Clean House, Clean Air: Pollution Prevention in Professional Housecleaning

Evaluation Report

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Preface

This Report is part of an **Environmental Justice Through Pollution Prevention** project supported by U.S. E.P.A. Region IX, called "Healthy Work, Healthy Homes".

The "Healthy Work, Healthy Homes" project establishes and expands eco-friendly housecleaning cooperatives in the San Francisco Bay Area, evaluates pollution prevention opportunities through professional housecleaning, and has published the bi-lingual (English-Spanish) *"Housecleaner's Guide to Eco-Friendly Cleaning"* which provides an occupational safety and environmental health context for eco-friendly cleaning, and offers a screening tool for professional housecleaning product selection.

The "Healthy Work, Healthy Homes" project is organized by WAGES (Women's Action to Gain Economic Security), a non-profit 501(c)3 economic development organization located in Oakland, California. WAGES assists low-income women to become more economically stable through business cooperative ownership. Founded in l994, WAGES has established several eco-friendly housecleaning cooperatives in the Bay Area, and has disseminated information about cooperative development and eco-friendly housecleaning nationally.

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1.0 Introduction

Throughout the years, air quality research has focused on global issues such as the environmental and health effects of greenhouse gases and the depletion of the ozone layer. Public perception, too, has focused on the health hazards associated with global warming, unauthorized hazardous waste disposal sites or large point sources of air pollution, such as factories. Recent studies, however, indicate that indoor sources of pollution represent a much higher public health hazard[1].

Studies estimate that Californians spend 80-90% of their time indoors, thus magnifying their exposure to chemicals contained in household products[2]. Household cleaning chemicals widely used by professional housecleaning companies that contain hazardous materials form one of the source categories for indoor pollution. Moreover, as large point sources of chemical releases become controlled, non-point chemical releases make up a greater percentage of the remaining chemical load to the environment. After usage, the hazardous materials in household cleaning products eventually enter the environment as sources that are unregulated and that cannot be traced back to the emitters. These untraceable hazardous materials are defined as non-point sources as they enter the environment via municipal wastewater or through air release.

Household cleaning products directly expose the public to hazardous materials. For example, aerosol sprays may remain suspended in breathing areas or absorbed into rugs and carpets only to be released into the air again. Residues from bathroom tile cleaners may dissolve in shower steam to enter airways as a gas or vapor. All purpose surface cleaners can leave residues on cooking and eating surfaces and kitchenware. According to the Environmental Protection Agency (EPA), the chemicals used in the home make the indoor air we breathe 2-5 times and sometimes 100 times more toxic than outdoor air[3].

The hazardous substances found in most commercial cleaning products, such as heavy metals, petrochemicals, chlorine and volatile organic compounds, resist break down into non-toxic forms. When discharged into municipal wastewater, hazardous chemicals found in cleaning products receive conventional wastewater treatment that is mostly designed to treat biological waste. In the case of the San Francisco Bay Area, most treated wastewaters are discharged into the Bay where these toxic cleaning products affect the aquatic life and the public.

Professional housecleaners that use toxic household cleaning products are directly exposed to hazardous materials. Many of these hazardous products are recognized or suspected carcinogens and many are believed to have the potential of causing birth defects, reproductive and developmental disorders. Many of the products used in the home are corrosive to the eyes and skin, are flammable, and give off toxic fumes. With prolonged usage, many cleaners develop allergies and respiratory problems.

Pollution of the air, water and land, and human health risks can be greatly reduced by replacing household cleaning products that contain hazardous materials with products that are non-toxic or less-toxic. Many alternative products exist which are not hazardous

or harmful to the environment and which do not pose occupational safety hazards. Through the use of such products, pollution and health risks are reduced and/or eliminated.

2.0 Executive Summary

The substitution of household cleaning products that contain hazardous substances with eco-friendly products in the professional housecleaning industry is a simple and effective way of reducing occupational exposure hazards and pollution. Many of the substances found in household cleaning agents are recognized or suspected by the National Toxicology Program and the International Agency for Research on Cancer to be toxins. Some substances are recognized carcinogens while others are suspected developmental toxins.

