NATIONAL HAZARDOUS WASTE CONSTITUENT SURVEY (NHWCS)

SUMMARY REPORT

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BACKGROUND

In 1996, EPA's Office of Solid Waste administered the *National Hazardous Waste Constituent Survey* (the Survey, or NHWCS) to 221 of the largest generators and managers of hazardous industrial process waste in the U.S. These facilities accounting for over 90 percent of the total waste quantity in the hazardous waste universe as reported in the 1993 *National Biennial RCRA Hazardous Waste Report* database (BRS). The Survey requested data describing many important physical characteristics of process waste streams. For example, it asked facilities for specific quantitative descriptions of waste, such as heat content and ignitability, as well as various data describing the physical form of waste streams (percent suspended solids, percent water).

In addition to providing key data points from the 1993 BRS that describe waste stream characteristics, the NHWCS, also and most importantly provides EPA with a unique source of recent, up-to-date concentration information for individual constituents appearing in RCRA waste. This Survey is the first source of such specific constituent information since EPA's 1986 *National Survey of Hazardous Waste Generators* (the Generator Survey*)*. Over the past decade, there have been substantial changes in industrial processes, waste treatment technologies and management methods, waste minimization efforts, and economic trends affecting industries and individual facilities. Similarly, a number of significant EPA regulations affecting industrial activities have been promulgated in the period since the Generator Survey, including the Land Disposal Restrictions, the expansion of the Toxicity Characteristic list, and the Hazardous Waste Identification Rule (HWIR). Due to both regulatory changes and industry trends, there have been significant changes in the types of hazardous constituents, quantities of constituents, the frequency of constituent occurrences, and the relative toxicities of constituents reported in hazardous RCRA waste since the Generator Survey.

PURPOSE OF SURVEY

The intent of the Survey was to provide information to support the analysis of HWIR, through the collection of constituent concentration data that can be compared to risk-based levels established by HWIR. In addition to insights on the impacts of HWIR, however, the Survey also provides valuable information on broad hazardous waste issues and other regulatory policy issues of interest to EPA. In particular, the Survey provides insights on the following key RCRA program and hazardous waste issues:

- **Large Quantity Generators and Managers:** Which facilities generate or manage largest quantities of waste? Where are these facilities located? Which facilities generate or manage highly concentrated RCRA waste, highly dilute RCRA waste, and waste posing the greatest hazard to human health and the environment?

- **Characteristics of Waste Streams:** What are the most prevalent types of hazardous waste? What are the most prevalent constituents found in hazardous waste? What are the most common physical forms of hazardous waste (e.g., non-wastewater, wastewater)? How many different constituents are in hazardous waste? What are the relative concentrations of hazardous constituents in RCRA waste?

- **Waste Treatment and Management:** What management methods are employed to manage hazardous constituents? What methods do industries use to manage the most toxic constituents? How much of total hazardous constituent quantity is land disposed? How much is destroyed thermally (i.e., incinerated)? How is management of hazardous constituent quantities distributed geographically?

- **Major Industry Sectors:** Which industry sectors produce the majority of waste and constituent quantities? Which industry sectors generate the greatest number and variety of constituents? Which industry sectors generate the greatest quantity of hazardous constituents? How do dominant industry sectors choose to manage hazardous constituents?

OVERVIEW OF SURVEY ANALYTICAL APPROACH

This report presents insights and results from the review of the constituent information provided in the NHWCS; in particular, the analysis focused on the constituent concentrations and quantities reported in NHWCS waste streams. Because comparable constituent data are not available from BRS or other EPA data sources, we designed the analysis to address specific waste issues and aspects of the RCRA program that require knowledge of constituent generation and management, including the issues mentioned above. In addition, many of our analyses incorporate constituent data in conjunction with other waste stream information, such as system management data, to develop more detailed insights about specific industry sectors and waste groups.

For the majority of the constituent data analyses, we provide information on a subset of NHWCS constituents that coincide with the 1997 EPA Draft Prioritized Chemical List. EPA developed this list to identify constituents that pose serious threats to human health and the environment due to their toxicity and their tendency to bioaccumulate and persist in the environment.[1]

[1] Each of the persistent, bioaccumulative, and toxic (PBT constituents) constituents on EPA's Draft Prioritized Chemical List is assigned an overall 'score' ranging from 6 to 18, with 18 representing the greatest hazard to human health and the environment. The analyses focus on the hazardous PBTs, with an overall score of 12 to 18. We refer to these throughout the text in this report

Our analyses of these constituents focused on a subset of the list that represented 93 of the 267 constituents with the highest hazard scores on the complete PBT list (approximately the top one-third of the PBT list). The list of PBT constituents is still under development and is therefore subject to change however, analyses of this subset of the existing PBT list should provide EPA with an improved understanding of the potential threats posed by these types of constituents. For example, EPA might use constituent quantity results for these hazardous PBTs to target development of new pollution prevention initiatives.

SUMMARY OF RESULTS

The major findings of the NHWCS Analysis are as follows:

- *NHWCS provides good coverage of constituent concentrations in large RCRA waste streams*. Survey respondents provided constituent information for approximately 50 percent of the hazardous waste generated in 1993. For these large waste streams, the Survey includes representative data for wastewaters and non-wastewaters; for listed, characteristic, and listed and characteristic wastes; and for the predominant management methods and industry sectors.

