Toxicity Category	Bird acute oral LD50 (mg/kg)
Practically non-toxic (PNT)	>2000.
Slightly toxic (ST)	501-2000
Moderately toxic (MT)	51-500
Highly toxic (HT)	10-50
Very highly toxic (VHT)	<10

This additional information on active ingredient toxicity was not used in any ranking criteria, but was gathered to see if label warnings were consistent with toxicity of the ingredients.

Toxicity to Aquatic Organisms:

According to EPA regulations, the required label warnings for aquatic toxicity are derived in the following manner:

* Products labeled as "**toxic to fish**" contain an active ingredient with a fish acute LC50 of 1 ppm or less.
* Products labeled as "**extremely toxic to fish**" have been shown by accident history or field studies that they may result in fatality to fish**.**

Additional data for active ingredients was taken from *the Farm Chemicals Handbook* and EXTOXNET. Ingredients were classified according to the following scale:

Toxicity Category	Aquatic LC50 (ppm)
Practically non-toxic (PNT)	>100
Slightly toxic (ST)	10-100
Moderately toxic (MT)	1-10

Highly toxic (HT)	0.1-1
Very highly toxic (VHT)	<0.1

This additional information on active ingredient toxicity was not used in any ranking criteria, but was gathered to see if label warnings were consistent with toxicity of the ingredients.

Toxicity to Bees:

According to EPA regulations, the required label warnings for bee toxicity are derived in the following manner:

Honey Bee Toxicity Groups and Cautions

Toxicity Group	Precautionary Statement if Extended Residual Toxicity is Displayed	Precautionary Statement if Extended Residual Toxicity is not Displayed
I Product contains any active ingredient with acute LD50 of 2 μg/bee or less	This product is highly toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds if bees are visiting the treatment area.	This product is highly toxic to bees exposed to direct treatment on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area.
II Product contains any active ingredient(s) with acute LD50 of greater than 2 μg/bee but less than 11 μg /bee.	This product is toxic to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product if bees are visiting the treatment area.	This product is toxic to bees exposed to direct treatment. Do not apply this product while bees are actively visiting the treatment area.
III All others.	No bee caution required	No bee caution required.

Additional data was evaluated for the active ingredients as a supplemental source. Data for active ingredients was taken from *the Farm Chemicals Handbook* and EXTOXNET. Ingredients were classified according to the following scale:

Toxicity category	Meaning
Practically non-toxic (PNT)	Relatively nontoxic. Can be used with few precautions with minimum injury to bees.
Moderately toxic (MT)	Kills bees if applied over them. Can be used with limited danger to bees if not applied over bees in the field or hives.

	Correct dosage, timing, and method of application are essential.
Highly toxic (HT)	Kills on contact during application and for one or more days after.

This additional information on active ingredient toxicity was not used in any ranking criteria, but was gathered to see if label warnings were consistent with toxicity of the ingredients.

Toxicity to other Wildlife or Domestic Animals:
According to EPA regulations, the required label warnings for wildlife toxicity are derived in the following manner:
* Products labeled as "**toxic to wildlife**" contain an active ingredient with an mammalian acute oral LD50 of 100 mg/kg or less..
* Products labeled as "**extremely toxic to wildlife**" have been shown by accident history or field studies that they may result in fatality to wildlife**.**

In addition, certain products carry label warnings about hazards to domestic animals or secondary hazards to particular species. For example, rat poison may pose a secondary hazards to birds of prey. Such warnings were taken as an indication of the presence of hazards to wildlife as well.

Persistence (active ingredients only):
The environmental persistence of compounds varies widely depending on many factors. In addition to the inherent degradability of the compound itself, persistence is affected by where the compound is found (soil, water, air, leaf surface), temperature, moisture, amount of organic matter present, and so on. We chose as a standard measure of persistence the halflife in average soil, disregarding halflives in other media and in extreme soil types. This number, measured in days, is the amount of time required for the concentration of the chemical to decrease by one-half. For consistency, data were taken from the Oregon State University Extension Pesticide Properties Database,[12] the Agricultural Research Service/US Department of Agriculture Pesticide Properties Database,[13] or the Hazardous Substances Databank,[14] in that priority order.

