Quantifying the Disposal of Post-Consumer Architectural Paint

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Contents

1. Introduction 5

2. Data Collection 7

California 7

MSW – 1999 and 2003 California Statewide Waste Disposal Characterization Studies 7

HHW – FY1998/1999 and FY2002/2003 California HHW Collection 9

Combined Paint Estimate: MSW and HHW 10

Ongoing or Upcoming Studies 11

Iowa 11

MSW – 1998 Iowa Solid Waste Characterization Study 11

HHW - FY1998 Iowa Regional HHW Collection 12

Combined Paint Estimate: MSW and HHW 13

Ongoing or Upcoming Studies 14

Oregon 14

MSW – 2000 and 2002 Oregon Solid Waste Characterization and Composition Studies 14

HHW – 2000 and 2002 Oregon HHW Collection 17

Combined Paint Estimate: MSW and HHW 18

Ongoing or Upcoming Studies 18

Washington 19

MSW – 2003 Waste Composition Analysis for the State of Washington 19

HHW – 2003 Washington Moderate Risk Waste Collection 20

Combined Paint Estimate: MSW and HHW 21

Ongoing or Upcoming Studies 21

Wisconsin 21

MSW - 2002 Wisconsin Statewide Waste Characterization Study 21

HHW – 2001 Wisconsin HHW Collection 22

Combined Paint Estimate: MSW and HHW 24
Summary of State MSW Studies 25
3. National Estimates of Paint Disposal 26
Alternative Estimation Methods 28
National Estimate Compared with PPSI Estimate 30
4. Conclusions 31
References 32
Appendix A: Data Refinements and Other Considerations 35
Data Refinements 35
Definition of "paint" 35
Architectural vs. Non-Architectural Paint 36
Paint Weight 37
Dried Paint Weight 37
Residual (Liquid Paint Weight 39
Container Weight 39
Other Considerations 40
Paint Spillage 40
Seasonal Collection Efforts 41
Paint Disposition/Management 41
Paint Misclassification 41
Sample Size, Confidence Intervals, and Bias 41

1. Introduction

Leftover architectural paint is a concern to communities across the country because of its high volume in the waste stream, resulting waste management costs, and potential for reduction, recovery, reuse and recycling. Leftover paint can also contain volatile organic compounds, fungicides and, in the case of very old paint, significant quantities of hazardous metals such as mercury and lead. Of all household hazardous wastes (HHW), paint is the single most voluminous and expensive material that many local governments collect and manage. To address the challenges of reducing and managing leftover architectural paint, state and local agencies have joined together with paint manufacturers, retailers, recyclers, and others, under the auspices of the Paint Product Stewardship Initiative (PPSI). These stakeholders are now exploring a broad range of issues and approaches to leftover paint management with the goal of working toward a nationally coordinated leftover paint management system. This analysis supports the PPSI by providing an estimate of the quantity of architectural paint disposed annually by consumers in the U.S.

After a consumer has used paint from a particular purchase, any leftover paint may go into one of several disposition pathways. These include:

- Local municipal solid waste (MSW) landfill or incinerator (in liquid or dried form)
- Donation/exchange for reuse by another party
- Collection, management and disposal as hazardous waste, for example through a household hazardous waste (HHW) collection program
- Poured down a drain/sewer
- Stockpiled for future use or disposal (e.g., in a basement or garage)

Because comprehensive national data on the quantities of post-consumer architectural paint going to these pathways is not available, this study examines available data from selected states. Specifically, this report presents case studies from the states of California, Iowa, Oregon, Wisconsin and Washington, each of which has available data on the quantity of paint disposed in MSW landfills and incinerators, as well as the quantity brought to HHW collection centers. It is believed that these two major pathways account for the vast majority of post-consumer paint disposed each year. The case studies provide state-specific estimates of the annual quantity of paint that is disposed. These data are then scaled to provide national estimates.

Data on the quantity of post-consumer paint reaching MSW landfills and incinerators were obtained from MSW composition studies that were conducted in the five states. Data on the quantity of post-consumer paint brought to HHW collection sites were gathered directly from HHW program managers, or from published reports, for the annual period that most closely

corresponded to the year in which the state MSW composition study was conducted. Multiple years of MSW and HHW data were used in developing state-specific estimates, where available, to provide greater stability to the estimates, for a total of seven paired MSW/HHW data sets from the five states. Because of the relatively small quantity (and limited occurrence) of paint in the municipal solid waste stream, and the limited amount of sampling that states have been able to conduct in any individual MSW composition study, the estimates for paint disposal in the municipal solid waste stream in any individual state study are subject to higher error than those items that are more commonly found in the waste stream. Together, however, the seven state studies collectively represent the sorting of more than 4,500 samples of municipal solid waste, with a total sample weight of one million pounds or more. Reliance on the composite results of these seven studies reduces the uncertainty associated with the national estimates.

The national estimates derived in this analysis are intended to update and refine the estimates provided in the 2004 PPSI document entitled "Background Report for the National Dialogue on Paint Product Stewardship." That report estimated that approximately 2.5 to 5 percent of the architectural paint sold in the U.S. each year becomes leftover consumer house paint (PPSI 2004a). The expanded analysis presented here estimates that the amount of architectural paint that is disposed of each year is equivalent to approximately 6 to 16 percent of sales, with a best estimate of 10 percent. The report is comprised of the following sections:

- Section 2 presents available data on the quantity of post-consumer paint disposed at MSW landfills and incinerators, and brought to HHW collection centers in each of the 5 states.
- Data from the state studies is combined in Section 3 to provide national estimates of post-consumer paint disposal. Section 3 also compares the annual quantity of post-consumer paint disposed to annual U.S. paint sales.
- Section 4 presents conclusions and opportunities for future research.

Adjustments to state data (for comparability across waste studies and collection programs) and refinements to the national estimate are detailed in *Appendix A*.

2. Data Collection

To estimate the quantity of post-consumer paint disposed annually in each of the five states studied, available data from multiple paint waste streams were examined. This included paint disposed of in municipal solid waste (MSW) landfills and incinerators, as well as paint collected at household hazardous waste (HHW) collection sites. This section presents data from MSW waste composition studies and HHW collection programs from each of the five states.

California

The California Integrated Waste Management Board (CIWMB) has conducted detailed municipal solid waste characterization studies, and has also compiled statistics on household hazardous waste collection programs around the state. Data on both of these waste streams provide a basis for estimating the total amount of post-consumer paint disposed each year in the state of California.

MSW – 1999 and 2003 California Statewide Waste Disposal Characterization Studies

CIWMB conducted detailed statewide MSW characterization studies in 1999 and 2003. In most respects, the 2003 *California Statewide Waste Disposal Characterization Study* followed the standards and protocols established for the 1999 *Statewide Waste Disposal Characterization Study*. For example, both studies divide California into five sampling regions (referred to as strata) based on similarities in demographics, climate, geography, and economic characteristics. Also, the definition of "paint" remained the same in both studies. Given that the two studies were conducted over a relatively short time interval, and the methods used for characterizing paint disposed across the state in both studies were relatively consistent, this report considers paint disposal quantities from both statewide studies.

In both the 1999 and 2003 waste characterization studies, several disposal facilities (landfills and transfer stations) were randomly selected (i.e., with equal probability) in each of the five sampling regions as sampling sites for the single-family residential, commercial, and self-hauled waste streams. The number of single-family residential samples collected across all five regions was 148 in the 1999 study and 110 in the 2003 study, while the number of self-hauled samples collected was 247 in the 1999 study and 200 in the 2003 study. In addition, 80 multifamily residential samples were collected from randomly selected apartment buildings and complexes within the geographical areas surrounding the selected disposal sites in 1999 and 40 were collected in 2003. Finally, a total of 1,207 commercial generator samples were collected at randomly selected businesses in 1999, while in 2003, 200 samples were obtained from vehicles at

disposal facilities as a surrogate for commercial waste. It should be noted that not all MSW in California goes to a MSW landfill. California has three waste-to-energy incinerators that accept MSW. Further, one or two counties export MSW out of state.

To account for seasonal variations in waste disposal patterns, waste sampling was conducted in different seasons. The 1999 study considered two seasons—winter and summer, while the 2003 study was more detailed and also included autumn and spring. Each waste sample was hand sorted and characterized according to material types found in the California Integrated Waste Management Board's Uniform Waste Disposal Characterization Method. The 2003 study increased the number of waste material types it considered; yet all material types were chosen and defined such that they could be fit to the material types used during the 1999 study.

Both of the California waste studies defined paint as containers with paint in them. Paint types included in the definition are latex, oil-based, and tubes of pigment or fine art paint. The definition does not include dried paint, empty paint cans, or empty aerosol containers, which can often be found commingled with other waste types under "remainder/composite construction & demolition" or "tin/steel cans."