- *The majority of facilities included in the Survey managed between ten and sixty hazardous constituents.* None of the facilities managed fewer than ten constituents, while a small percentage of facilities (less than 5 percent) report waste with more than 100 hazardous constituents.

- *A relatively small number of hazardous constituents are found in a large proportion of NHWCS waste streams.* Each of the fifteen constituents found most frequently occurred in at least 20 percent of waste streams. These include five heavy metals (lead, chromium, cadmium, barium, and arsenic) as well as a number of organics and inorganics (toluene, xylenes, benzene, acetone, methyl ethyl ketone, methylene chloride, ethyl benzene, methanol, methyl isobutyl ketone, and ethyl acetate).

- *Concentrations of these highly prevalent constituents vary according to the type of constituent.* Reported concentrations of organics and inorganics are significantly higher than those reported for prevalent metals — median concentrations for five of these prevalent non-metals range between 10,000 and 100,000 parts per million. Median concentrations for three of four prevalent metals are an order of magnitude lower, from 1 to 200 parts per million.

- *Hazardous constituent quantities represent a relatively small proportion of the total quantity of hazardous waste.* The total quantity of all NHWCS constituents is 2.1 million tons, which accounts for 2 percent of NHWCS waste quantities in the respondent population. The distribution of total constituent quantities is highly skewed -- a small number of waste streams containing more than 10,000 tons of constituent quantity each account for the majority (60 percent) of NHWCS constituent quantities.

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as 'hazardous PBTs.'

- *Lead accounts for a significant percentage of both total hazardous constituent quantities and quantities of the hazardous PBTs.* However, only nine waste streams account for almost 90 percent of the total quantity of lead. Other high-quantity constituents include sulfate, sulfuric acid, toluene, xylenes, and methanol, each accounting for at least four percent of total constituent quantity.

- *Concentrations of these high-quantity constituents span a very wide range.* Concentrations of organics and lead, for instance, span as many as five orders of magnitude. High-quantity constituents that show a narrower range of concentrations, such as sulfate, sulfuric acid, and chlorine, appear in a small number of waste streams at very high concentrations.

- *Most of NHWCS constituent quantities are managed on-site, using a few major management methods.* Sixty percent of total constituent quantity is managed on-site by large generators; at least two-thirds is managed using one of the following methods -- underground injection, energy recovery, fuel blending, incineration, or metals recovery. Land disposal is still highly prevalent and is used to manage 23 percent of total NHWCS constituent quantities.

- *Constituent concentrations in NHWCS as-generated waste and treatment residuals indicate that waste treatment effectively reduces concentrations of many RCRA constituents, particularly organics.* Median concentrations of the most highly prevalent and high-quantity organics in treatment residuals are at least three orders of magnitude lower than those in as-generated organics. Differences in median concentrations of metals in as-generated waste and treatment residuals are less significant. However, metal concentrations are much lower as-generated compared to most organics.

- *A few major industries dominate the generation of constituent quantities.* Ten industries account for 96 percent of total NHWCS constituent quantity. Of these ten industry sectors, the Chemicals and Allied Products industry (SIC 28) is dominant, accounting for 65 percent of total constituent quantity.

USING AND INTERPRETING NHWCS DATA

While the NHWCS provides an excellent general overview of waste stream constituents and characteristics, users of the data need to recognize certain key limitations on its use and interpretation. First and foremost, the Survey does not necessarily provide representative information on smaller waste streams. The focus of the Survey sampling methodology was the large waste streams that account for the vast majority of quantities generated. The sampling procedure used in NHWCS did capture some smaller streams at facilities generating or managing the large streams, but these do not represent a random sample of all small streams. As a result, users of the NHWCS should exercise caution in extrapolating the survey results to the many smaller generators of hazardous waste.

Second, users interested in drawing conclusions that are representative of large streams nationwide should conduct additional analysis to ensure there are no systematic biases among sample facilities that did not respond to the Survey. For example, if constituents managed by sample facilities that did not respond to the Survey are generated by different industry sectors than constituents managed by facilities that did complete the Survey, we have no guarantee that the constituent data for facilities represented by the non-respondents are similar to that of respondents. We conducted some initial review of this issue and did not find significant differences among quantities and the number of facilities among the industries represented; however, there may be other biases represented by non-respondents that are not evident from examining differences among quantities or facilities.

A third factor complicating interpretation of NHWCS results is that a few facilities appear to have reported the same waste stream multiple times. This poses problems when estimating total constituent quantities because the same waste quantities and constituent quantities are reported more than once for these facilities. Survey users should examine whether this potential double-counting may have a significant influence on results and needs to be corrected for in their analyses.

Finally, the NHWCS data set includes information on some constituents that are not defined as hazardous under the RCRA regulations. Nonhazardous constituents are interesting to evaluate because they often co-occur with hazardous constituents, and may also contribute to a hazardous characteristic exhibited by a waste (e.g., reactivity). Users of the information in this report should note that we include all constituents reported in the Survey, both hazardous and non-hazardous, in these results. Users interested solely in RCRA hazardous constituents, however, will need to screen out non-hazardous constituents before conducting their analyses.