Pesticides are classified as non-persistent, moderately persistent, or persistent based on their halflives.[12] Those classifications are as follows:

Non-persistent	<30 days
Moderately persistent	30-100 days
Persistent	>100 days

In the cases of ingredients which are minerals, biodegradation of the metals does not occur, although the valence state may change, new compounds may be formed, or materials may be washed from the soil or taken up by plants. For minerals, the notation NA indicates not applicable. Halflives were found for most, but not all, ingredients.

When thinking conceptually about degradation of pesticides, it is important to remember that after one halflife, half of the chemical remains. If the decay follows first order kinetics, another halflife would be required before the residue reaches 1/4 of the original. To decrease by one order of magnitude (a factor of 10), more than three halflives are required. So even a pesticide considered non-persistent could remain in average soil at levels of around 10% of the applied concentration for as much as three months.

A final important issue relating to persistence is the presence of breakdown metabolites that may pose hazards in themselves. When one looks at the halflife and other attributes of the parent compound, it is easy to disregard the fact that as this compound disappears, other compounds may be forming that may be more toxic, persistent, or more mobile than the parent compound. These compounds can be overlooked in studies that are not specifically looking for them. No attempt was made in this assessment to look systematically for hazardous breakdown products for each active ingredient. However, in the course of looking at the environmental fate (persistence and mobility) data, it became apparent that in at least several cases major metabolites possess one or more properties that should not be ignored in evaluating the parent compound. The compounds identified thus far are the following:

Parent Compound	**Metabolite**	**Concern**
acephate	methamidophos	Metabolite is about 40 times more toxic than parent as measured by oral rat LD50[11]
daminozide	unsymmetrical dimethyl hydrazine (UDMH)	Also a probable carcinogen[4,5,6,7]
dichlobenil	2,6-dichlorobenzamide	More persistent, more soluble, more mobile, detected in ground-water[20]
malathion	malaoxon	1000 times more potent cholinesterase inhibitor, more persistent, slightly more mobile[14]
mancozeb	ethylene thiourea (ETU)	Also a probable carcinogen[4,5,6,7]
metaldehyde	acetaldehyde	Probable carcinogen[4,5,6,7]

Water Pollution Hazard (active ingredients only):
The potential for ground-water or surface-water pollution by pesticides is dependent on many factors, including persistence of the ingredients, water solubility, soil binding, amount of rainfall or irrigation, soil properties, amount and frequency of applications, soil slope, vegetation present, proximity to ground- or surface-water, etc. The parameters

considered below are those that relate strictly to the pesticide itself. In use, the water pollution risk can often be mitigated by product choices based on site-specific factors. Generally the risk is reduced when soil quality is high, vegetation is dense, and water is distant. The parameters discussed below can be used to identify the products with the highest inherent risk characteristics.

Leaching Potential

The Ground-water Ubiquity Score (GUS) is an empirically derived index that relates pesticide persistence and soil binding to mobility. GUS can be used to rank pesticides for their potential to move toward groundwater. [12] The GUS index is defined mathematically as follows:

$$GUS = \log_{10}(\text{halflife}) \times [4 - \log_{10}(\text{Koc})]$$

where Koc is the soil sorption coefficient and halflife is the soil halflife in days. GUS values for typical pesticides range from a low of about -6 to a high of about 7. A pesticide movement rating ranging from "extremely low" to "very high" has been assigned to the numerical values by the researchers in the OSU Extension Pesticide Properties Database.[12] The values are as follows:

GUS value	Pesticide Movement Rating
<0.1	extremely low
0.1 - 1.0	very low
1.0 - 2.0	low
2.0 - 3.0	moderate
3.0 - 4.0	high
> 4.0	very high

The GUS index was found for most, but not all, active ingredients in the OSU Database. When it was not found, it was calculated from the halflife and soil binding coefficient, if those were available. In a few cases, even though the GUS index could not be found or calculated due to data gaps, qualitative information on soil binding or mobility was identified in either EXTOXNET or the Hazardous Substances Databank.