Table 1 presents the amount of paint disposed of in landfills or incinerated in California as presented in California's 1999 and 2003 studies. The number of paint samples taken during each study was small; the disposal facilities considered for sampling in each study were selected with equal probability within each region (irrespective of the fact that these facilities could vary in size); and the studies did not employ sampling weights when estimating waste tons. Therefore, data from both studies were combined to generate a best estimate of paint disposed or incinerated in California. Combining these data could add stability to the estimate of paint in the MSW stream in California.

Table 1. California Statewide Waste Characterization Study Results: 1999 and 2003

Waste Category	Quantity (tons)		
	1999	2003	Average
MSW	37,500,002	40,235,328	38,867,665
HHW	112,385	73,600	92,993
Paint	**44,498**	**19,192**	**31,845**
Paint as a % of MSW	**0.12**	**0.05**	**0.08**
Paint as a % of HHW	**40**	**26**	**34**

Sources: CIWMB, 1999 and 2003.
The study provides a 90 percent confidence interval for these estimates, even though sampling weights were not used to estimate the totals.

As detailed in Table 1, the amount of paint disposed of in landfills or incinerated in 2003 was nearly 60 percent lower than in 1999. Due to the small number of paint-containing samples considered, a single sample could result in a large variation in disposal quantities. For example,

the inclusion of a single household that stockpiled large quantities of paint during one year could drive up paint disposal quantities. Averaging data from two study years help reduce the impact of such instances on the overall paint estimate.

HHW – FY1998/1999 and FY2002/2003 California HHW Collection

Local governments in California are required to keep HHW out of the solid waste stream pursuant to Public Resources Code 47100. They do this by providing both temporary and permanent HHW collection events and facilities, and public education to their residents. Currently, descriptive program information is available for the 1999 study, but not for that conducted in 2003. In fiscal year (FY) 1998/99, 85 permanent HHW collection facilities, 245 temporary facilities/one day events and 107 Recycle-Only facilities[1] were operated. About 50 percent of the state's population had access to permanent facilities, and temporary facilities served about 40 percent of the population. Approximately 10 percent of the state's population had no access to collection opportunities. While the majority of the public had access to HHW collection programs, actual usage may have been lower. Some HHW collection sites may not have been convenient due to location or operating hours. Advertising and outreach is limited by budget constraints (CIWMB, 2001). Based on annual statistics, CIWMB estimates that only approximately 4 percent of residents participate in HHW collection programs each year (CIWMB, 2000).

Local governments are required to report annually the quantity of waste collected by HHW programs and the method of waste management. The quantity of paint collected and the percentage of HHW that was paint during FY1998/99 and FY2002/03 are shown in Table 2. These quantities reflect only those amounts of paint actually *collected* in HHW programs.

The quantity of HHW collected by California programs has grown, as has the percentage of the HHW that is paint, since the programs were first introduced in California in FY1993. In FY1993, approximately 3,000 tons of paint was collected, and paint accounted for 31 percent of all the waste collected at HHW collection centers. By FY2004, paint collection grew to 11,500 tons, or approximately 35 percent of all HHW collected. Data for 1998/99 and 2002/03 are used in this analysis due to availability of corresponding MSW information for those years.

[1] Recycle-only facilities are those that receive materials that could potentially be recycled, including latex paint.

Table 2. Paint Collected in CA HHW Programs: FY1998/99 and FY2002/03

Waste Category	Paint (tons)		
	FY1998/99	FY2002/03	Average
Oil-Based Paint	3,650	5,161	4,406
Latex Paint	3,722	5,324	4,523
Total Paint Collected	**7,372**	**10,485**	**8,929**
Total HHW Collected	**17,247**	**24,750**	**20,998**
Percent of HHW Collected that is Paint (%)	**43**	**42**	**43**

Sources: Data received from Anna Ward, CIWMB2004 and Glenn Gallagher, CIWMB, 2006.

Combined Paint Estimate: MSW and HHW

While it is legal to dispose of dried paint in MSW landfills in California, air drying is not encouraged. Instead, disposal of wet paint at HHW collections is the suggested management method. As shown in Table 3, approximately 78 percent of all of the paint that was disposed of in 1999 and 2003 was disposed in MSW landfills or incinerated. The large percentage of paint in the MSW stream illustrates the importance of including MSW data when estimating the quantity of leftover paint in the United States.

Table 3. Total Leftover Paint in California: Reported Data

Disposition Pathway	Total Paint (tons)*	Percent of Paint by Pathway (%)
MSW Landfill/Incineration	31,845	78
HHW Collection	8,940	22
Total	**40,785**	**100**

Sources: CIWMB, 1999 and 2003, and data provided by Anna Ward, CIWMB, 2004 and Glenn Gallagher, CIWMB, 2006.
* Derived by averaging estimates from the 1999 and 2003 statewide waste characterization studies.

In order to use these data to develop a national estimate, California's data were adjusted (for example, to exclude quantities of non-architectural paints), as detailed in *Appendix A (Refinements and Considerations)*. Table 4 presents California's MSW and HHW data after these data refinements.

Table 4. Total Leftover Paint in California: Adjusted Values

Disposition Pathway	Total Paint (tons)	Refinements
MSW Landfill/Incineration	24,789	* excludes non-architectural paint * excludes container weight * adds back dried paint
HHW Collection	8,929	* none made
Total	**33,718**	

Ongoing or Upcoming Studies

California's 2006 four-part Targeted Statewide Waste Characterization Study was scheduled to be released in the summer of 2006. California collects HHW data annually; the most current year of data available is for FY2004/05. This HHW data was not used because corresponding MSW data was not available.

Iowa

MSW – 1998 Iowa Solid Waste Characterization Study

The 1998 statewide solid waste characterization analysis for Iowa was conducted in the fall of 1997 and the spring of 1998. More than 420 samples of MSW were randomly selected from the residential, industrial/commercial/institutional (ICI), and mixed generator loads using various random cell selection processes. Once selected, the materials were sorted into 45 discrete material categories, weighed, and weights were recorded on individual data sheets based on the material classification determined during sorting. Data from these sites (together with data from a previous MSW characterization study conducted within the state) were used to develop waste composition estimates for the 45 material categories, as well as for the residential and ICI waste streams and for statewide totals.

Paint is not defined specifically or quantified individually in this study. Rather, it is included in the "paints and solvents" subcategory, which is part of the broader household hazardous materials (HHM) category. Based on the experience and judgment of two professionals who conduct waste composition studies, paint is estimated to comprise approximately 90 percent of the "paints and solvents" subcategory[2]. Although Table 5 (below) presents the quantity including solvents, this quantity is ultimately excluded from our analysis, as detailed in Table 8. In addition, Table 5 includes the weight of the container when the contents are liquid, while containers with dried

[2] Based on conversations and data provided by Tanya Tarnecki of Cascadia Consulting, and Brad Anderson of Sky Valley Associates.

paint in them were placed in the "metal" category (Chamberlain, 2006). Table 8 also excludes container weight.

Table 5. Iowa Statewide Landfill Composition Study Results: 1998

Waste Type	Quantity (tons)	Percent of Total Waste (%)	Percent of HHM (%)
Household Hazardous Materials	16,472	0.7	100.0
Paint and solvents	2,797	0.1	17.0
Total MSW	**2,203,848**	**100.0**	-

Source: IA DNR, 1998.
Note: The study notes a 90 percent confidence interval for these estimates.

HHW - FY1998 Iowa Regional HHW Collection

In FY1998, Regional Collection Centers (RCCs) in Iowa collected over 620 tons of HHW. These facilities accept hazardous materials free of charge from households; they also accept paint and hazardous materials from Conditionally Exempt Small Quantity Generators (CESQGs)[3] for a fee. Consisting of five permanent facilities, the RCCs serviced a population of 789,980 in 1998, and 12,062 households (29,673 people)[4] and 165 CESQGs brought paint to them. This represented approximately 3.8 percent of all households in the RCC service area (Theresa Stiner, Iowa DNR, 2004).

Latex paint and oil-based paint are two of the most common types of HHW and CESQG waste collected by RCC programs in the state. In 1998, a total of 198 tons of paint were collected by the RCCs, accounting for approximately 32 percent of all the waste collected. Approximately 36 percent of this paint was oil-based and 64 percent was latex.

In areas that did not have access to permanent RCCs, Iowa held 26 Toxic Cleanup Days (TCDs) in FY1998. TCDs are one-day events that accept hazardous materials free of charge from households and farms but charge a fee to CESQGs. In FY1998, 3,243 households participated out of 136,047 households in the counties that held the events, representing approximately 2.4 percent of the households in the area. These events collected 47 tons of paint, which accounted for approximately 40 percent of all the waste collected (Theresa Stiner, Iowa DNR, 2004).

The quantity of paint collected by RCC and TCD programs in Iowa and the percentage of HHW that is paint are shown in Table 6. In Iowa, some paint is weighed in cans and other paint is 'bulked' into 55-gallon drums before being weighed. The sum of the RCC and TCD quantities represents the total amount of HHW that was collected in Iowa for FY1998.

[3] As defined by the Resource Conservation and Recovery Act (RCRA).