ORGANIZATION OF THE REPORT

This remainder of this report is divided into seven chapters. Chapter 2 briefly describes the design and implementation of the Survey, as well as the extent to which the Survey results accurately represent the universe of hazardous waste. Chapters 3 and 4 discuss key constituent data provided by the Survey -- specifically, the prevalence and relative quantities of NHWCS hazardous constituents. Chapter 5 describes treatment and management of NHWCS constituents, and Chapter 6 provides results of NHWCS constituent analysis for key industry sectors. Chapter 7 provides major conclusions and implications of the NHWCS analysis.

EPA designed the *National Hazardous Waste Constituent Survey* to update and improve upon existing data characterizing hazardous RCRA constituent generation and management. The design of the Survey reflects the fact that its primary goal is to acquire data that accurately describes the composition of waste streams comprising a majority of the RCRA hazardous waste universe. The secondary goal of the Survey is to collect waste stream and facility information relevant for other EPA analyses of the RCRA program. For example, the survey provides data to analyze constituents generated by specific industry groups, including constituent quantities and prevalence by industry.

SURVEY DESIGN

EPA designed the NHWCS Survey instrument with several unique features. First, in contrast to the Generator Survey, the NHWCS measures some waste stream and constituent characteristics at the point of management rather than at the point of generation. To capture a significant portion of the RCRA waste universe, EPA targeted facilities that manage over 90 percent of hazardous waste in each of the following categories: total waste, listed waste, characteristic waste, listed and characteristic waste, non-wastewaters, and combusted waste.[1] By using this design, the Survey focused on treatment, disposal, and recycling facilities (TDRs), as well as very large generators that manage their own waste exclusively onsite.

The second feature reduced the overall reporting burden on targeted facilities. EPA used facility and waste stream information from the 1993 *National Biennial RCRA Hazardous Waste Report* (BRS) database and pre-loaded each facility's BRS responses into their questionnaire. Hence, unless respondents needed to correct their responses to the 1993 BRS, the Survey only required respondents to provide physical characteristic and constituent concentration data. To provide further reporting relief, EPA only requested data on the top twenty 'major' waste streams generated or managed by a facility. To account for waste quantities associated with smaller, 'minor' wastestreams,

[1] To identify the TDRs and other facilities that account for the majority of hazardous waste, EPA used facility and waste quantity data from the *1993 National Biennial RCRA Hazardous Waste Report*.

EPA developed statistical weights to allow scaling of waste quantities to facility totals.[2] The implications of these sampling techniques on analyses of NHWCS data are described further in Chapter 7.

Survey Questions

The Structure of the Survey is divided into three main sections. The first requested verification of basic facility information, including the facility EPA identification number, location, and respondent contact information. The second section, which required a significant amount of input from respondents, addressed attributes and physical characteristics of waste streams, including waste stream quantity, waste type, waste form, source code, form code, management system type, and the industry sector that generated the waste stream. Many of the questions in the second section were identical to questions on the 1993 BRS form. For these questions, the Survey questionnaire included the facilities' answers from the 1993 BRS, pre-loaded onto the NHWCS form. Respondents had the option to correct this pre-loaded information if inaccurate or out-of-date.

The third and final section of the Survey asked respondents to provide concentration data for each constituent found in their surveyed waste streams. The questionnaire contained a pre-loaded list of constituents expected to be found in waste streams, based on EPA waste codes reported in the 1993 BRS. Respondents could add constituents to the pre-loaded list, or they could remove constituents they believed not to be present in waste streams. The Survey asked respondents for an average concentration for each constituent, both on a whole waste basis and on a leachate basis. Respondents were also asked whether they based their concentration estimates on actual testing of constituents or engineering judgement. A respondent could also note if a constituent was probably present but measured below detection limits, or if a constituent was not detected.

Survey Implementation

Prior to sending the Survey to the targeted facilities, EPA conducted a pre-test of the Survey instrument by administering it to nine facilities.[3] The purpose of the pre-test was to gauge the clarity and effectiveness of the questionnaire and instructions, and to determine whether the data requested in the survey were readily available. In addition, EPA sought feedback from the pre-test respondents about the Survey's reporting burden, i.e., the time and cost to complete the Survey. Based on the feedback from these facilities, EPA revised the draft Survey to make some questions more succinct.

After finalizing the Survey, EPA sent it to 212 facilities. Of these 212 facilities, 156 facilities returned completed surveys. The final NHWCS data set includes data submitted by these 165 facilities and the nine pre-test facilities. EPA then conducted an extensive quality assurance/quality control (QA/QC) review, focusing on whether respondents interpreted questions clearly and

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[2] EPA defined 'major' waste streams as greater than or equal to 40,000 tons for wastewater waste streams, or greater than or equal to 400 tons for non-wastewater waste streams.