In addition to the GUS index, information on pesticide movement potential was noted from product label warnings about the leachability of the products and/or the detection of such or similar chemicals in ground-water. EPA requires two levels of warnings for products with characteristics determined to result in likely contamination of ground-water from use as labeled.[9] A lower level of warning is required if no actual detections have occurred or no field studies have been done. A higher level of warning is required if detections have occurred or field studies have shown that the chemical leaches. For purposes of this initial screening, the presence of either warning was considered an indication that the chemical has high mobility. This approach was most consistent with the use of the GUS index, which does not indicate actual detections in ground-water or below a certain soil depth. In rare cases where a label ground-water advisory occurs but the GUS index did not indicate high mobility (e.g. glufosinate ammonium), the label advisory was given priority.

Runoff Potential

The potential of a pesticide to run off from the application site with applied (rain or irrigation) water is strongly influenced by its solubility in water and its soil binding. There are two main mechanisms whereby a pesticide can run off: dissolved in water or

bound to soil particles. The properties which govern these processes are quite different. A pesticide that binds to soil can run off when the soil particles themselves are washed or eroded away. Products with high risk for this type of runoff have high soil binding, generally considered a desirable property because it prevents movement of the chemicals through or away from the soil. It is my judgment that this type of runoff is best prevented by site-specific factors or by avoiding pesticides entirely rather than by product selection, since the products that have low risk for movement with soil particles are generally those with high risk for groundwater pollution. If erosion is occurring at the site, no pesticide will stay put. For this reason, no parameter was included to evaluate pesticide runoff via adsorption to soil. Although a "runoff potential" is listed in worksheet 2 of the Excel workbook that accompanies these notes, that information was not used because it appears to take account only of this one type of runoff mechanism and was judged of little value in this assessment for the reasons discussed above.

The other type of runoff scenario does lend itself more reasonably to product comparisons. If a pesticide is highly soluble in water but has poor soil binding, it has potential to move with applied water. If that water is tending to move laterally over or through the top layers of soil, the pesticide will move with it. Products at risk for runoff in water would tend to have high solubility, low soil binding, and a long halflife. Most pesticides that have high solubility also have low soil binding[15], so for those products the low soil binding itself is an indication of the potential for both ground-water and surface-water hazard and the GUS index should be a reasonable index of hazard for both processes. The important exception to be considered is products with both high binding and high solubility or low binding and low solubility. The former group will have low GUS values, the latter high GUS values. Some products with low GUS values, considered low risk for ground-water, may pose a higher risk for surface water runoff if their solubility is high. On the other hand, some products with high GUS values, considered high risk for leaching, may be less prone to runoff because they do not dissolve in water. I have so far identified no standard benchmarks for making decisions in these cases, but if the City intends to continue using any pesticides near surface water or storm drains, a good GUS score should not automatically indicate low probability for runoff. Other factors must be considered, such as product solubility, application method (i.e. spray, wipe on, etc.), application rate and frequency, application timing, and site conditions that allow substantial water runoff or soil erosion from treated areas. Poor soil, high slope, and absence of vegetation are all risk factors for runoff.

Initial Ranking by Tiers

The City requested that all products on the list be classified into one of three tiers: products that should be highest priority for phasing out, those of moderate concern that might be used only under certain conditions, and those of lower concern that might be considered usable tools in an IPM framework. A set of sample criteria was written following the model provided in the form of a discussion draft. A proposed ranking follows in Tables 1-4, based on the test criteria below. A final determination will require finalization of the City's criteria for ranking pesticides. The factors influencing the tier assignments are shown in the tables so that products can easily be reassigned when

changes are made to the criteria. As noted earlier, the pesticides must still undergo use and alternatives analysis.