[4] Based on an estimate of 2.46 persons per household in Iowa in 2000 (State Library of Iowa, 2004)

Table 6. Paint Collected at Iowa RCCs and TCDs: FY1998

Waste Category	RCC Total (tons)	TCD Total (tons)	HHW Total (tons)
Bulk oil-based paint	51	NA	51
Oil-based paint in cans	20	NA	20
Bulk latex paint	113	NA	113
Latex paint in cans	14	NA	14
Total bulk paint	**164**	**24**	**188**
Total paint in cans	**34**	**23**	**57**
Total Paint Collected	**198**	**47**	**245**
Total HHW collected	**625**	**118**	**743**
Percent of HHW Collected that is Paint (%)	**32**	**40**	**33**

Source: data provided by Theresa Stiner, IA DNR, 2004.
NA: Breakdown of oil-based and latex paint data are not available for TCDs.

Combined Paint Estimate: MSW and HHW

Despite a restriction on landfill disposal of oil-based paint and wet latex paint, a large quantity of paint is disposed of in this manner every year. As shown in Table 7, approximately 92 percent of the paint that was disposed of in Iowa went to MSW landfills.

Table 7. Total Leftover Paint in Iowa: Reported Data

Disposition Pathway	Total Paint (tons)	Percent of Paint Disposed by Pathway (%)
MSW Landfill	2,797	92
HHW Collected*	245	8
Total	**3,042**	**100**

Sources: IA DNR, 1998; Theresa Stiner, IA DNR, 2004.
* The HHW quantities reflect the total amount of paint collected at RCCs and TCDs.

In order to use these data to develop a national estimate, Iowa's data were adjusted (for example, to subtract the weight of paint containers), as detailed in *Appendix A*. Table 8 presents Iowa's MSW and HHW data after these data refinements.

Table 8. Total Leftover Paint in Iowa: Adjusted Values

Disposition Pathway	Total Paint (tons)	Refinements
MSW Landfill	1,615	* excludes solvents * excludes non-architectural paint * excludes container weight
HHW Collected	234	* excludes container weight (from portions that include it)
Total	**1,849**	**NA**

As is the case in California, the large percentage of paint going to Iowa MSW landfills emphasizes the importance of including MSW data when estimating the quantity of leftover paint in the United States.

Ongoing or Upcoming Studies

Although Iowa's 2005 Statewide Waste Characterization Study has been released, it was not available during the preparation of this report, and was therefore not included. The most current year of HHW data available for Iowa is 2005.

Oregon

MSW – 2000 and 2002 Oregon Solid Waste Characterization and Composition Studies

The state of Oregon regularly conducts solid waste composition studies as required by state law. Statewide studies were conducted by the Department of Environmental Quality (DEQ) in 1992/93, 1994/95, 1998, 2000, and 2002. This analysis considered the two most recent studies, from 2000 and 2002, for the quantity and composition of paint collected and disposed to landfills or incinerated in Oregon.

To conserve funds, the DEQ conducts "half-studies", using a consistent general methodology. During each of the half study years used for this analysis, 2000 and 2002, the DEQ collected 300 disposal site samples statewide, of which 75 were from the Metro tri-county area. Metro funded an additional 225 Metro-area samples. In addition, samples were collected by the DEQ, Metro, Marion County and the City of Eugene. These extra samples helped increase the precision of the statewide composition estimates. These studies also included contamination analyses (detailed sample analyses), discussed in *Appendix A*.

The 2000 study comprised 591 composition samples in 2 geographic areas – Metro and the "rest of Oregon". The 2002 study collected 844 composition samples in 4 geographic areas – Portland Metro, Marion County, Eugene and the "rest of Oregon." The Metro area alone considered 350 composition samples in 2000 and 349 in 2002. Within each geographic area, representative loads of waste weighing approximately 200 pounds from each load were selected as field samples. The 2000 study considered waste samples from seven "waste substreams:"

- Residential route garbage trucks (over 90 percent of this waste is from single-family or multifamily residences)
- Commercial route garbage trucks (over 90 percent of this waste is from businesses)
- Mixed route garbage trucks (contains a mixture of residential and commercial wastes)
- Compacting drop boxes (used by individual grocery stores, malls, or other retail operations)

- Loose drop boxes (used for construction and demolition and for "yard-cleaning" activities)
- Self-haul (wastes hauled directly to the transfer station or landfill by the person or business that generated the waste)
- Mixed Solid Waste Processing Facility (MSWPF) residual wastes (wastes leftover for disposal after recoverable materials have been removed at the facility)

In addition to these substreams, the 2002 study considered the following waste substream:

- Special Purpose Landfills (mostly collected either at general-purpose landfills or at transfer stations that ship all their waste to general-purpose landfills. In the Metro area however, significant waste amounts were from limited-purpose landfills that prohibit accepting food and other putrescible wastes.)

The number of samples collected from each waste substream depended on the absolute quantity of waste disposed from each substream, and the expected variability of waste in the substream based on past composition studies.

As part of the 2002 study, DEQ also conducted a "contamination analysis" to better characterize the actual quantities of solid waste materials being disposed. This effort was conducted with a goal of developing a "correction factor" for each material, which could then be multiplied by the field data results in order to determine more precisely the amount of each material, excluding contaminants, that was being disposed. The data presented in this section reflect the field data; details on the contamination analysis are presented in *Appendix A*.

According to the 2000 and 2002 DEQ studies, more than 2.7 million tons of MSW were disposed in Oregon in landfills or solid waste burning facilities in each study year. Total MSW generated accounted for 75 percent of statewide solid wastes in 2000 and 73 percent in 2002.[5] Table 9 presents the amount of MSW paint disposed in Oregon in 2000 and 2002.

[5] The remaining portion of solid wastes generated included industrial and other wastes, alternative daily cover, contaminated soils, inerts, asbestos, and septage sludge. Data in this report reflects MSW data and construction and demolition waste excluding pure inerts (for example, concrete).

Table 9. Paint Disposed in Oregon: 2000 and 2002

Waste Type	Quantity (tons)			Percent of Other Hazardous Materials (%)	Percent of MSW (%)
	2000	2002	Average		
Latex Paint	704	2,489	1,597	9.9	0.1
Oil Paints / Thinners	1,709	1,655	1,682	10.4	0.1
Total Paint	**2,413**	**4,144**	**3,279**	**20.2**	**0.1**
Total *Other Hazardous Materials*	**14,047**	**18,346**	**16,197**	**100.0**	**0.6**
Total MSW	**2,763,282**	**2,743,561**	**2,753,422**		**100.0**

Sources: OR DEQ, 2000 and 2002(a).
Percents are based on averaged "best estimates".
Paint is included in the "Other Hazardous Materials" category.
Quantity of paint landfilled is derived based on the percent of paint in total solid waste.

Paint disposed includes latex paint and oil-based paints and thinners. Based on the experience and judgment of the professionals who conducted this waste composition study, oil paint is estimated to comprise approximately 95 percent of the "oil paints/thinners" subcategory.6 Table 10 presents the breakdown of latex and oil-based paint by waste substream.

Table 10. Paint Disposed in Oregon by Waste Substream: 2000 and 2002

Waste Substream	Latex (tons)		Oil-Based/ Thinners (tons)		Total Paint (tons)		
	2000	2002	2000	2002	2000	2002	Average
Residential Garbage Route Trucks	154	523	373	348	527	871	699
Commercial Garbage Route Trucks	104	357	252	237	356	595	475
Mixed Garbage Route Trucks	107	393	261	261	368	654	511
Compacting Drop Boxes	47	176	115	117	162	293	227
Loose Drop Boxes	80	247	195	164	275	411	343
Self-Haul - Regular Landfill or T.S.	132	509	321	339	453	848	651
Special Purpose Landfill (hauler & self-haul)	43	138	105	92	149	230	189
Residuals: Mixed Solid Waste Processing Facility	36	145	87	96	124	241	182
Total	**704**	**2,489**	**1,709**	**1,655**	**2,413**	**4,144**	**3,278**

Sources: OR DEQ, 2000 and 2002(a).
Quantity of paint landfilled is derived based on the percent of paint in total solid waste.

[6] Based on conversation with Brad Anderson, Sky Valley Associates.

HHW – 2000 and 2002 Oregon HHW Collection

Oregon DEQ's Solid Waste Policy and Program Development Section annually compiles a *Material Recovery and Waste Generation Survey*. Oregon's waste haulers and private recycling companies are required to report the amount collected, county of origin, and markets for all of the recyclable materials they handle. Data on disposed tonnage comes from quarterly or annual disposal fee report forms. Together, recovery and disposal data are used to calculate total waste generation.

In 2000, Oregon recovered 1,223 tons of latex and oil-based HHW paint and in 2002 they recovered 1,586 tons, as shown in Table 11. HHW was recovered from Portland Metro and Oregon DEQ collection programs, garbage haulers across the state, the Knott Landfill (in Deschutes County) and a waste-to-energy plant in Marion County (for 2002 onwards). Not all programs provided data by paint type; of the available data, however, an average of 55 percent of paint was latex paint and 45 percent was oil-based (Peter Spendelow, 2004(b) and 2006(a)). Additional detail of the paint recovered by collection program is also available and has been presented in Table 11. During both years, Portland Metro's HHW collection accounted for an average of 77 percent of the total HHW paint recovered across the state. (Peter Spendelow, 2004(b) and 2006(a)).