[3] The final NHWCS data set includes data submitted by the nine pre-test facilities.

consistently, and whether responses were internally consistent. EPA developed priorities for the QA/QC review based on feedback from the primary users of the data about critical data fields. For example, EPA compared the responses for the question "Is the waste stream a wastewater?" with the BRS form code response to ensure consistency in how respondents characterized the physical form of a given waste stream. After completing the QA/QC review, EPA distributed copies of the NHWCS database to EPA staff and consultants conducting analyses of various OSW rulemakings, such as Combustion MACT, HWIR Process Waste, and HWIR Media.

SURVEY COVERAGE

To understand and interpret the results of NHWCS data analyses, it is essential to consider the extent to which the Survey data covers the hazardous waste universe. The survey coverage section of this report, examines key NHWCS data elements, including waste quantities, waste types, waste form, and waste codes. In this section we compare these findings to the 1993 hazardous waste universe totals. While the intent of this report is to analyze the unique constituent data provided by NHWCS, the goal of this discussion is to provide insights on information that the NHWCS survey effectively captures relative to the hazardous waste universe, as reported in the 1993 BRS, and to comment on the types of analyses for which it may not be appropriate. As always, BRS itself should remain the primary data source for those interested in hazardous waste quantity data.

Before describing the coverage of national waste and constituent totals provided by the NHWCS, it is important to describe in more detail the distinction between the NHWCS *sample population* and the NHWCS *respondent population*. The NHWCS sample population consists of 221 facilities (including the 9 pre-test facilities) that received the Survey; these facilities account for 1,760 waste streams. Because the Survey included responses to the 1993 BRS, NHWCS includes waste stream information for all 221 facilities and 1,760 waste streams in the sample population, even for those facilities that did not formally respond. Actual *respondents* to the Survey, however, provided completed surveys that included constituent information in addition to the pre-loaded waste stream information. Of the 221 facilities in the sample population, the 156 facilities (69 percent of sampled facilities) that responded with constituent data for their 1,020 waste streams (58 percent of sampled waste streams) make up the NHWCS respondent population

In general, because the NHWCS survey is based, in part, on responses to the 1993 BRS, the sample population provides quite complete coverage of total hazardous waste as reported in 1993. As indicated by Exhibit 2-1, total hazardous waste quantity reported by facilities in the NHWCS sample is 217 million tons, or 92 percent of the total hazardous waste quantity reported in the 1993 BRS (235 million tons).[4] Similarly, the NHWCS captures most of the waste quantities within each of several major categories of waste, including wastewaters and non-wastewaters. Based on sample population data, wastewaters in NHWCS account for approximately 90 percent of total 1993 BRS wastewaters. For non-wastewaters the coverage in the NHWCS survey is very complete; in fact, the quantity of non-wastewaters in NHWCS exceeds 1993 BRS non-wastewater quantities by

[4] Since the NHWCS survey focuses primarily on large treatment, disposal and recycling facilities (TDRs), the BRS total waste quantity managed is greater than NHWCS because BRS data includes waste handled by medium and small TDRs.

approximately 25 percent.[5]

Coverage of the universe by the NHWCS sample population is also fairly broad for major RCRA waste types (i.e., characteristic, listed, and listed and characteristic waste). In terms of waste quantity, the Survey's sample population represents 100 percent of listed only waste, 91 percent of characteristic only waste, and 94 percent of listed plus characteristic waste in the 1993 hazardous waste universe.

Because constituent information is provided only for the respondent population, coverage of the RCRA universe is somewhat less complete. In terms of overall constituent coverage, the NHWCS includes constituent data for approximately 50 percent of the total hazardous waste universe. Of waste reported by the respondents, approximately 52 percent of the total wastewater quantities are represented. As presented in Exhibit 2-1, when considering only Survey respondents, the percentages of listed only and listed and characteristic waste quantities covered drop to 55 percent and 62 percent, respectively. Coverage of characteristic waste quantities in the hazardous waste universe by respondent facilities is lowest of all categories, at only 19 percent.

Exhibit 2-1
NHWCS WASTE SUMMARY

	Total	**Listed Waste**[b]	**Characteristic Waste**[b]	**Listed and Characteristic Waste**[b]	**Waste-waters**[a,c]	**Non-wastewaters**[a,c]
1993 Hazardous Waste Universe: Quantity of Waste Managed (tons)	234,864,033	22,071,356	143,517,121	68,807,074	219,917,201	14,946,832
NHWCS: Sample Quantity of Waste Managed, (tons)	216,814,690	22,105,469	130,352,382	64,356,840	198,064,799	18,660,756
Percent of 1993 Universe	92	*100*	*91*	*94*	*91*	*125*

[5] This disparity between the sample population and the universe for non-wastewaters may be attributable to the use of statistical weights that are used to scale non-wastewater quantities to facility totals.