Using the replacement of two commonly used cleaners as an example, this study found that professional cleaning agencies, such as Eco-Care Professional Housecleaning and Emma's Eco-Clean, LLC that use eco-friendly products can reduce the amount of hazardous materials used by 85%. In the past two years, Emma's served over 400 clients in San Mateo and Santa Clara counties, preventing the exposure to and use of at least **3,604** pounds of hazardous materials in these two cleaning products. That is an average of **1,802** pounds a year. With the increased demand for professional cleaning services in Silicon Valley, it is estimated that Emma's and Eco-Care alone can prevent the release of as much as **3,863** pounds of hazardous materials per year from these two product categories alone.

3.0 Background - Goals of the WAGES Program

Women's Action to Gain Economic Security (WAGES) promotes eco-friendly cleaning business development in the San Francisco Bay Area. This non-profit 501(c)3 organization is currently assisting two household cleaning cooperatives, Emma's Eco-Clean, LLC in San Mateo County and Eco Care Professional Housecleaning in Santa Clara County. Emma's opened in 1999 and consists of 12 members. Eco-Care opened in April 2001 with 9 members. All cooperative members are professionally trained to use eco-friendly cleaning products and methods. Both companies clean homes using the least toxic cleaning agents available such as vegetable based soaps, baking soda, Borax, white vinegar and water.

4.0 Overview of Pollution Prevention Evaluation Report

To establish the pollution prevention benefits of WAGES programs, a hazardous materials comparison was made between non-toxic, less-toxic and toxic cleaning products. The evaluation and documentation was performed by selecting two commonly used household cleaning products that contain hazardous materials, products A and B. The active ingredients and the hazardous chemicals noted on the product label and on the Material and Safety Data Sheet (MSDS) for each product were researched for toxicity.

By interviewing the members of Emma's and Eco-Care, the quantities used of toxic cleaning products A and B were estimated as well as the quantities for their respective eco-friendly product substitute. Calculations of pollution prevention were then made by comparing pounds of hazardous materials released to the environment through the use of products A and B versus the use of eco-friendly cleaning products.

4.1 Discussion of Toxicity Categories and Environmental Impacts

Chemical pollutants fall under many different categories. Some are considered to be cancer causing while others are known to cause birth defects. Below are brief descriptions and definitions of the terms used throughout this report.

Carcinogen: An agent that induces the formation of tumors in humans or laboratory animals. Cancer induced by the exposure of toxic chemicals tends to develop many years after exposure[4].

Developmental Toxicity: Chemicals that cause birth defects are called teratogens. Some malformations are seen at birth while others, such as psychological or behavioral problems are seen later in childhood. Developmental toxicity usually results from prenatal toxin exposure by the mother or father. It can also result from a child's exposure after birth[4].

Endocrine Disrupter: The endocrine system is composed of organs and glands that secrete hormones to the bloodstream to control and regulate body processes. A toxin that has an adverse effect on the endocrine system may hinder hormone secretion and regulation. Endocrine disrupters may cause diseases such as hypothyroidism, hypoglycemia, cancer and reproductive disorders[4].

Neurotoxicants: Chemicals that have adverse effects on the structure or function of the nervous system (brain, spinal cord, or peripheral nerves). They damage nerve cells and alter nerve impulses potentially causing learning, memory, and other behavioral changes, or numbness, tingling, or weakness in the hands or feet[4].

Reproductive Toxicity: Chemicals that have adverse effects on the female and male reproductive systems such as abnormal changes in sexual behavior, decreased fertility or miscarriages[4].

Skin or Sense Organ Toxicity: Defined as changes in skin condition or the senses such as smell, vision, hearing, and taste[4]. Symptoms of skin injury include inflammation and itching as well as diseases such as dermatitis and cancer.

4.2 Toxicity Analysis

Hazardous materials can contaminate and impair the air, land and water where they have negative impacts on people, birds, plants and aquatic life. For example, hazardous materials can accumulate in the sediments of lakes, rivers, or oceans. When these

sediments are disturbed, toxins are released into the water where they become available to fish, wildlife and plants. Some compounds can accumulate in animals and be transferred up the food chain where they can be fatal or cause reproductive defects. Toxins can also contaminate groundwater aquifers serving as municipal drinking water sources when pollutants are directly released into these systems.