Table 11. Paint Collected in OR HHW Programs: 2000 and 2002

HHW Waste Collection	Latex Paint (tons)		Oil-Based Paint (tons)		Total Paint (tons)		
	2000	2002	2000	2002	2000	2002	Average
Portland Metro HHW collection	571.6	660.8	419.1	497.0	990.7	1,157.8	1,074.2
Garbage haulers (Marion County)*	NA	188.7	NA	NA	96.0	188.7	142.3
Knott Landfill (Deschutes County)	NA	NA	NA	NA	19.8	70.2	45.0
DEQ sponsored HHW collection	6.2	15.2	39.4	33.4	45.5	48.5	47.0
Other garbage haulers**	NA	NA	NA	NA	14.6	8.0	11.3
Lane County	0	0	56.0	0	56.0	0	28.0
Marion County burned (oil-based)***	0	0	0	112.6****	0	112.6	56.3
Total HHW Paint	**NA**	**NA**	**NA**	**NA**	**1,222.6**	**1,585.8**	**1,404.2**

Source: Data provided by Peter Spendelow, OR DEQ, 2004(b) and 2006(a).
NA: Breakdown of latex versus oil-based paint is either not collected or not available.
* Of the 188.7 tons reported, 119 tons were reported by garbage haulers in Marion County and an additional 69 tons were reported by the county.
** Marion county programs collect latex paint only, although it is possible that some oil-based paint is mixed in. (All Marion County's oil-based paint gets burned in their waste-to-energy plant.)
*** Paint from this source can probably be attributed to HHW collection events sponsored by the garbage haulers or collection at their disposal sites.
**** Tons are an estimate of the amount of oil-based paint burned in the Marion County waste-to-energy plant. Based on a law passed in 2001, Marion County counts certain materials that are burned in their energy recovery facility towards the county recovery rate. These data are not estimated for 2001 and prior years.

Combined Paint Estimate: MSW and HHW

As in other states, a large quantity of paint is disposed to landfills every year. As shown in Table 12, the majority of disposed paint in Oregon was disposed at landfills.

Table 12. Total Leftover Paint in Oregon: Reported Data

Disposition Pathway	Total Paint (tons)	Percent of Paint by Disposition Pathway (%)
MSW Landfill	3,279	70
HHW Collection	1,404	30
Total	**4,683**	**100**

Sources: OR DEQ, 2000, 2002(a) and 2002(b), and data provided by Peter Spendelow, OR DEQ, 2004(b) and 2006(a).
Quantity of paint landfilled is derived based on the percent of paint in total solid waste.
Total paint quantities are based on averaged "best estimates".

In order to use these data to develop a national estimate, Oregon's data were adjusted (for example, to exclude thinners from the oil estimates), as detailed in *Appendix A*. Table 13 presents Oregon's MSW and HHW data after these refinements.

Table 13. Total Leftover Paint in Oregon: Adjusted Values

Disposition Pathway	Total Paint (tons)	Refinements
MSW Landfill	2,507	*excludes thinners *excludes non-architectural paints *excludes container weight *adds back dried paint
HHW Collection	1,404	*none made
Total	**3,911**	**NA**

Ongoing or Upcoming Studies

Oregon's next statewide waste composition study was scheduled to be conducted in 2005 - the same year that statewide and wasteshed recovery goals were to be achieved under Oregon Revised Statute 459A.010. Consistent with past years, the study was to be conducted by the DEQ, with additional sponsorship by Metro.

Washington

MSW – 2003 Waste Composition Analysis for the State of Washington

The composition of solid waste in the State of Washington has been studied several times over the past 15 years. These studies have been conducted on a statewide basis (in 1987 and 1992) or on a more local basis (by various counties and cities). The data from statewide studies prior to 2003 have become outdated by recent advancements in waste diversion programs (recycling and composting in particular) and by ongoing changes in consumer habits, shifts in packaging, and other factors. Therefore, only results for the 2003 study are discussed here.

The *2003 Waste Composition Analysis for the State of Washington* uses data from studies of 10 counties and one city to estimate the quantity and percentage breakdown of 76 material categories making up the solid waste stream of Washington State. In order to extrapolate beyond these 11 jurisdictions to the whole state, the percentage breakdown of the material categories in each of these jurisdictions were applied to the disposal tonnages for other counties with similar demographics. Those figures were then summed to derive a statewide total for each waste category, as well as for residential and commercial sources and the waste stream as a whole.

The statewide analysis focuses on MSW brought to landfills for disposal. Hazardous wastes are not addressed in the analysis, except in cases when these are disposed of with MSW.

Latex paint and oil-based paint are included in the analysis as subcategories within the broader category of hazardous and special waste. Paint quantities include the weight of the container if over 50 percent of the combined weight appeared to be from paint (liquid or dried) (Hlavka, 2006). Table 14 shows the total quantities of MSW, Hazardous and Special Waste, and paint waste going to MSW landfills in Washington.

Table 14. Washington Statewide Waste Composition Study Results: 2003

Waste Type	Quantity (tons)	Percent of Total Waste (%)	Percent of HSW (%)
Hazardous and Special Waste	50,090	0.90	100.0
Latex Paint	8,250	0.15	16.5
Oil Paint	2,810	0.05	5.6
Total Paint	**11,060**	**0.20**	**22.1**
Total MSW	**5,538,700**	**100.0**	-

Source: WA ECY, 2003(b).

There is a significant degree of statistical uncertainty associated with the tonnage figures presented in Table 14. These are uncertainties associated with the estimates that were generated for each of the 11 jurisdictions that served as the basis for the statewide waste composition

analysis. An additional and even larger source of uncertainty results from extrapolating the data from these jurisdictions to other counties, with all of the associated assumptions about similar demographics and other factors. The resulting level of uncertainty cannot be precisely quantified (WA ECY, 2003(b).

HHW – 2003 Washington Moderate Risk Waste Collection

In 2003, the state of Washington published the *Solid Waste in Washington Twelfth Annual Status Report*, which includes information on moderate risk waste (MRW). MRW is a combination of HHW, CESQG waste, and used oil (UO). HHW is considered waste that was generated in the home, while CESQG is small quantities of business or non-household waste. Both HHW and CESQG waste are exempt from most hazardous waste regulations.

In Washington there are 42 programs that manage MRW. All 39 counties have some sort of MRW program (or access to a MRW program in a neighboring county). Three types of MRW collections operate in the state – permanent facilities, mobile units, and periodic collection events. It is estimated that 6 percent of all households in Washington use collection events and fixed facilities (WA, 2003a).

In 2002, MRW programs in Washington collected over 6,750 tons of HHW, almost 4,600 tons of UO, and over 700 tons of CESQG waste, for a total of nearly 12,150 tons.

Latex paint and oil-based paint are two of the dominant types of HHW and CESQG waste collected in the state. Approximately 44 percent of the paint that is collected as HHW, and approximately 69 percent of the paint that is collected as CESQG waste, is oil-based. The amount of paint collected from households and from CESQGs, and the percentage of MRW that is paint are shown in Table 15.

Table 15. Paint Collected in Washington MRW Programs: 2002

Waste Category	HHW (tons)	CESQG (tons)	Total (tons)
Latex Paint	1,342	57	1,399
Latex Paint, Contaminated*	428	1	430
Oil-Based Paint	1,297	129	1,425
Total Paint	**3,067**	**187**	**3,254**
Total MRW	**6,757**	**698**	**7,455**
Percent of MRW that is Paint (%)	**45.4**	**26.7**	**43.6**

Source: WA ECY, 2003(a).
* Latex paint was classified as contaminated when paint containers included anything that made the latex paint un-recyclable; such as: latex paint mixed with solvents, oil-based paints, dirt or garbage, or other unknowns.

Combined Paint Estimate: MSW and HHW

Despite restrictions on the landfill disposal of paint, a large quantity of paint is disposed of in this manner every year. As shown in Table 16, approximately 77 percent of the paint that was disposed of in Washington in 2002 went to MSW landfills.

Table 16. Total Leftover Paint in Washington: Reported Data

Disposition Pathway	Total Paint (tons)	Percent of Paint by Disposition Pathway (%)
HSW in MSW Landfill	11,060	77
MRW Collection	3,254	23
Total	**14,314**	**100**

Sources: WA ECY, 2003(a), and WA ECY, 2003(b).

In order to use these data to develop a national estimate, Washington's data were adjusted (for example, to exclude the weight of containers), as detailed in *Appendix A*. Table 17 presents Washington's MSW and HHW data after these data refinements.