Exhibit 2-1
NHWCS WASTE SUMMARY

	Total	Listed Waste[b]	Characteristic Waste[b]	Listed and Characteristic Waste[b]	Waste-waters[a,c]	Non-wastewaters[a,c]
NHWCS: Respondent Quantity of Waste Managed, 1993 (tons)	114,704,335	12,086,453	88,555,647	12,843,142	106,730,333	7,974,003
Percent of 1993 Universe	*49*	*55*	*62*	*19*	*49*	*53*
NHWCS: Total Number of Waste Streams	1,760	399	741	620	142	1,611

1993 BRS: Number of Generators	24,362
NHWCS: Number of Generators[d]	995
Generators Managing Onsite Exclusively:	*115*
Generators Managing Onsite and Offsite:	*880*

Notes:

(a) Total wastewater and non-wastewater waste quantities as well as total number of generators in the 1993 hazardous waste universe are from EPA's 1993 BRS Biennial Report.

(b) Listed, Characteristic, and Listed and Characteristic waste quantities are from ICF's briefing to EPA Office of Solid Waste (March 30, 1998). Figures from briefing may not include waste quantities for facilities designated as CBI.

(c) The sum of the number of NHWCS wastewater and non-wastewater streams does not equal the total waste stream count of 1,760 because no physical form information is reported for seven waste streams in the NHWCS ans some were characterized as neither.

(d) We define the number of generators in the NHWCS as unique facilities that manage waste on-site in addition to unique facilities from which TDRs receive waste. This figure includes over 70 fuel blenders and other waste intermediaries. 995accounts for not only those facilities who responded to the survey, but also any facility who generates waste and shipped that waste to facilities for disposal/management.

Overall, the NHWCS sample covers a significant proportion of the hazardous waste quantities in the universe, with respondents reporting constituent data for about half of the universe of waste quantities. Furthermore, the Survey achieves fairly broad coverage despite the fact that it includes data for a very small number of waste streams and generators relative to the 1993 BRS population. This is the case because management and generation of hazardous wastes is highly skewed to a small number of facilities in NHWCS that handle very large waste streams, as described below:

- The median NHWCS facility manages approximately 63,000 tons of waste;

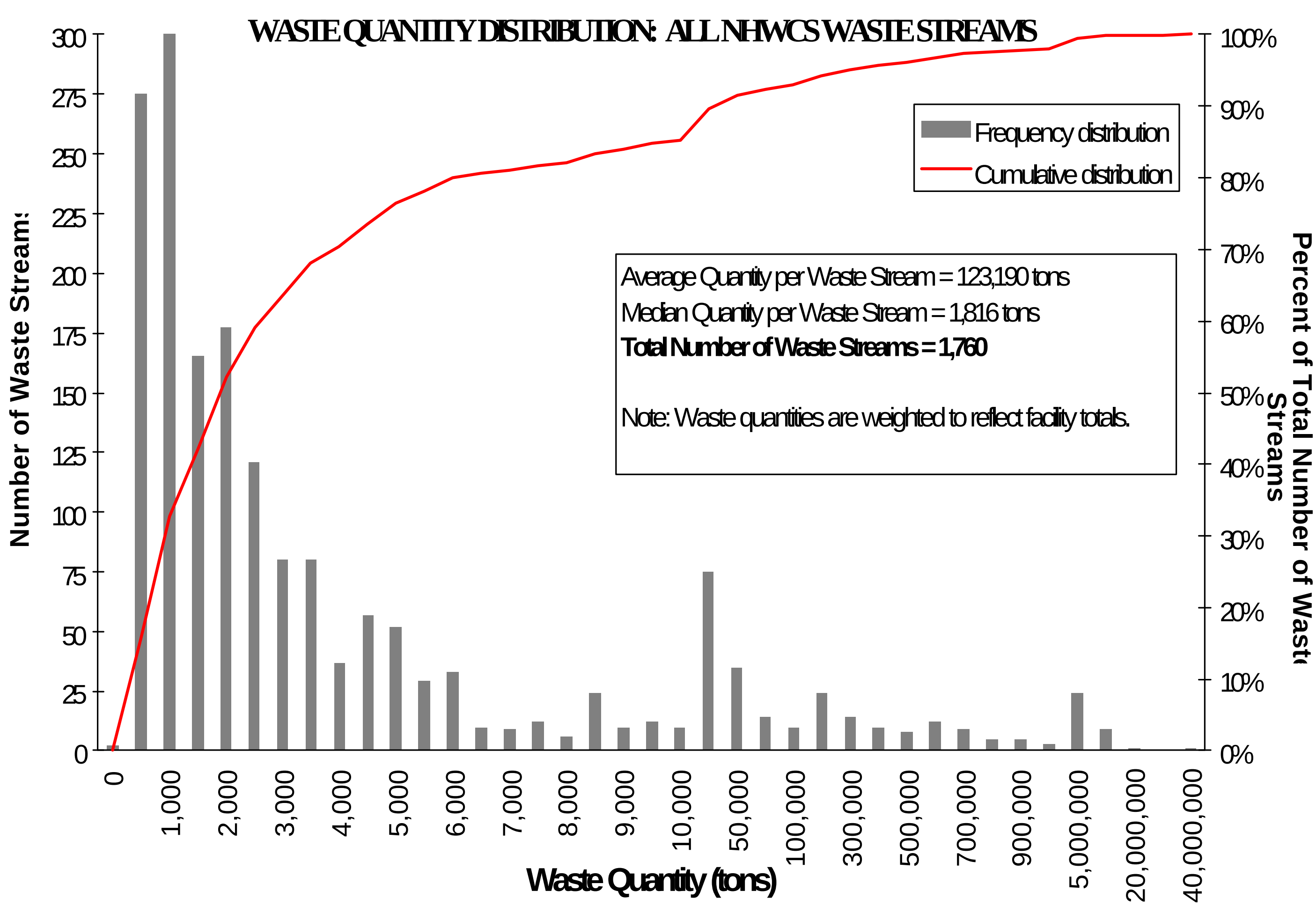
- Ten percent of the facilities in the NHWCS manage over 170 million tons (80 percent of the total waste quantity);