Contamination of land occurs when hazardous substances are used through the application of pesticides on crops, herbicides on park or house lawns or through accidental hazardous waste spills. Toxic substances can accumulate on soil particles exposing humans on contact. Contaminated soils also transfer toxins to plants and animals and they may release toxins to the air.

Cleaning products that contain toxic chemicals not only contaminate and impair the air and water, but they pose a serious occupational hazard to housecleaners that are exposed to such products on a daily basis. Housecleaners use a variety of products such as all-purpose liquid agents, powdered scrubbing agents, aerosols and detergents. Many of these products contain chemicals that easily volatilize when used, thereby exposing housecleaners to air pollution. It is important to note that even though cleaning products can have acute toxicity effects, such as skin or eye irritation, chronic effects also result due to breathing volatile toxic chemicals during daily occupational exposure.

In this study, two commonly used cleaning products were chosen and evaluated, Products A and B. The detailed evaluation is summarized in Tables 1 and 2 and in the following sections.

4.3 Product A – All Purpose Cleaner

Product A is an all-purpose liquid cleaner that is commonly used by housecleaners in all areas of the home. For example, in the kitchen, these types of cleaners are used to scrub countertops, stoves and refrigerators. In the bathroom, they are used to clean tiles, toilets, sinks and bathtubs. In other rooms, they are commonly used to clean walls and dusty surfaces. Because these products are effective grease removers, disinfectants and deodorizers they are used throughout the house in large quantities. Table 1, below, summarizes the ingredients found in the product and their respective toxicity.

TABLE 1 – Product A Liquid All Purpose Cleaner Toxicity Documentation

Active Ingredients MSDS/Label	MSDS Toxicity Report	Recognized/Suspected Toxicity (sources numbered)
0.5-5% 2-Butoxyethanol (Ethyleneglycol Monobutyl Ether), Buty Cellosolve, Butyl Glycol, Glycoether EB CAS:111-76-2	Exposure causes blood and bone marrow damage.	**Suspected:** cardiovascular/blood [6,7,12,13], developmental [14], endocrine [13], gastrointestinal/liver [13], kidney [13], neuro [2, 13], respiratory [10,13], skin/sensory organ [13] toxicant
TRACE Ethylene Oxide CAS: 75-21-8	Suspected 2A Human Carcinogen by IARC, Confirmed animal carcinogen by IARC & NTP	**Recognized:** Carcinogen and reproductive toxicant [9]. **Suspected:** cardiovascular/blood [6,7,12,13], developmental [4], gastrointestinal/liver [13], kidney [13], neuro [2,11, 13], respiratory [12,13], skin/sensory organ [5, 11,13] toxicant
<10% Glycol Ethers, Diethylene Glycol, 2,2-Oxybisethanol CAS:111-46-6		**Suspected:** cardiovascular/blood [13], developmental [4], gastrointestinal/liver [13], kidney [5,13], neuro [13], respiratory [13], skin/sensory organ [5,11,13] toxicant
< 1% Magnesium Sodium Ethylenediaminetetraacetate *92-2* CAS:14402-88-1		No adverse effects noted.
<0.5% Sodium Hydroxide, Caustic Soda Lye CAS:1310-73-2		**Suspected:** respiratory [12], skin/sense organ [5], [12] toxicant
0.3% Alkyl (40%C12, 50%C14, 10%C16) Dimethyl Benzyl Ammonium Chloride, Other 99.7%, No phosphates		**Suspected:** gastrointestinal/liver [13], neuro [13] toxicant

References Noted:

1. CAS: Chemical Abstracts Service Registry Number.
2. DAN: Nordic Council of Ministers and Danish National Institute of Occupational Health. Neurotoxic Substances in the Working Environment (Danish ad hoc list). List originally published in Neurotoxic Substances in the Work Environment, Danish Working Environment Service, At-report Nr. 13/1990. Suspect neurotoxicity identification now incorporated into 1998 Danish EPA All Chemicals List. http://www.mst.dk/udgiv/publications/2000/87-7909-501-1/pdf/87-7909-500-3.pdf
3. IARC: International Agency for the Research of Cancer http://www.iarc.fr
4. JANK: Jankovic, J. A Screening Method for Occupational Reproductive Health Risk. American Industrial Hygiene Association Journal 57: 641-649. 1996.
5. KLAA: Klaassen, C., M Amdur and J. Doull (eds.) Casarett and Doull's Toxicology. The Basic Science of Poisons, Eth Ed. Pergamon Press, NY 1996.
6. LADO: LaDou, J, (ed.) Occupational Medicine. Appleton & Lange, Norwalk, CN 1990.
7. MALA: Malachowsky, M.J. Health Effects of Toxic Substances. Government Institutes. Rockville, MD. 1995.
8. NTP: National Toxicology Program
9. P65: The current Proposition 65 List of Carcinogens (February 2001) can be obtained from http://www.oehha.ca.gov/prop65/prop65_list/Newlist.html.
10. OEHHA-AREL: Office of Environmental Health Hazard Assessment, California Environmental Protection Agency. All acute reference exposure levels developed by OEHHA as of May 2000. http://www.oehha.org/air/acute_rels/allAcRELs.html.
11. OEHHA-99: Office of Environmental Health Hazard Assessment, CA Environmental Protection Agency, Air Toxics Hot Spots Program Risk Assessment Guidelines, Part III, Draft Technical Support Document for the Determination of Noncancer Chronic Reference Exposure Levels. June 99 http://www.oehha.ca.gov/air/chronic_rels/RAGSII.html.
12. OEHHA-2000: Office of Environmental Health Hazard Assessment, CA Environmental Protection Agency, Air Toxics Hot Spots Program Risk Assessment Guidelines, Part III. Feb 2000 http://www.oehha.ca.gov/air/chronic_rels/22RELS2k.html.
13. RTECS: National Institute for Occupational Safety and Health's Registry of Toxic Effects of Chemical Substances. http://www.cdc.gov/niosh/rtecs.html
14. SCH: Schardein, J. Chemically Induced Birth Defects. New York; Dekker, 1985.

As shown on Table 1, Product A has five active ingredients that make up approximately 15.8% of the solution. The rest of the solution is either composed of water or of ingredients that are not reported as hazardous. The ingredients listed on the label and on the product Material Safety Data Sheet (MSDS) are all recognized or suspected toxins. The chemical **ethyleneglycol monobutyl ether (EGBE)**, for example, is widely used in industry, consumer products, building materials and furnishings. Over 1 million pounds a year are used in the United States in products such as hydraulic brake fluids, paint stripping solvents, markers, insecticides, disinfectants and deodorants[4].

Product A's MSDS notes that EGBE can cause blood and bone marrow damage. The chemical can be absorbed through the skin or inhaled, exposing anyone handling the product to levels above the exposure limit set by the Occupational Safety and Health Administration (OSHA) of 50 ppm (MSDS). EGBE is listed on the National Institute for Occupational Safety and Health's Registry of Toxic Effects of Chemical Substances (RTECS) as a suspected developmental, reproductive, gastrointestinal and liver, kidney, respiratory and neuro toxicant[4,5].

Experiments performed on mice have shown that glycol ether derivatives are suspected developmental and reproductive toxicants. Following exposure at high concentrations, maternal mortality and fetolethality were observed in a group of pregnant mice. Increased number of dead pups and reduced birth weights were observed along with reduced maternal weight gain. Abnormal sperm morphology and infertility were observed in male mice as well[9].

Ethylene oxide occurs in the product as a trace element, meaning that it is found in the product at extremely low concentrations. Ethylene oxide, however, is a recognized carcinogen by the International Agency for the Research of Cancer[6] and is currently listed on the Proposition 65 List of Carcinogens, February 2001[4]. According to the Environmental Defense Fund, the chemical ranks as one of the most hazardous compounds to the ecosystem and human health[4]. Ethylene oxide is recognized as a reproductive toxicant and is suspected to be a cardiovascular/blood, gastrointestinal/liver, kidney, neuro, respiratory and skin/sensory organ toxicant by RTECS[4,5].