Table 17. Total Leftover Paint in Washington: Adjusted Values

Disposition Pathway	Total Paint (tons)	Refinements
HSW in MSW Landfill	6,896	* excludes non-architectural paints * excludes container weight
MRW Collection	3,254	* none made
Total	**10,150**	**NA**

Ongoing or Upcoming Studies

Resources permitting, the Department of Ecology expects to conduct the next statewide waste composition analysis in 2007/2008, followed by the release of a report in 2009.

Wisconsin

Wisconsin conducted a statewide waste characterization study in 2002 to estimate the quantity and composition of waste disposed in the state's MSW landfills. In addition, the Environmental Resources Center (ERC) located at University of Wisconsin-Madison, has compiled data for Wisconsin one-day HHW collection programs from 1984 to the present and permanent household collection programs since 1996.

MSW - 2002 Wisconsin Statewide Waste Characterization Study

As part of the statewide waste characterization study, waste loads at 14 of 36 active MSW landfills (comprising approximately 78 percent of all MSW disposed in the state) located in each of five

distinct geographic regions were randomly selected for sampling. Seasonal variations were accounted for by sampling half of the landfills in summer and half in winter; however, the results were presented as an aggregate for the entire year. Samples were first divided into three distinct substreams—residential, industrial/commercial/institutional (ICI), and construction and demolition (C&D) activities—and then further divided between commercially collected (including private and municipal haulers) and self-hauled waste loads. A total of 400 waste samples (116 residential, 166 ICI, and 118 C&D) were taken from the selected loads and sorted into 64 distinct material categories. Waste tonnages were estimated for the individual landfills, and then composition estimates were calculated at a 90 percent confidence level for the state as a whole and the 5 distinct geographic regions; for residential, ICI, and C&D generators; and for self-hauled and commercially collected wastes. Results from the 14 landfills were aggregated using a weighted averaging technique to develop a statewide estimate for the composition of disposed waste. Paint is characterized as either latex or oil paint. Paint quantities include the weight of the container if over 50 percent of the combined weight appeared to be from paint (liquid or dried) (Tarnecki, 2006). Table 18 shows statewide estimates for total MSW, the HHW portion of that, and latex and oil paint waste for each waste sector (WI DNR, 2003).

Table 18. Wisconsin Statewide Waste Characterization Study Results: 2002

Sector	Total MSW (tons)	HHW (tons)	Latex Paint (tons)	Oil Paint (tons)	Total Paint (tons)	Percent of HHW (%)
Residential	1,535,679	3,286	293	49	342	10.4
Industrial/Commercial/ Institutional	2,100,198	15,524	1,028	411	1,439	93.0
Construction & Demolition	1,116,341	7,345	5,667	635	6,302	85.5
Total Waste	**4,752,218**	**26,155**	**6,988**	**1,095**	**8,083**	**30.9**

Source: WI DNR, 2003

Note: Latex paint is estimated to be 0.1 percent of total MSW, with 90 percent confidence that it is between 0.00 and 0.3 percent. For oil paint, the study notes a 90 percent confidence interval, however because oil paint is a very small percentage of the total waste stream, and because numbers are rounded, the upper and lower confidence limits of the 90 percent confidence interval for oil paint are the same as the estimate.

HHW – 2001 Wisconsin HHW Collection

Wisconsin collects HHW through both permanent and one-day collection programs. Although the number of permanent programs has been growing since 1996, the number of one-day programs fluctuates annually based on funding. In 2001, there were 12 permanent programs and 9 one-day programs. ERC distributes annual surveys to collect data from these programs. For the permanent programs, the survey breaks down the waste by type (e.g., pesticides, latex paint, lead/oil paint, etc.); the one-day programs are only asked to report the total volume of HHW collected. The most recent year for which complete waste data are available for the permanent and one-day programs is 2001, with the exception of Milwaukee County, which is only complete to 2000. Tables 19 and 20 show the HHW collection data by county for the permanent and one-day programs, respectively.

Table 19. Wisconsin HHW Collected by Permanent Programs: 2001

County	Total HHW (tons)	Lead/Oil Paint (tons)	Latex Paint (tons)	Total Paint (tons)	Percent of HHW (%)
Brown	212.5	77.5	65.5	143.0	67
Dane	230.0	59.4	105.4	164.8	72
Kenosha	10.3	–	–	–	–
Marathon	19.9	–	–	–	–
Milwaukee (2000 data)	417.6	139.0	182.1	321.1	77
NWRPC*	98.0	–	–	–	–
Oneida	32.2	–	19.2	19.2	60
Ozaukee	11.0	–	–	–	–
Sheboygan	18.6	7.5	–	7.5	40
Waukesha**	121.2	–	–	–	–
Waupaca	0.59	–	–	–	–
Winnebago	10.3	6.7	–	6.7	65
Total	**1,182.2**	**290.1**	**372.2**	**662.3**	**56**

Source: ERC, 2004
Note: Some counties did not report quantities of waste that was paint.
*Northwest Regional Planning Commission (NWRPC) is a group of 10 counties that collect and report on HHW as a cooperative group.
**Includes data for the Superior Emerald Park Landfill (SEPL), which is in Waukesha County but reported separately in 2001; these two facilities began reporting a combined value in 2003.

Table 20. Wisconsin HHW Collected by One-Day Programs: 2001

County	Total HHW (tons)
Chippewa	16.5
Eau Claire	24.8
Green	11.9
Iowa	3.3
Langlade*	12.0
Menominee	4.0
Racine	3.5
Trempeleau	2.0
Washington*	5.2
Total	**83.2**

Source: ERC, 2004
*These counties reported waste in pounds (6,618; 7,304) and gallons (4,290; 775). The totals represent the (pounds + (gallons*4))/2000, assuming the gallon containers are half full.

Of the 12 permanent programs, 10 reported that they collected lead/oil paint, but only 5 reported the quantities of lead/oil paint collected. Reporting on lead/oil paint quantities was more complete than for latex paint. Four of the permanent programs reported the quantity of latex paint collected.

The statistical method of ratio estimation was used in this report to estimate the total amount of paint that goes to HHW collection programs annually in Wisconsin. This uses the available data on paint quantities to scale up and provide a statewide estimate of paint waste. The total estimated amount of lead/oil paint was calculated by dividing the total weight of lead/oil paint collected by permanent programs by the total weight of HHW collected by permanent programs that reported a lead/oil paint quantity. This value was multiplied by the total HHW (permanent and one-day) collected in the state to provide an estimated volume of lead/oil paint that would be collected statewide:

$$\frac{291 \text{ tons Pb/oil paint}}{889 \text{ tons HHW}} * (84 \text{ tons HHW} + 1183 \text{ tons HHW}) = 415 \text{ tons Pb/oil paint statewide}$$

The same methodology was applied to estimate the volume of latex paint that would be collected statewide:

$$\frac{372 \text{ tons latex paint}}{892 \text{ tons HHW}} * (84 \text{ tons HHW} + 1183 \text{ tons HHW}) = 528 \text{ tons latex paint statewide}$$

This shows a total estimated weight of paint that would be collected by HHW programs annually to be 943 tons. This is the amount of paint *projected* to be collected statewide, for illustration purposes. However, the *actual* paint collected based on available county data is used in this analysis.

Combined Paint Estimate: MSW and HHW

The majority of the paint disposed of in Wisconsin (92 percent) goes to MSW landfills.

Table 21. Total Leftover Paint in Wisconsin: Reported Data

Disposition Pathway	Total Paint (tons)	Percent of Paint by Disposition Pathway (%)
MSW Landfill	8,083	92
HHW Collection	662*	8
Total	**8,745**	**100**

Sources: WI DNR, 2003; ERC, 2004
*Actual paint collected by permanent programs only.

In order to use these data to develop a national estimate, Wisconsin's data were adjusted (for example, to exclude non-architectural paint), as detailed in *Appendix A*. Table 22 presents Wisconsin's MSW and HHW data after these data refinements.

Table 22. Total Leftover Paint in Wisconsin: Adjusted Values

Disposition Pathway	Total Paint (Tons)	Refinements
MSW Landfill	6,519	* excludes non-architectural paints * excludes container weight * adds back dried latex paint
HHW Collection	662*	* none made
Total	**7,181**	**NA**

Sources: WI DNR, 2003; ERC, 2004
*Actual paint collected by permanent programs only.

Summary of State MSW Studies

The state MSW composition studies used in this report rely on similar statistical sampling and sorting procedures and other similar methodological techniques to characterize the municipal solid waste stream. Thus, there is some methodological consistency among the studies. Similarities as well as differences in definitions, assumptions, and waste sorting procedures have been identified in this report and are summarized here. The differences have been carefully examined so that adjustments could be made for normalization across states.

The table below summarizes the key differences and adjustments carried out to make the state MSW data comparable. For further detail, refer to *Appendix A*. For HHW, definitions and calculation methods were generally found to be comparable across state studies, with the exception of Iowa, which weighed bulk paint along with paint in containers. Consequently, Iowa was the only state where adjustments were made to HHW data, i.e., to exclude container weight.