- Generators represented by the Survey, which account for less than five percent of the total number of generators in the hazardous waste universe, represent 92 percent of total waste in the 1993 hazardous waste universe.[6]

OVERVIEW OF NHWCS WASTE QUANTITIES AND FORMS

As general background for interpreting the constituent information provided by the Survey, Exhibit 2-2 shows the frequency and cumulative distribution of NHWCS waste quantities. As is true

Exhibit 2-2



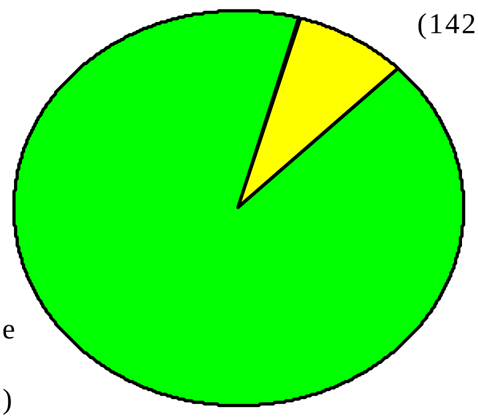
[6] The reason for the large difference in the number of the generators is due to the nature of the Survey; since the Survey captures the largest hazardous waste streams managed nationally, it also mainly represents large waste quantity generators. Small and medium-sized hazardous waste generators, which constitute the majority of generators, generally do not produce the largest waste streams and are therefore less likely to be represented in the NHWCS data.

for the larger RCRA waste universe, the distribution of waste quantities among facilities, waste streams, and waste types is highly skewed. This is illustrated by the significant difference between average waste stream quantity (123,190 tons) and median waste stream quantity (1,816 tons), resulting from the fact that a small number of very large-quantity waste streams dominate total waste quantity.

As illustrated in Exhibit 2-3, a large majority (92 percent) of the 1,760 waste streams in NHWCS are non-wastewaters; only eight percent are wastewater waste streams (142 waste streams).[7] However, wastewaters account for 91 percent (198 million tons) of total waste quantity, whereas non-wastewaters account for only eight percent (19 million tons).[8] This imbalance between the number of waste streams and quantity is due to the fact that wastewater streams are generally much larger than non-wastewater streams. In fact, the median wastewater waste stream in NHWCS is over 400,000 tons, while the median non-wastewater waste stream is approximately 1,600 tons.

Exhibit 2-3

NUMBER OF WASTE STREAMS BY PHYSICAL FORM



Total number of NHWCS waste streams: 1,760

Note: Waste stream numbers do not add to totals because for seven waste streams in the NHWCS database, no physical form information (e.g., nonwastewater or wastewater) was provided.

[7] The NHWCS provides physical form data (e.g., wastewater, non-wastewater) for most waste streams; some of the non-wastewater waste streams reported in the data may be residuals resulting from dewatering or treatment of wastewaters that are then sent off-site.

[8] Because no physical form information is provided for seven waste streams, numbers of wastewater and non-wastewater waste stream and quantities do not add to totals.

Two general categories of waste are highly prevalent in the NHWCS. As illustrated in Exhibit 2-4, characteristic wastes (i.e., D001 to D018) are the most common, occurring as 16 of the 20 most prevalent waste types. Waste streams that carry characteristic waste codes also account for at least 50 percent of the total quantity in NHWCS. Ignitable waste (i.e., D001), which is present in 47 percent of the NHWCS waste streams, is the most common type of characteristic waste. The second waste category of note in terms of prevalence are spent solvents (i.e., F001 to F006). Spent halogenated and non-halogenated solvents occur in at least 30 percent of waste streams, and these waste streams account for over fifty million tons of waste in NHWCS.

Exhibit 2-4
WASTE TYPE PREVALENCE IN THE NHWCS DATABASE
(Descending sort by number of wastestreams designated with wastecode in the database)

Highly Prevalent Waste Codes	Waste Description	Number of Waste of Streams	Percent of Waste Streams	Quantity of Waste Streams (tons)
D001	Ignitable waste	827	47%	16,856,865
F003	Spent non-halogenated solvents	541	31%	57,459,603
F005	Spent non-halogenated solvents	458	26%	57,669,721
D008	Lead	414	24%	11,612,686
D018	Benzene	376	21%	105,767,460
F002	Spent halogenated solvents	360	21%	59,679,874
D007	Chromium	306	17%	28,064,748
F001	Spent halogenated solvents	272	16%	23,323,855
D006	Cadmium	251	14%	5,137,844
D035	Methyl ethyl ketone	218	12%	825,173
D005	Barium	203	12%	2,632,057
D039	Tetrachloroethylene	178	10%	4,102,044
D002	Corrosive waste	169	10%	45,130,493
D004	Arsenic	151	9%	2,652,166
D022	Chloroform	129	7%	11,932,239
D009	Mercury	125	7%	4,806,370
D028	1,2-Dichloroethane	122	7%	16,090,868
D019	Carbon tetrachloride	120	7%	4,473,379
D040	Trichloroethylene	120	7%	694,783
D010	Selenium	116	7%	1,961,731

Note: Based on total number of waste streams in NHWCS of 1,760.