As reported in the National Toxicology Program's Ninth Report on Carcinogens, laboratory experiments have shown that ethylene oxide causes cancer in rats and mice. The chemical was observed to induce tumor growth in the mammary gland, uterus and lungs of mice and in the brain and hematopoietic system of rats. Furthermore, links with leukemia, liver and lymphatic cancer have been found with humans who work in the production of ethylene oxide and its derivatives. The chemical's effectiveness as a sterilant and disinfectant is the same property that accounts for its carcinogenic risk to humans[7].

Ethylene oxide is commonly found in disinfectants and is widely used in pesticides. It is estimated that over 1 million pounds of the chemical are produced each year in the United States[4].

Less than 10% of product A consists of **diethylene glycol ether.** According to RTECS, diethylene glycol ether is a suspected cardiovascular/blood, gastrointestinal/liver, kidney, neuro, respiratory and skin/sensory organ toxicant. The chemical is also a suspected developmental toxicant and studies done by the National Toxicology Program show that it is a suspected reproductive toxicant. Glycol ether derivatives have been found to cause fetolethality in pregnant mice and infertility in male mice[9].

Like ethyleneglycol monobutyl ether and ethylene oxide, diethylene glycol ether is a toxicant that is used in high volumes in industries that produce consumer products, building materials, and furnishings. The chemical is used in anti-freezing agents, printing solvents, automotive products, lubricating oils and household tints and dyes. It is estimated that more than 1 million pounds of diethylene glycol ether are produced annually[4].

The next ingredient listed is **Magnesium Sodium Ethylenediaminetetraacetate,** also known as Magnesium Sodium EDTA. Currently, there is limited research on its effects on human toxicity. However, EDTA, is considered an ecological toxicant due to its binding properties. Studies have shown that EDTA forms very strong metal complexes that are resistant to conventional wastewater treatment. As a result, high concentrations of metals, such as Nickel, Zinc, Iron and Copper, remain dissolved in the water[10]. When present in the water column, these metals become readily available to aquatic life, posing serious hazardous threats to fish. In South San Francisco Bay, for example, concentrations of Nickel and Copper occasionally exceed water quality standards set by the Environmental Protection Agency.

Sodium hydroxide is a widely used substance in many consumer products, pesticides and manufacturing processes. Also referred to as caustic soda and lye, it is a product that is widely used in disinfectants, drain pipe solvents, household surface cleaners, paint removers, detergents, soaps and shampoos. Although considered to be less hazardous than other chemicals, sodium hydroxide is suspected to be a respiratory and skin/sense organ toxicant. The California Air Resources Board lists sodium hydroxide as a substance that poses chronic or acute threats to the public if present in the air. The compound is also one of OSHA's regulated air contaminants[4].

A strong base (i.e., high pH), sodium hydroxide, can cause severe skin irritation and burns if exposed. Occupational hazards have mostly been related to severe eye burns, severe damage to skin and throat and respiratory problems[8].

Alkyl (40%C12, 50%C14, 10%C16) dimethyl benzyl ammonium chloride is a commonly used product found in such products as hair mousse, disinfectants, pesticides and toilet cleaners. The chemical is listed on RTECS as a suspected gastrointestinal/liver/neuro toxicant. Alkyl dimethyl benzyl ammonium chloride is also known to cause adverse effects to the aquatic environment. It appears on the Nordic Council of Ministers List of Dangerous Substances[4].

Approximately 15.8% of the Product A solution consists of chemicals that are recognized carcinogens and suspected to cause a wide range of reproductive, developmental and respiratory problems. With respect to acute toxicity, the product's material and safety data sheet notes that it is an eye irritant and that it can be absorbed through the skin.

4.4 Product B – Liquid Glass Cleaner

Glass cleaners are widely used throughout the home by professional housecleaners. They are used to clean windows and glass surfaces such as tables, doors and mirrors. Product B is a popularly used glass cleaner that, as shown on Table 2, consists mostly of different types of alcohols.