Tier Definitions
Tier 1: Highest concern, highest priority for phaseout
Tier 2: Moderate concern, second priority
Tier 3: Lowest concern
Tier 4: Insufficient information available to assign to above tiers

Tier 1: (Any of the following are true) (All ingredients should be identified so that they can be screened using these tests)

* Products in Hazard Category I: Signal word DANGER
* Restricted use pesticides (except aquatic herbicides#)
* Products that cannot be disposed of because of dioxin contamination
* Products with active ingredient on the state list of acutely dangerous wastes (P list)
* Products with known, likely, or probable carcinogens as active ingredients
* Products with reproductive toxicants as active ingredients (CA Prop 65 list)
* Products with known or probable endocrine disruptors as active ingredients
* Products labeled as highly toxic or extremely toxic to birds, aquatic species, bees, or wildlife. (exceptions for products used only indoors; exception to bee toxicity will be needed for products intended to control bees, wasps, or hornets, possible BMP needed)
* Products with active ingredients with soil halflives greater than 100 days (possible exception for products used only indoors)
* Products with active ingredients with mobility ratings high or very high or with specific label warnings about groundwater hazard. (possible exception for products used only indoors)

#Note: aquatic herbicides are not included in this criterion because all aquatic applications in the state are restricted because of the need for a permit rather than because of particular properties of the chemicals involved. Aquatic herbicides could be included here, and if so, should be added via a separate criterion.

Tier 2:

* All products not specifically assigned to tier 1 or tier 3.

Tier 3: (All of the following are true) (All ingredients should be identified so that they can be screened using these tests)

* Product contains no possible or probable carcinogens
* Product contains no reproductive toxicants (CA Prop 65 list)
* Product contains no ingredients listed by Illinois EPA as known, probable, or suspect endocrine disruptors
* Active ingredient has soil halflife of 30 days or less (exception for minerals)
* Active ingredient has extremely low or very low mobility in soils. (possible exception for indoor products)

* Product is not labeled as toxic to fish, birds, bees, wildlife, or domestic animals.

Tier 4: Not enough information.

Product registration or label not found

or

Key data not located for active ingredient (halflife, soil binding, ecotoxicity, etc.)

Discussion

All of the products analyzed were registered by EPA and were legal to use in accordance with the label at the time they were purchased. The City has determined that it wishes to reduce pesticide use, indicating that it desires to curtail or cease the use of certain products that it could legally use. In essence, the City wishes to set a higher standard than EPA registration as a basis for its pesticide use. There are many good reasons for doing so, not the least of which is bringing the City's own practices into accord with those that it recommends to its residents. Detection of a wide variety of pesticides in Puget Sound streams,[22,23] in some cases at levels exceeding chronic safety standards for aquatic life, has focused attention on the need to find and eliminate the sources of contamination. Preliminary research has begun to draw connections between pesticide levels in surface-water and pesticide sales.[23] The recent listing of salmon under the Endangered Species Act underscores the urgency of removing anthropogenic stresses on aquatic species. Recent research in the San Francisco Bay Area has shown that runoff of diazinon from only a few homes in a watershed is sufficient to raise diazinon levels in streams to levels that threaten some aquatic species.[24] The study further demonstrated that the contamination can occur even if the products are used scrupulously as directed on the label. These results lend support to the idea that some products need to be eliminated from use, not merely reduced.

Within the context of an integrated pest management program, choices of which control methods to use are based on many factors, including product hazards, label restrictions, effectiveness, site-specific factors, and available alternatives. The work reported here can be used to compare certain product attributes to screen products for desirability of use. It should be reiterated that actual risk from using products depends on many factors, some of which are not product dependent, such as weather, site conditions, application rates, and so on.