USE OF SURVEY RESULTS

The NHWCS provides an excellent overview of the distribution and concentrations of hazardous constituents in major RCRA waste streams. Even when non-respondents to the Survey are removed, facilities in the Survey provide constituent data for over half the hazardous waste generated across the nation. Data for these wastes provide adequate coverage for most major subcategories of waste in the RCRA universe, including wastewaters and non-wastewaters, as well as listed, characteristic, and listed and characteristic wastes. Respondents to the Survey also represent a broad spectrum of industries and management methods, which are discussed in detail in later chapters of this report.

In using and interpreting the Survey results, however, analysts and policymakers should keep in mind several important caveats. Of primary importance is the fact that the Survey focused on larger waste streams reported by the largest generators and managers of hazardous waste. As a result, the Survey does not necessarily provide a comprehensive or representative picture of waste composition for smaller waste streams and smaller generators. For instance, the Survey may not be a good source for developing a comprehensive list of constituents in hazardous wastes, nor can it provide a representative picture of the smaller waste streams in the hazardous waste universe.

The broader implication of this is that users of the Survey should exercise caution in the extrapolation of quantitative results to national totals. While NHWCS provides good information on major waste streams generated across the country, there is no simple means of scaling the results of the Survey to project national totals. As noted above, this is particularly true with respect to estimating numbers of waste streams, since smaller waste streams are not captured in a systematic way by the Survey sampling protocols. Essentially, analysts using the data from the NHWCS need to carefully consider how they are using the data, and make case-by-case determinations about approaches that might be used to give a better understanding of national totals.

In spite of these limitations, the Survey provides EPA and other analysts with a source of more recent and precise data about the constituent composition and physical characteristics of the majority of hazardous waste managed in the U.S. These data should be useful as a starting point for analyzing and thinking prospectively about a broad array of RCRA policy and enforcement issues.

A major benefit of the NHWCS is that, in addition to providing waste quantity and physical characteristic data for a large proportion of hazardous RCRA wastes, it describes in detail the constituent composition of major waste streams. Assessing the prevalence of hazardous constituents (i.e, counting the frequency with which constituents occur in the NHWCS database) may provide EPA with insights on important trends in constituent generation and management. In particular, constituent prevalence describes the variety of hazardous constituents used in industrial processes. An analysis of highly prevalent constituents (i.e., constituents that appear in a large number of waste streams) also can reveal which constituents are used in processes that are common to many industry sectors. For example, within virtually every major industry, solvents are used to clean and strip equipment, parts, and materials. Conversely, only a few facilities or industries may report highly specialized constituents used in one or two industrial processes. This type of constituent prevalence data may be especially timely, as EPA is currently identifying lists of 'constituents of concern' to better focus risk assessment and modeling resources that support risk-based rulemakings such as the Hazardous Waste Identification Rule.

Before the collection of the NHWCS, the only other significant source of constituent information in RCRA waste came from the 1986 *National Survey of Hazardous Waste Generators* (the Generator Survey). The constituent information in NHWCS which is based on the 1993 BRS is more up-to-date than the Generator Survey data. It reflects changes in waste generation and management that have occurred as a result of the RCRA program over the past decade. For example, based on customer needs, an automotive parts manufacturer recently reported instituting a major materials change by replacing copper with aluminum in all products. This change has increased the recyclability of their products and has eliminated copper completely from their process wastes, which as a result has reduced the overall toxicity of their waste streams.

To analyze the prevalence of hazardous constituents appearing in the NHWCS, we calculated the total number of occurrences of individual constituents appearing in the database. Next we evaluated the distribution of prevalent constituents across various waste categories (e.g., in non-wastewater waste streams), and the concentrations of highly prevalent constituents. We also evaluated the prevalence of the most hazardous persistent, bioaccumulative, and toxic (PBT) constituents that appear on EPA's most current Draft Chemical Prioritization List.[1] These results supply EPA with a more

[1] Throughout this report, most hazardous PBT constituents refers to constituents on EPA's 1997 Draft Prioritized Chemical List with an overall PBT score of 12 through 18. Of the 879 total

accurate picture of the extent to which high-risk constituents appear in industrial process wastes, and whether management of these constituents is likely to minimize threats to human health or to ecosystems.

The remainder of this chapter addresses the following questions about the occurrence of certain constituents in listed and characteristic RCRA wastes.

- How many different hazardous constituents occur in the universe of RCRA waste?
- How many different constituents are reported, on average, by each facility and for each waste stream?
- What constituents occur with the greatest frequency? What are typical concentrations of these highly prevalent constituents?
- Which of the most hazardous PBT constituents occur frequently in the RCRA waste universe? What are typical concentrations of these constituents?