TABLE 2 – Product B Liquid Glass Cleaner Toxicity Documentation

Active Ingredients – MSDS/Product Label	MSDS Toxicity Report	Recognized/Suspected Toxicity (sources numbered)
2-9% Isopropanol (isopropyl alcohol), 2-propanol, dimethyl carbinol CAS:67-63-0	IARC Cancer Review Group 3 "96-2"	**Suspected:** cardiovascular/blood[13], developmental [12], gastrointestinal/liver [13], kidney [12], neuro [13], respiratory [10,13], skin/sensory organ[10] toxicant
2-butoxyethanol		**Suspected:** cardiovascular/blood [6,7,10,13], developmental[4], endocrine[13], gastrointestinal/liver[13], kidney[13], neuro [2,13], respiratory [10,13], skin/sensory organ[13] toxicant

References Noted:

1. CAS: Chemical Abstracts Service Registry Number.
2. DAN: Nordic Council of Ministers and Danish National Institute of Occupational Health. Neurotoxic Substances in the Working Environment (Danish ad hoc list). List originally published in Neurotoxic Substances in the Work Environment, Danish Working Environment Service, At-report Nr. 13/1990. Suspect neurotoxicity identification now incorporated into 1998 Danish EPA All Chemicals List. http://www.mst.dk/udgiv/publications/2000/87-7909-501-1/pdf/87-7909-500-3.pdf
3. IARC: International Agency for the Research of Cancer http://www.iarc.fr
4. JANK: Jankovic, J. A Screening Method for Occupational Reproductive Health Risk. American Industrial Hygiene Association Journal 57: 641-649. 1996.
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8. NTP: National Toxicology Program
9. P65: The current Proposition 65 List of Carcinogens (February 2001) can be obtained from http://www.oehha.ca.gov/prop65/prop65_list/Newlist.html.
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13. RTECS: National Institute for Occupational Safety and Health's Registry of Toxic Effects of Chemical Substances. http://www.cdc.gov/niosh/rtecs.html
14. SCH: Schardein, J. Chemically Induced Birth Defects. New York; Dekker, 1985.

Isopropanol is listed as a suspected carcinogen by the International Agency for Research on Cancer. Although there is inadequate evidence linking isopropanol carcinogenicity to humans and animals, studies have shown an increase in paranasal sinus and laryngeal cancer in workers. Studies have also shown increased incidence of reproductive abnormalities in male rats. Prolonged exposure to isopropanol was observed to cause degenerative changes in the brain of rats. The chemical is also known to be a central nervous system depressant[7]. Studies done by the Office of Environmental Health Hazard Assessment and by the National Institute for Occupational Safety and Health's Registry of Toxic Effects of Chemical Substances also show that isopropanol is a suspected cardiovascular/blood, developmental, gastrointestinal/liver, kidney, neuro, respiratory, and skin/sensory organ toxicant[4,5].

Isopropanol is a widely used product in industry and it is found in products such as pesticides and consumer products. Found in metal degreasing products, paint stripping solvents, pharmaceutical solvents, bathroom tub cleaners, disinfectants, deodorants, insecticides, moisturizing creams, shampoos, and pesticides, isopropanol is produced in large quantities. It is estimated that more than 1 million pounds of the compound are produced a year in the United States alone[4].

The other compound used in the glass cleaner solution is **2-Butoxyethanol**. The compound **2-butoxyethanol** is a synonym for **ethyleneglycol monobutyl ether**, which is also found in product A. According to studies done by the Occupational Safety and Health's Registry of Toxic Effects of Chemical Substances, the chemical is also a suspected cardiovascular/blood, endocrine, gastrointestinal/liver, developmental, kidney, neuro, respiratory, skin/sensory organ toxicant[4,5].

Approximately 9% of the product B solution consists of chemicals that are considered to be hazardous by several federal and state agencies. With respect to acute toxicity, the product's material and safety data sheet notes that it is an eye irritant and that it can cause temporary eye redness.