Nearly every chemical product (with a few exceptions) scores poorly in at least one parameter recorded in this analysis. For example, the Tier 1 lists (115 products) contained:

* 25 products with known, likely, or probable carcinogens (mostly fungicides)
* 20 products with known or probable endocrine disruptors
* 14 products with persistent ingredients (mostly herbicides and fungicides)
* 24 products with predicted high or very high soil mobility (mostly herbicides)
* 27 products labeled as highly toxic or extremely toxic to birds, fish, bees, or wildlife (mostly insecticides and molluscicides)

The decisions as to which products to use and which to discontinue requires applying a set of criteria over the hazard matrix to group the products into tiers. Only one set of

criteria is offered here as an example. This particular set of criteria happens to screen many products into Tier I, those products of highest concern. Many of the products in Tier 1 were placed there because of only one of the criteria (not always the same one). Clearly, the choice of criteria is critical. I have indicated in the ranking criteria some cases where exceptions would seem to make sense. However, these products should be looked at carefully in the context of their uses to determine applicability of the criteria. Products for which elimination is not practical should undergo the second level of review to ensure that they are the best choice for the circumstances, that use will be as low as possible, and that all possible safety precautions will be applied.

Recommendations

1. The enclosed set of screening criteria is proposed as a starting point that identifies important issues of concern that can be used as a basis for prioritizing products for phaseout, restrictions, or further review. This screening should be considered as preliminary. A second stage of toxicity review and exposure evaluation is suggested for any products that fall into Tier 1 or 2 but which the City would like to consider continuing to use after the use and alternatives analysis. (Details of how this would work are presented at the end of this section). The City should make its own decision, with public input, as to which of the screening criteria should be considered pass/fail for all products.

2. The City should use the ranking charts from the preliminary screening with the following understanding:

a) Blank cells can mean that tests have not been done or other information is unavailable.
b) Some criteria may be found not to apply to products (including those in Tier 1) after uses are analyzed.
c) Placement of a product in Tier 2 or even Tier 3 does not mean that the product is necessarily safe. In addition, concerns raised by the presence of unknown, so-called “inert” ingredients should be addressed (see point #3 below).

3. The City should require knowledge of all ingredients in any products they continue to use. These additional “inert” (non-active) ingredients should then be screened against the same lists as the active ingredients, as shown in the flow chart. Without this information, it is impossible to do a valid scientific review. A recent study of poor salmon returns in Canada[16] hypothesizes that the culprit may be an inert ingredient (nonylphenol) in pesticides applied over the watershed. If this hypothesis is proven, the situation would illustrate very clearly the importance of non-active ingredients in environmental safety. It would be fruitless to select products for salmon protection without knowing the identity of toxic inert ingredients that have produced toxic effects in salmon. In other words, you can rule out a product without knowing all ingredients, but you cannot with certainty rule it in.

4. The sheer volume of products used by the City, many for the same apparent purpose, reveals the need to reduce duplication and try to standardize usage. One area where this seemed most striking was in the array of products used for controlling bees, wasps, and

hornets, presumably in the vicinity of utility meters or other similar sites. If it is determined that chemical use needs to continue for this purpose, it would be desirable to settle on the least hazardous formulation and to standardize that product or similar products city-wide. Unfortunately, I have not yet been able to adequately compare these products because of the lack of complete data for several pyrethroids widely used as active ingredients. There is need for followup work in this area.

5. The City must establish criteria that define the “need” for a pesticide based on reasonable thresholds in the IPM framework. The City should consider input from the public in establishing these need criteria. If it is eventually determined from the use/alternatives analysis that certain products will be retained for limited uses, reductions might be obtained through best management practices that clearly limit and define the uses that will be allowed. However, if comparison of new BMPs to actual current uses shows little reduction potential, the City will not have achieved its goals.