Table 23: Comparing State MSW Studies

State	Definition of "paint" includes latex & oil only?	Container weight included in "paint" weight?	Dried latex paint included in "paint" weight?	Non-Architectural paint included in "paint" weight?
California	Yes	Yes: Adjusted (to exclude)	No: Adjusted (to add-back)	Yes: Adjusted (to exclude)
Iowa	No: Adjusted (to exclude solvents)	Yes: Adjusted (to exclude)	Yes	Yes: Adjusted (to exclude)
Oregon	No: Adjusted (to exclude thinners)	Yes: Adjusted (to exclude)	No: Adjusted (to add-back)	Yes: Adjusted (to exclude)
Washington	Yes	Yes: Adjusted (to exclude)	Yes	Yes: Adjusted (to exclude)
Wisconsin	Yes	Yes: Adjusted (to exclude)	No: Adjusted (to add-back)	Yes: Adjusted (to exclude)

3. National Estimates of Paint Disposal

This section presents estimates of the total quantity of post-consumer architectural paint sent to municipal solid waste (MSW) landfills and incinerators, and collected by household hazardous waste (HHW) programs in the United States. National estimates have been derived based on data from the 5 states discussed in Section 2. The data from these states have been adjusted to account for three key factors (non-architectural paint, container weight, and dried latex paint), as discussed in detail in *Appendix A*. In addition to presenting national estimates of the total amount of post-consumer paint disposed of each year as MSW and HHW, this section also presents estimates of the relative proportion of the discarded paint that is latex versus oil-based. Finally, the quantity of paint disposed of each year is compared with the quantity of paint purchased.

National estimates of the total quantity of paint disposed of each year can be derived in two ways:

- By using data from each state to individually project to national levels; or
- By combining data from all the states to generate a pooled estimate.

The first method provides a broad range for the national estimate, based on data for each individual state. Each of the national estimates thus obtained assumes that the individual state estimate can be reasonably projected to the national level. However, states differ in characteristics that can impact the estimated totals. Thus, we also present a national estimate that pools the results for the five states.

The following table presents estimates of the quantity of post-consumer paint disposed by state, based on MSW composition data, HHW collection data, and U.S. Census data on population (all ages included in the counts) and households, for each state and for the nation as a whole. Each state-level estimate is then extrapolated to the national level based on the state's percentage of U.S. population and households. Similar estimates can also be based on sales of architectural coatings; however, state-specific architectural coatings sales data are not available, with the exception of the state of California.

Table 24. Estimated Quantity of Post-Consumer Architectural Paint Disposed Annually in the U.S.

State	Percent of U.S. (%)			Estimated Quantity of Paint Disposed Within State (1,000 Gallons)			Estimated Quantity of Paint Disposed Nationally (1,000 Gallons), Extrapolated Based On:		
	House-holds	Pop-ulation	Sales*	HHW Collection	MSW Disposed/ Incinerated	Total	Households	Population	Sales*
	[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]
California	10.91	12.04	13.66	2,036	5,128	7,165	65,698	59,526	52,460
Iowa	1.09	1.04	-	51	334	385	35,312	37,001	-
Oregon	1.26	1.22	-	303	518	821	64,896	67,495	-
Washington	2.15	2.09	-	728	1,426	2,154	100,042	102,859	-
Wisconsin	1.98	1.91	-	143	1,347	1,490	75,372	78,153	-
All States Combined	**17.39**	**18.29**	**-**	**3,261**	**8,753**	**12,014**	**69,088**	**65,678**	**-**

Calculations will not match due to rounding.
Incorporates adjusted state data.

Sources: U.S. Census Bureau, 2000(a); U.S. Census Bureau, 2000(b); CARB, 2003; CIWMB, 2004; data provided by Anna Ward, CIWMB, 2004, IA DNR, 1998; data provided by Theresa Stiner, IA DNR, 2004; OR DEQ, 2002(a); data provided by Peter Spendelow, OR DEQ, 2004(b); OR DEQ, 2002(b); WA ECY, 2003(a), and WA ECY, 2003(b).
Notes: Paint quantities were converted from tons to gallons, assuming an average weight of 10.5 lbs/gallon for latex and 7.5 lbs/gallon for oil-based paint.
Calculations:
A. Based on 105 million households in the U.S. according to U.S. Census Bureau, 2000(a).
B. Based on a population of 281 million in the U.S. according to U.S. Census Bureau, 2000(b).
C. Based on architectural coatings sales of 661 million gallons in the U.S. according to U.S. Census Bureau data (derived, U.S. Census Bureau, 1994-2004). Sales data are not available, except for California, which is for 2000.
D. Quantities of paint collected in HHW programs in this state (quantities were converted from tons to gallons assuming an average weight of 10.5 lbs/gallon for latex and 7.5 lbs/gallon for oil-based paint).
E. Quantities of paint disposed of to landfills or incinerated in the state (quantities were converted from tons to gallons assuming an average weight of 10.5 lbs/gallon for latex and 7.5 lbs/gallon for oil-based paint).
F. Combines paint collected from HHW programs and landfills.
G. National estimate of the quantity of leftover paint extrapolating by percent of households in the state: [F]/[A]
H. National estimate of the quantity of leftover paint extrapolating by percent of population in the state: [F]/[B]
I. National estimate of the quantity of leftover paint extrapolating by percent of architectural coatings sales in California: [F]/[C].
*Architectural coatings sales data are not available, except for California, which is for 2000.

As shown above, when considering each individual state's projection to the national level, the estimated quantity of post-consumer architectural paint disposed of annually in the U.S. ranges between 35 million and 103 million gallons. The pooled estimate provides an estimate of 66 to 69 million gallons of post-consumer architectural paint disposed or incinerated annually in the U.S.

According to the U.S. Census Bureau, architectural paint sales in the U.S. (for data collection and sampling years included in this analysis) ranged from 621 to 809 million gallons. (U.S. Census Bureau, 1994-2004). Using sales data for the year in which the underlying MSW and HHW data were collected for each of the national estimates of paint disposal reflected in Table 24,(and an average if multiple years were used), the total quantity of post-consumer architectural paint disposed was calculated as a percentage of annual architectural paint sales. As presented in Table 25, the annual quantity of architectural paint disposed in the U.S. is estimated to be

approximately 6 to 16 percent of annual sales, based on the projection of the individual state-level estimates to the national level or a pooled estimate of around 10 percent.

Table 25. Percent of Architectural Paint Sold in the U.S. that is Disposed

State	Percent based on:		
	Households	Population	Sales*
California	9.4	8.5	7.5
Iowa	5.7	6.0	
Oregon	9.9	10.3	
Washington	15.2	15.6	
Wisconsin	11.1	11.5	
All States Combined	**10.4**	**9.9**	

Sources: U.S. Census Bureau, 2000(a); U.S. Census Bureau , 2000(b); CARB, 2003; CIWMB, 2004; data provided by Anna Ward, CIWMB, 2004, IA DNR, 1998; data provided by Theresa Stiner, IA DNR, 2004; OR DEQ, 2002(a); OR DEQ, 2002(b); data provided by Peter Spendelow, OR DEQ, 2004(b); WA ECY, 2003(a), and WA ECY, 2003(b).
* Architectural coatings sales data not available by state, except for California. California's architectural coatings sales data are for 2000.

Alternative Estimation Methods

Using the same data, this section presents two alternative methods for estimating the total quantity of post-consumer architectural paint sent to MSW landfills and incinerators, and collected by HHW programs in the U.S. In the first method, household data are used to estimate the quantity of paint disposed annually in the U.S., based on a pooling of the estimates developed for the 5 states. The second method uses population data to determine the same.

Table 26A presents the ratio of the total amount of architectural paint that is disposed of as MSW or HHW in the 5 states to the total number of households in these jurisdictions. This ratio (0.65 gallons per household) is then applied to the total number of households in the U.S. (105 million households (U.S. Census Bureau, 2000(a))), resulting in a national estimate of 69 million gallons of post-consumer architectural paint disposed annually.

Table 26A. Gallons of Architectural Paint Disposed Annually Per Household for Five States (Based on the total number of households)

State	Number of Households (1,000s)	Total Leftover Paint (1,000 Gallons)	Gallons per Household
California	11,503	7,163	0.62
Iowa	1,149	385	0.34
Oregon	1,334	821	0.62
Washington	2,271	2,155	0.95
Wisconsin	2,085	1,491	0.72
All Five States	**18,342**	**12,014**	**0.65**

Sources: U.S. Census Bureau, 2000(a); CIWMB, 2004; data provided by Anna Ward, CIWMB, 2004, IA DNR, 1998; data provided by Theresa Stiner, IA DNR, 2004; OR DEQ, 2002; data provided by Peter Spendelow, OR DEQ, 2004(b); WA ECY, 2003(a), and WA ECY, 2003(b).