5.0 Pollution Prevention

The quantity of cleaning products used by housecleaners clearly varies with respect to technique, size of home and product strength. In order to make sensible estimates in the amounts of products used, the members of both Emma's and Eco-Care were interviewed. The women at Eco-Care recently received training on the use of eco-friendly products and opened their business in April 2001. Before the co-op opened, however, some individual members were employed by professional cleaning companies that use toxic products. The women at Eco-Care were therefore able to provide estimates of the amounts of toxic products used in a typical household.

The women at Emma's have been using eco-friendly cleaning (EFC) products for over two years. The products currently in use have passed through WAGES' EFC™ Product Screen, which sets parameters for evaluating and choosing products that do not contain hazardous materials and that pose minimal occupational hazards. By interviewing the

women in the two cooperatives, information was gathered on the types and quantities of eco-friendly cleaners that are being used in substitution for toxic cleaners. Due to proprietary concerns, the commercial names of the products evaluated in this study are not used.

Product A is an all-purpose cleaner that contains hazardous chemicals. It is used throughout the home for numerous tasks. In the kitchen, all-purpose cleaners are used for cleaning countertops, refrigerators, stoves, and cabinets. In the bathroom, they are used to clean bathtubs, tiles, and toilets. In other rooms, they are used to clean plastic surfaces such as tables or desks, window blinds, televisions, computers and walls. The eco-friendly cleaner that is used as a substitute is a soap that contains no hazardous materials.

Product B is used to clean all glass surfaces that consist mostly of windows, glass table tops and mirrors. The eco-friendly cleaner that is used as a substitute is white vinegar which is dilute acetic acid, a non hazardous substance. Tables 3 and 4, below, summarize the main tasks performed with the cleaning agents along with a range of amounts for toxic agents and their least toxic cleaner substitutes. The eco-friendly products used by the cooperatives are diluted with water and applied with spray bottles. The values reported in the table are based on diluted quantities and for the most part do not differ from the Product A and B quantities.

TABLE 3 - Product A Quantity Estimates for Cleaning Tasks

Task	Product A Quantity (liquid oz)	EFC Substitute	EFC Quantity
Bathroom			
Toilet	0.5 oz.	EFC Soap	0.5 oz.
Wood cabinets	0.5 oz.	EFC Soap	0.5 oz.
Showers	1 oz.	EFC Soap w/ Baking Soda	1 oz.
Tiles	2 oz.	EFC Soap w/ Baking Soda	2 oz.
Kitchen			
Grease remover	2 oz.	EFC Soap	2 oz.
Countertops	2 oz.	EFC Soap	2 oz.
Stove	2 oz.	EFC Scouring Powder	2 Tbsp.
Other Rooms			
Surfaces - dusting	1 oz.	EFC Soap	1 oz.
Walls	1 oz.	EFC Soap	1 oz.

1) Approximately 1 tsp. of EFC soap is diluted with 16 oz. of water.

TABLE 4 - Product B Quantity Estimates for Cleaning Tasks

Task	Product B Quantity (liquid oz)	EFC Substitute	EFC Quantity
Bathroom			
Mirrors	2 oz.	Vinegar	2 oz.
Other Rooms			
Mirrors	1 oz.	Vinegar	1 oz.
Windows	2 oz.	Vinegar	2 oz.
Glass surfaces	1 oz.	Vinegar	1 oz.

1) Approximately 0.5-1 oz of vinegar is diluted with 16 oz. of water.

Almost all of the eco-friendly cleaners used by WAGES have ingredients that are considered non-hazardous. There are some products, however, such as the scouring agent, that produce dust when used. The exposure to dust over time can cause chronic respiratory problems. Due to the occupational hazard, the scouring agent was considered to be a pollutant in the pollution prevention calculations described below.

The average home cleaned by the cooperatives consists of 3 bedrooms, 2 bathrooms, a kitchen, living room and dining room. By using products A and B for the tasks listed in Tables 3 and 4, it is estimated that a housecleaner would use 48 fluid ounces of products A and B combined per home. The 48 fluid ounces equal 0.4 dry pounds of pollutants per home. House cleaners that use toxic products, such as products A and B, therefore release on average 0.4 pounds of hazardous materials into the environment per home. By substituting products A and B with eco-friendly cleaners, only 0.06 pounds of pollutants would be released per home. The 0.06 pounds of pollutants are attributed to the use of scouring agents that can pose an occupational hazard due to the dust they produce when used. In summary, through the use of eco-friendly cleaners, the environment receives 0.34 pounds less hazardous materials per home, amounting to a reduction in pollutant loading of 85%. All calculations are included as part of Appendix A.