6. As new products are introduced, the City will want to do ongoing evaluations to determine if these products are acceptable or not. A considerable fraction of the time required in doing this assessment was spent gathering product labels and other information. Regardless of whether such evaluations are done in-house or by a consultant, the City can save time and money by providing product labels and MSDSs to the person or persons doing the evaluation. Additional product information such as product brochures, toxicology reports, etc. should also be collected as products are considered.

7. While it would be tempting to use actual detections in surface-water or ground-water as a criterion for ranking products, I have not followed this approach because of the time required to acquire the data and because the presence of chemicals in water is a lagging indicator of both use and product properties. The City may well decide to use the results of recent surface-water testing to phase out widely found contaminants such as 2,4-D, MCPP, dicamba, and dichlobenil, or those found to exceed chronic aquatic standards, such as diazinon, carbaryl, chlorpyrifos, and malathion. However, it is critical to remember that some of the ingredients in other products are not detected either because they are not widely enough used or because the studies have not looked for them. If the science indicates that these chemicals are highly persistent and/or mobile, then continuing to use them (or especially increasing use of them) likely will result in their being found in water at a later time.

8. The time and budget allotted for this evaluation were far too small for a complete review of more than 200 products with approximately 100 active ingredients. New products continued to come in throughout the evaluation process. While I have made every effort to be accurate and have reviewed virtually every cell in the spreadsheets for errors, under the level of pressure imposed by this work the probably of mistakes in data entry or consistency inevitably goes up. In addition, I have been unable, within the time allowed, to locate adequate data on roughly 16 of the active ingredients. I suggest that the data gathered here, especially the tiered list of products, be considered preliminary and subject to revision and expansion as the process proceeds.

9. Finally, the City is to be commended for embarking on this important process. The City should remain committed to reducing pesticide use and persistent in reaching that goal. It would be tempting to take the easy way out and to maintain the *status quo* without trying hard to demonstrate leadership by challenging assumptions and finding wisdom and experience both inside and outside the local area. The Endangered Species Act listing should tell us that we cannot continue as we have been. But it's more than just salmon. We must also protect our residents, our workers, and our air, land, and water.

Proposal for Additional Toxicology and Exposure Evaluation

The diagram on the next page shows how the proposed two levels of screening would fit into the full evaluation process with its use and alternatives analyses.