Similarly, Table 26B presents the ratio of the total amount of paint disposed in the 5 states to the total population (all ages included[7]) in these states. This pooled ratio (0.23 gallons per person) is then applied to the total U.S. population (281 million people (U.S. Census Bureau, 2000(b))), resulting in a national estimate of 65 million gallons of post-consumer architectural paint disposed annually.

Table 26B. Gallons of Architectural Paint Disposed Annually Per Person for Five States (Based on the total population)

State	Population (1,000s)	Total Leftover Paint (1,000 Gallons)	Gallons per Person
California	33,872	7,163	0.21
Iowa	2,926	385	0.13
Oregon	3,421	821	0.24
Washington	5,894	2,155	0.37
Wisconsin	5,364	1,491	0.28
All Five States	**51,477**	**12,014**	**0.23**

Sources: U.S. Census Bureau, 2000(b); CIWMB, 2004; data provided by Anna Ward, CIWMB, 2004, IA DNR, 1998; data provided by Theresa Stiner, IA DNR, 2004; OR DEQ, 2002; data provided by Peter Spendelow, OR DEQ, 2004(b); WA ECY, 2003(a), and WA ECY, 2003(b).

As was done previously in Table 25, we can compare these two national estimates of the amount of post-consumer architectural paint disposed annually to the amount of paint annually sold in the U.S. According to numbers from the U.S. Census Bureau, the estimated total quantity of architectural coatings sold in the U.S. (averaged over the different study years used for the 5

[7] Another approach would be to use the population age 18 years and older to better reflect the population using paint.

states) was 662 million gallons (derived, U.S. Census Bureau, 1994-2004). Table 27 shows that around 10 percent of this can be estimated to be disposed annually, within the range presented in Table 25.

Table 27. Percent of Architectural Paint Sold in the U.S. that is Disposed

Avg. Annual Quantity of Architectural Paint Sold in the U.S.* (1,000 Gallons)	Estimated Annual Quantity of Architectural Paint Disposed in the U.S. (1,000 Gallons), based on:		Quantity of Architectural Paint Disposed Annually as a Percent of Sales (%)
661,790	Household	69,088	10.4
	Population	65,678	9.9

Source: U.S. Census Bureau
* Averaged over the different study years used for each of the 5 states.

National Estimate Compared with PPSI Estimate

The *PPSI Background Report* provided an estimate of the quantity of leftover paint generated annually in the U.S., based on data from California HHW and Washington MRW (HHW) collection programs, as well as U.S. Census data on population and households in each of the two states and the country as a whole, and an estimate of the percent of the population served by permanent or temporary HHW or MRW collection programs in the two states. The estimate was based on the assumption that existing HHW programs in the two states were collecting between 50 and 100 percent of leftover paint generated by residents served by those programs. The PPSI Background Report estimated the quantity of leftover paint generated in the U.S. to be in the range of 16 million to 35 million gallons per year, or 2.5 to 5 percent of annual paint sales (PPSI 2004a).

The national estimates presented in this report refine the estimate provided in the PPSI Background Report by:

- Incorporating HHW collection data from three additional states (Iowa, Oregon and Wisconsin);
- Estimating the actual quantity of paint collected by HHW programs and disposed via the MSW waste stream

4. Conclusions

From the data examined in this report, it is estimated that when considering each of five individual state's projections to the national level, between 35 and 103 million gallons of post-consumer architectural paint (or between 6 and 16 percent of annual sales) is disposed of annually. Further, based on a pooled estimate of these five states, 66 to 69 million gallons of architectural paint are estimated to be disposed of each year. These quantities may not represent all of the leftover paint generated annually in the U.S. Some leftover paint is undoubtedly dried out by consumers outside of the original container, spilled down drains, or disposed of by contractors and large industrial, commercial and institutional users as solid or hazardous waste. On the other hand, there are also factors that may lead to over-estimation of the amount of leftover paint disposed annually. In addition, the estimates presented in this report do not account for the large quantity of leftover paint that is currently stockpiled in homes, nor do they provide a basis for determining if that stockpile is increasing or diminishing over time.

Nevertheless, these estimates may provide a useful measure of the total quantity of post-consumer architectural paint disposed in the U.S. each year, and a rough approximation of the percentage of paint sold each year that becomes leftover post-consumer waste.

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Appendix A: Data Refinements and Other Considerations

In conducting the analysis presented in this report, numerous factors were identified that could affect the results. This Appendix describes these factors and, where quantitative adjustments were made to the results, describes the methodology for doing so.

Data Refinements

The national estimates presented in this report are based on data pertaining to the disposal of architectural latex and oil-based paint in the municipal solid waste stream, as well as data collected by household hazardous waste collection centers, as reported in studies from five states across the country. In combining individual state-level data sets to develop a national estimate, similarities and differences in definitions, assumptions, and data collection methodologies were examined to determine their possible effect on the results, and adjustments were made to the data when warranted. For example, the paint quantities reflected within some state MSW composition studies excluded the quantity of dried paint in containers that was sorted into a non-paint category, or included the weight of the container with the paint weight. Adjustments were made to the results of these studies, where possible, to address such issues. This report assumes that household behavioral patterns associated with stockpiling and disposing of leftover paint are relatively consistent across the U.S. and so adjustments are not made for this variable. This section details all adjustments made to the state data in the course of developing the national estimates.

MSW Data Refinements. The various state MSW composition studies generally have consistent methodologies (as presented in the *Other Considerations* section below), but also present some measurable differences. For example, some studies include other materials such as solvents or thinners in their definition of "paint." Consequently, adjustments were made using the best obtainable data to make these studies more comparable before combining their data for the national estimate. Adjustments to MSW data are especially important as, from the available state data, it is apparent that paint in the MSW stream accounts for the majority of leftover paint.

HHW Data Refinements. In general, the five states analyzed have mature HHW collection programs that compile reliable data on the quantity of paint collected.

Definition of "paint"

The goal of this study was to examine latex and oil paint. However, some states may also include other materials in their definition of "paint."

- In HHW collection efforts Washington includes contaminated latex paint (such as latex paint mixed with solvents, oil-based paints, dirt or garbage). Additionally, some HHW studies may record "paint" differently based on the available categories listed on data sheets. However, these factors were not expected to have a major impact on the results of this study, and data were not adjusted due to insufficient additional information.

- In state MSW studies, two states explicitly included other materials in the paint category during their waste sorts: Iowa quantified "paints and solvents," and Oregon quantified "oil paint and thinners." In addition to these known factors, factors such as personal interpretation by the sorting crew could potentially make the categories different in ways that are not easy to detect. In Oregon and Iowa adjustments were made based on estimates of the portion of the combined categories that were paint.

In addition, the Association of Municipal Recycling Coordinators (AMRC)'s *2005 HHW Baseline Study* (conducted in Ontario Canada), indicates that latex and oil-based paint categories may also include quantities of other materials. For example, the "latex paint" category also includes stain, rust or metal paint, specialty paints, liquid plastic, and varnish. Similarly, the "oil-based paint" category includes other product types, such as: stain, driveway sealer, varnish, wood finish, and lacquer. Since sufficient data on the potential mix of materials in each paint category does not exist, with the exception of the adjustments detailed below, this analysis assumes that one hundred percent of the paint in the latex category is latex paint, and the same for the oil-based category.

Adjustments made:

- *Iowa* – excluded 10 percent (solvents)[8] from the total tons of paints and solvents in MSW (IA DNR, 1998).
- *Oregon* - excluded 5 percent (thinners)[9] from the total tons of oil paint and thinners in MSW (averaged, OR DEQ, 2000 and 2002(a)).

Architectural vs. Non-Architectural Paint

The goal of this study was to estimate national quantities of *architectural* paint disposed, defined as paint used in and on buildings. However, all statewide MSW studies used in this analysis included both architectural and non-architectural paint in their "paint" category. From AMRC's 2005 Baseline Study, it was determined that, on average, 12 percent of the waste "paint" is comprised of non-architectural paint types. Specifically, the latex paint category was found to include 4 percent non-architectural products, while 27 percent of oil-based paints included non-architectural products. For the purposes of this analysis, each state's data was adjusted to exclude non-architectural paint, as presented below.

[8] Based on conversations and data provided by Tanya Tarnecki of Cascadia Consulting, and Brad Anderson of Sky Valley Associates.

[9] Per Brad Anderson, Sky Valley Associates, August 10, 2006.

Adjustments made:

- *California, Iowa, Oregon, Washington, and Wisconsin* – excluded 4 percent (non-architectural latex paints) from the total tons of latex paint and 27 percent (non-architectural oil-based paints) from the total tons of oil-based paint in MSW.

Paint Weight

Research indicates that the waste sorting protocols used in most waste characterization studies call for distinguishing between:

- *empty* paint containers (which are typically classified as the material of the container itself);
- containers containing *dried* paint (which are typically classified as the material of the container or as a mixed material category); and
- containers containing *liquid* paint (which are typically classified as paint).

This leads to two factors for consideration:

- whether dried paint is included in the overall paint estimate; and
- whether the weight of the container is included in the overall paint estimate.