5.1 Pollution Prevention Impacts

The professional housecleaning industry has been growing rapidly over the past few decades. Approximately 9% of the households in the United States hired professional housecleaners in 1996, totaling 9,436,000 single-family homes. This number is expected to increase to 10,740,000 by the year 2006[11]. In California, housecleaning services are among the fastest growing industries.

Eco-Care and Emma's Eco-Clean serve the Santa Clara and San Mateo Counties. In the past two years, Emma's Eco-Clean has served over 400 clients. Using the quantities of hazardous and eco-friendly products presented in the previous section and assuming that half of the clients were served once and the rest every other week, a reduction of 3,604 pounds of hazardous materials is calculated for the past 2 years (104 weeks). That averages to 1,802 pounds per year (52 weeks).

Due to the high concentration of double income families in the Bay Area and direct marketing data, it can be assumed that the average number of households hiring professional cleaners is twice the national average. Therefore, assuming 18% of the 80,865 homes in the service region will use cleaning services, the total market size is 14,555 homes. If Emma's and Eco-Clean obtain 3% of the market, the co-ops would serve 437 households. Assuming each household is cleaned every other week, it is estimated that the co-ops would prevent the release of 3,863 pounds of hazardous materials to the environment in one year (52 weeks).

The marketing assumptions made in this report are conservative. If Eco-Care attains the same success as Emma's has for the past two years, it is expected that the cooperatives will obtain more than 3% of the market. We therefore expect the pollution prevention impacts of the two cooperatives to increase significantly in the future.

References

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Appendix A

Pollution Prevention - CALCULATIONS

Product A	Quantity (liquid oz)	Rooms per home	Total (liquid oz)
Bathroom	4	2	8
Kitchen	6	1	6
Other Rooms	2	5	10
TOTAL			**24**

1) Based on a house with 3 bedrooms, 2 bathrooms, a kitchen, living room and dining room.

Calculations:
Product A: Weight = 8.77 lbs/gal, 15.8% pollutants by weight
24 oz x 1 cup/ 8 oz x 1 gal/ 16 cups = 0.1875 gal Product A

0.1875 gal x 8.77 lbs/gal x 15.8% = 0.26 lbs Product A Pollutants

Product B	Quantity (liquid oz)	Rooms per home	Total (liquid oz)
Bathroom	2	2	4
Other Rooms	4	5	20
TOTAL			**24**

1) Based on a house with 3 bedrooms, 2 bathrooms, a kitchen, living room and dining room.

Calculations:
Product B: Weight = 8.18 lbs/gal, 9% pollutants by weight
24 oz x 1 cup/ 8 oz x 1 gal/ 16 cups = 0.1875 gal Product B

0.1875 gal x 8.18 lbs/gal x 9% = 0.14 lbs Product B Pollutants

Product A + Product B = 0.40 lbs pollutants

LTC	Quantity (Tbsp.)	Rooms per home	Total (Tbsp.)
Kitchen	2	1	2
TOTAL			**2**

1) Based on a house with 3 bedrooms, 2 bathrooms, a kitchen, living room and dining room.
2) Product quantity is based on use of the scouring powder. The scouring agent produces dust which can create an occupational hazard. It is therefore considered a pollutant in these calculations. The other products used in substitution to Products A and B are non-hazardous.

Calculations:
Scouring powder: Bulk Density = 900g/L
2 Tbsp. = 27 grams x 2.2 lbs/ 1000g = 0.06 lbs powder

WAGES: LTC/Scouring Agent = 0.06 lbs Pollutants

Reduction in Pollutant Load:

[Product A + Product B – LTC / (Product A + Product B)] x 100% = **0.36/0.4*100% = 85%**

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