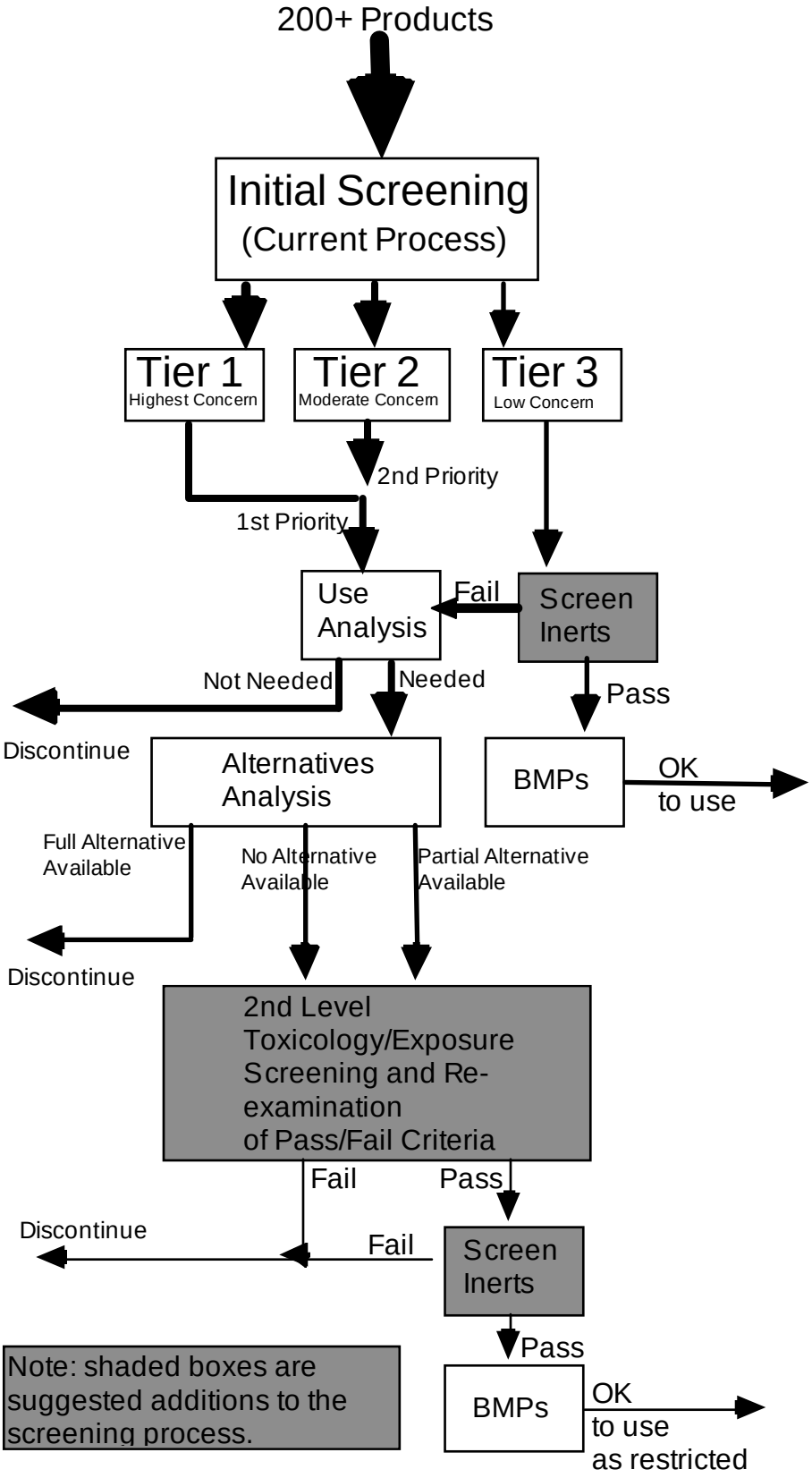
1. The initial stage catalogues the products used and identifies a number of potential hazards such as acute toxicity or irritation potential, carcinogens, reproductive toxicants, endocrine disruptors, persistent chemicals, highly mobile chemicals, and chemicals that contain ingredients toxic to non-target organisms. The screening net at this stage must be quite wide-mouthed and fine meshed, so that all the important issues are picked up. For example, if a product is persistent (has a halflife over 100 days), that can have major implications for exposure potential and for mobility. The product needs to be flagged for that possibility. Later it may be found that the concerns about persistence are not likely to result in high exposure (e.g. used only in areas inaccessible to the public or wildlife) or mobility (e.g. very high soil binding and minimal solubility in water). On the other hand, if biological or mechanical methods are available that can control the problem, the chemical may be eliminated as unnecessary. Alternatively, if another chemical is available that has a much shorter halflife and is less toxic, the choice can be made to use it instead of the original chemical. Whatever the outcome, the initial flagging of the persistence allowed this decision to be made in a reasoned manner.

2. The screening criteria are used to generate lists (Tier 1, Tier 2, Tier 3) based on concerns raised about product characteristics. That has been done at this point. (A Tier 4 list was also generated, containing products for which more information is needed before screening can take place.)

3. The Tier 1 list (highest concern) is then examined for product uses, perceived need for the product, the availability of alternatives, and cost of implementing the alternatives. At this point, many products may be found to be obsolete, unnecessary, duplicative, and inappropriate for some uses. Those products can be discarded (through appropriate hazardous waste disposal channels!) and eliminated from further consideration. In addition, an examination and reassessment of pest and weed tolerances should provide additional opportunities to eliminate some products. A similar look should then be given to Tier 2.