Dried Paint Weight

Most states do not include dried paint in their "paint" category[10]. Several studies indicate that increasingly, consumers are drying latex paint prior to disposal. It is important to understand the impact of dried paint on a national estimate. To do this, we considered three sources of information that indicate a substantial portion of dried paint can be expected in disposed containers.

- Many states and/or local communities advise their residents to dry out their leftover latex paint for disposal in the garbage or at a collection center. Even states like California that do not encourage this practice, nevertheless permit residents to dispose of dried latex paint in the MSW stream. Organizations such as the National Paint and Coatings Association (NPCA) also promote this approach. For example, NPCA's Six Point Program for Leftover Paints advises consumers to properly dispose of latex paint by drying it (as a last resort after reusing, recycling, and exchanging leftover paint). (NPCA 2004b).
- A survey conducted for NPCA in the mid 1990s sought to learn about the disposition of leftover paint, stain, thinners and similar materials in households. The survey was conducted in 1,000 households, by a national market research firm, National Family Opinion (NFO) using their

[10] Washington does include dried paint and Wisconsin includes dried oil-based paint only.

nonprobability consumer panel sample. The study had an interview response rate of more than 70 percent. The study reported that, on a volume basis, 30 percent of leftover paint was from homes that use evaporation as a disposal method. (The survey did not ask the respondents to differentiate between latex and oil-based paint.) (NFO, 1995).

- The two Oregon waste characterization studies (2000 and 2002) included an analysis of contaminants in disposed waste. For this analysis, paint containers that were nearly empty or contained dried paint were included in the appropriate container category – non-food steel cans, rigid plastic containers, or mixed material – and then subject to contamination analysis. Paint found in these containers was scraped out, weighed, and then "added back" to the paint category. The amount of dried latex paint found in containers was fairly large, so a correction factor was produced. The Oregon contamination analysis provided the following results for 4 detailed samples containing paint in 2002 and 2 samples in 2000. It should be noted that this study alone does not constitute conclusive evidence regarding the quantity of dried paint that is disposed in containers in MSW, since it is based on a limited sample size. However, it does provide supporting evidence that a significant quantity of leftover paint may be dried out by the consumer prior to disposal in MSW. In addition, it suggests that a substantial percentage of latex paint is dried out prior to disposal in landfills and incinerators, but the percentage of oil-based paint that is dried out is negligible.

Table 28. Oregon contamination analysis in 2000 and 2002

	# Samples		Percent of Dry Add-Backs		Contamination Correction Factor (%)		90% Confidence Intervals		Avg. Contamination Correction Factor (%)
	2000	2002	2000	2002	2000	2002	2000	2002	
Latex paint	1	3	30.40	20.50	30.40	20.45	(-12.75 to 78.53)	(2.65 to 51.26)	25.4
Oil-based paint/thinner	1	1	4.40	4.50	4.37	4.52	(0.00 to 8.25)	(0.47 to 10.97)	4.5

Source: OR DEQ, 2000 and 2002

It should be noted that despite the small sample sizes and large confidence intervals for latex paint, the two individual analyses present fairly consistent results.

The NPCA study suggests that about 30 percent of leftover paint may be dried out prior to disposal, and therefore would not be reflected in the paint quantity estimates developed by state waste composition studies. In order to fully capture the quantities of paint disposed, dried paint may be "added back" to these paint quantities. Because guidance to consumers to dry out paint only applies to latex paint, and considering that the Oregon contamination analyses show far more dried latex than dried oil-based paint in cans, the latex paint quantities in three state MSW studies were adjusted upward by 30 percent, while the oil-based paint quantities were left as-is. This adjustment does not factor in the following considerations, which are not resolvable due to the lack of data:

- Weight of dried paint reported in the Oregon contamination analyses does not represent the original weight of the paint as a liquid.

- Consumers may be drying paint and disposing of it outside of containers.

Adjustments made:

- *California, Oregon, and Wisconsin* – added-back 30 percent (dried paint) to the total tons of latex paint in MSW.

Residual (Liquid) Paint Weight

Residual amounts of liquid paint in a container are categorized in some waste composition studies as mixed materials or the material of the container itself rather than as paint. The amount considered residual is subject to interpretation by the sorting crew, since most states have no definitive threshold. Waste composition study experts indicate that a container is categorized as "paint" if it contains *any* liquid paint (with the exception of Washington and Wisconsin, which categorize a container as "paint" when paint accounts for the majority of the combined container and paint weight). Because these distinctions in classification could not be quantified, residual liquid paint quantities in disposed containers are considered negligible and no adjustments were made.

Container Weight

Inclusion of container weight with paint weight was also considered in this analysis. For MSW, once a container is classified as "paint," the paint and its container are weighed and recorded within this category. The weight of the container therefore should be excluded from the paint quantities in order to develop a more accurate estimate. Detailed analyses documenting the type and size of container were not undertaken at this time. However, we look at the following studies to determine the portion of weight that is container alone:

- An expert at Portland Metro[11] estimates that an average gallon paint container weighs 0.9 pounds, with gallon containers being the most common size. They further estimate that latex paint weighs between 10-11 pounds per gallon and oil-based paint weighs between 7-8 pounds per gallon, and that paint cans come into their HHW collection program, on average, 45 percent full.

- Product Care in British Columbia, Canada, estimates that approximately 20-25 percent of the combined weight of the paint and containers it collects can be attributed to the containers. From these data, and given the weight of paint above, we estimate that on average containers in this program are 21 percent full.

[11] Based on conversations and data provided by Jim Quinn of Portland Metro.

- The AMRC 2005 Baseline Study presents data on container quantity and residual paint quantities for oil and latex paints. From these data we estimate that latex and oil-based paint containers are 51 percent full.

It should be recognized, however, that paint containers collected by HHW programs might contain more paint, on average, than containers disposed in MSW landfills, although this has not been formally examined. As the amount of paint in a container decreases, the weight of the container, relative to that of its contents, increases. Due to the lack of hard evidence comparing the relative fullness of paint containers in HHW and MSW programs, this analysis assumes that containers in the MSW stream are half the fullness of those collected at HHW collection centers. Thus, averaging Portland Metro, Product Care, and AMRC's estimates on container fullness and assuming half this fullness for MSW, we estimate that 32 percent of the combined weight of the paint and containers can be attributed to the containers themselves and should be "backed out" from the overall paint weight.

In addition, it was learned that a portion of the paint coming to Iowa's HHW collection center was not bulked prior to weighing, thereby including the weight of the container. By averaging the estimates on container fullness from the above-mentioned studies, we estimate that 19 percent of the combined weight of the HHW paint and containers can be attributed to the containers themselves and should also be "backed out" from the overall paint weight.

Adjustments made:

- *California, Iowa, Oregon, Washington, and Wisconsin* – excluded 32 percent (container weight) from the total tons of MSW paint estimates.
- *Iowa* – excluded 19 percent (container weight) from the 57 tons of HHW paint known to include container weight.

Other Considerations

Paint Spillage

Paint may spill from containers en route to the disposal location, where it is subsequently weighed. The loss of paint (presumably adhered to paper, food and other adjacent waste materials) would be reflected in an undercount of total paint at the disposal site. It is safe to assume that some cans may get crushed on the way to the landfill, and that lids may pop off. Per Brad Anderson, a consultant with Sky Valley Associates, approximately 1 percent of their waste characterization samples showed spilled paint, suggesting that spilled paint quantities are small. Sky Valley Associates does not quantify the percentage of paint containers that arrive with open lids.

Seasonal Collection Efforts

State waste composition studies sometimes conduct sampling of MSW during different times of the year, such as in a cold and warm seasons. In the 2002 Oregon Solid Waste Characterization and Composition Study, samples collected during four seasons present little to no variability in the overall results based on season. In the 2005 Iowa Study, IDNR also concluded that seasonal differences in the MSW stream are not statistically significant due to minimal difference observed from their seasonal waste sort in the 1998 study.

Paint Disposition/Management

Some of the states included in this analysis have incinerators or waste-to-energy facilities, where amounts of paint, along with other MSW, are sent for energy recovery. The paint quantity data reflected in the state MSW case studies includes these quantities.

Paint Misclassification

The misclassification of unknown paint or solvents is another factor that can lead to errors in the estimation of paint in waste composition studies. For example, a waste sorter might categorize an unlabeled container of paints or solvents as "unknown," or define other liquids (for example, solvents) as "paint." Factors such as personal interpretation by the sorting crew could potentially make the categories different in ways that are not easy to detect. This could lead to over- or under-estimation of the amount of paint being disposed.

Sample Size, Confidence Intervals, and Bias

Sampling variance of the state estimates can be influenced by sample sizes, sampling weights, and measurement protocols (for example, random versus nonrandom sampling). Sample size (for example, 100 versus 10 samples) directly impacts the precision of the state estimates, with a larger number of samples yielding more statistically robust results. In addition, results could be biased if states ignored the sampling weights in forming their estimates. The actual measurement protocols used within each state can also have an impact of the error of the state estimates (as discussed under Paint Misclassification).