4. Products that groundskeepers feel they must continue using or for which there are no apparent viable alternatives will then need to be looked at further. At this point the City

should revisit the preliminary criteria to decide which of these should eliminate products absolutely and without exception. I suggest that many, if not most, of them should be. A precautionary approach to worker safety, public safety, and environmental protection will send an important philosophical message and set a good example for the public. Criteria that are deemed not applicable for particular product uses, such as toxicity to birds for products used only indoors, can be dropped for those products. At the same time, the


200+ Products
Initial Screening
(Current Process)
Tier 1
Highest Concern
Tier 2
Moderate Concern
Tier 3
Low Concern
2nd Priority
1st Priority
Use Analysis
Fail
Screen Inerts
Not Needed
Needed
Pass
Discontinue
Alternatives Analysis
BMPs
OK to use
Full Alternative Available
No Alternative Available
Partial Alternative Available
Discontinue
2nd Level Toxicology/Exposure Screening and Re-examination of Pass/Fail Criteria
Fail
Pass
Discontinue
Fail
Screen Inerts
Pass
BMPs
OK to use as restricted
Note: shaded boxes are suggested additions to the screening process.

highest standard of safety should be adopted for parks or other areas where small children are present. By this time, the initial list will have been pared down to a considerable extent.

5. Any products that have not been eliminated will pass to the next stage. At this point, product uses can be examined to see the potential for human exposure, proximity to water, and other factors that will affect health and environmental impacts. It may be necessary (as is mentioned at several points in these notes) to gather further information on product toxicity so that comparisons can be made between products that might be used for the same purpose. Factors like application rates and frequency of application will be factored in at this point. It is critical that these decisions not be made simply on the basis of an LD50 (acute oral toxicity) and an application rate. A range of parameters will have to be considered here, including chronic as well as acute toxicity. This step is not a risk assessment in the classical sense, but rather an informed comparison of product hazards, likelihood of exposures or other adverse impacts, appropriateness of products for use at the particular sites, ways of mitigating these impacts, and ways to minimize product use.

6. For products that are still in the running at this point, best management practices should be written to ensure that products will be used in such a way to minimize harm and to promote use reduction. A comparison of BMPs to current usage and a followup evaluation of pesticide use after one or two years should be done to ensure that reductions in use are actually occurring. If they are not, further possible cuts identified in the foregoing analysis should be implemented. Finally, all products that will be used should be screened for “inert” ingredients that fail the criteria. This issue will be discussed in more detail later.

This process may seem lengthy, but it is certain to be less time consuming than a complete toxicological analysis of every product at the beginning. In addition, it is more likely to satisfy the needs of the landscape managers and crews.

Tables with Tier Assignments

Table 1. Herbicides (found on sheet #3 of Excel file)

Table 2. Insecticides (found on sheet #5 of Excel file)

Table 3. Fungicides (found on sheet #6 of Excel file)

Table 4. Other Products (found on sheet #7 of Excel file)

Key to abbreviations used on tables:
Restr: indicates restricted use pesticide
Signal: label signal word (Danger = Category I; Warning = Category II; Caution = Category III/IV)
Cancer: listing of carcinogenic active ingredients (see text for explanation of individual agency cancer categories)
Repro: listing of reproductive toxicants by State of California
Neuro: indicates active ingredient affects the nervous system
(organophosphate (OP), carbamate (carbam), organochlorine (OCl), pyrethrin (pyrn), pyrethroid (pyrd))
Endo: Known, Probable, or Suspect endocrine disruptor as listed by State of Illinois EPA
Pers: soil halflife in days
Mobil: soil mobility based on GUS index (see text)
Bird: label warnings of toxicity to birds
Fish: label warnings of toxicity to fish
Bee: label warnings of toxicity to bees
Wild: label warnings of toxicity to wildlife

Note: raw data are found on spreadsheets #1 (products) and #2 (ingredients).

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