NATIONAL DISTRIBUTION OF CONSTITUENT OCCURRENCES

This section will present results for analyses of all NHWCS constituents, as well as for the subset of constituents found on EPA's 1997 Draft Prioritized Chemical List of PBT constituents

The distribution of constituent occurrences across waste streams suggests that the majority of waste streams contain 30 or fewer constituents per waste stream. Exhibit 3-1 illustrates that about 90 percent of waste streams for which there is constituent data carry fewer than 30 constituents. Also, a large number of waste streams carry between zero and ten constituents. The average number of constituents per waste stream is twelve; the median number is six. These distributions do not change significantly when considering wastewaters and non-wastewater waste streams, except that, on average, there are more non-wastewater waste streams that carry a very large number of constituents (i.e., over 70 constituents).

The distribution of hazardous PBTs across waste streams is much more skewed than the distribution of occurrences of all NHWCS constituents. As shown in Exhibit 3-2, of the waste streams that carry at least one hazardous PBT constituent, most waste streams carry 10 or fewer PBT constituents. Approximately 40 percent of waste streams carry two or fewer hazardous PBTs.

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constituents on the list, 267 constituents have a PBT score from 12 to 18. Of these, 93 appear at least once in the NHWCS database.

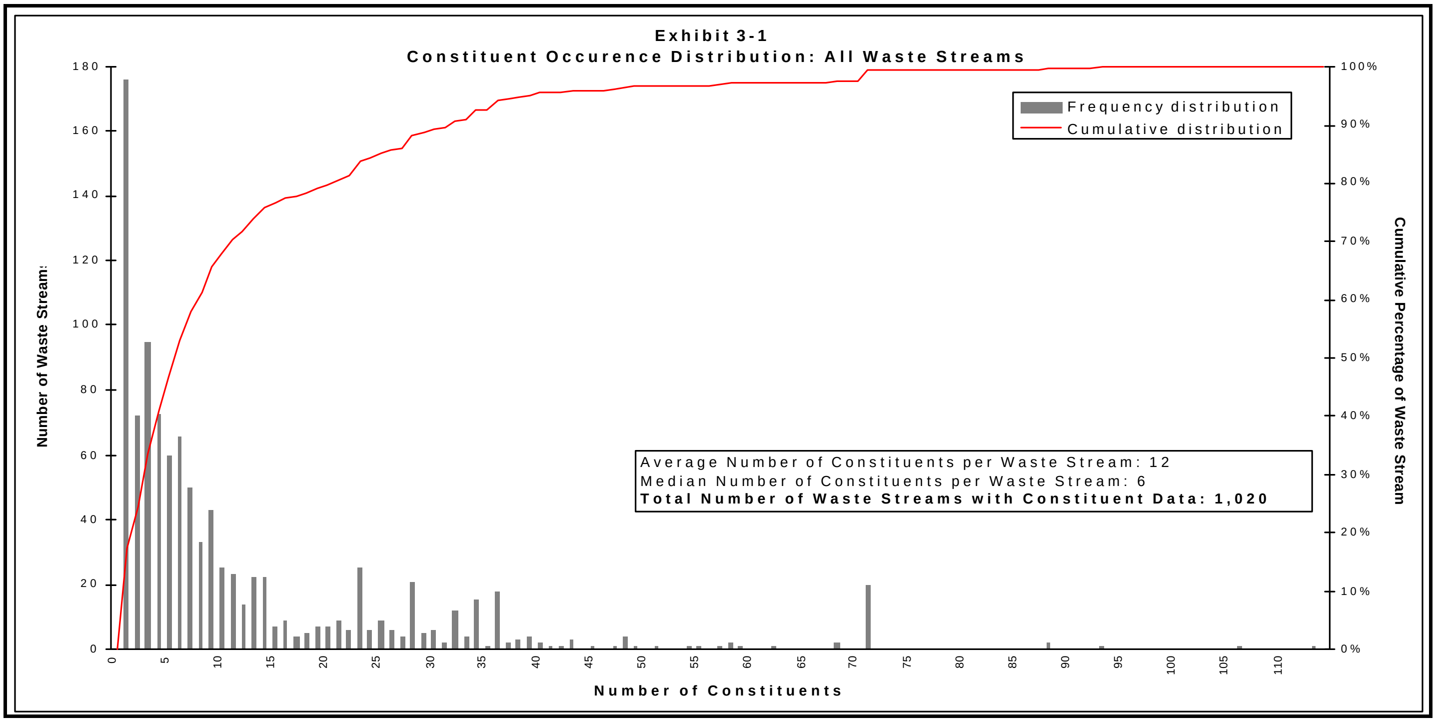


Exhibit 3-1
Constituent Occurence Distribution: All Waste Streams
Frequency distribution
Cumulative distribution
Average Number of Constituents per Waste Stream: 12
Median Number of Constituents per Waste Stream: 6
Total Number of Waste Streams with Constituent Data: 1,020
Number of Waste Streams
Cumulative Percentage of Waste Stream
Number of Constituents

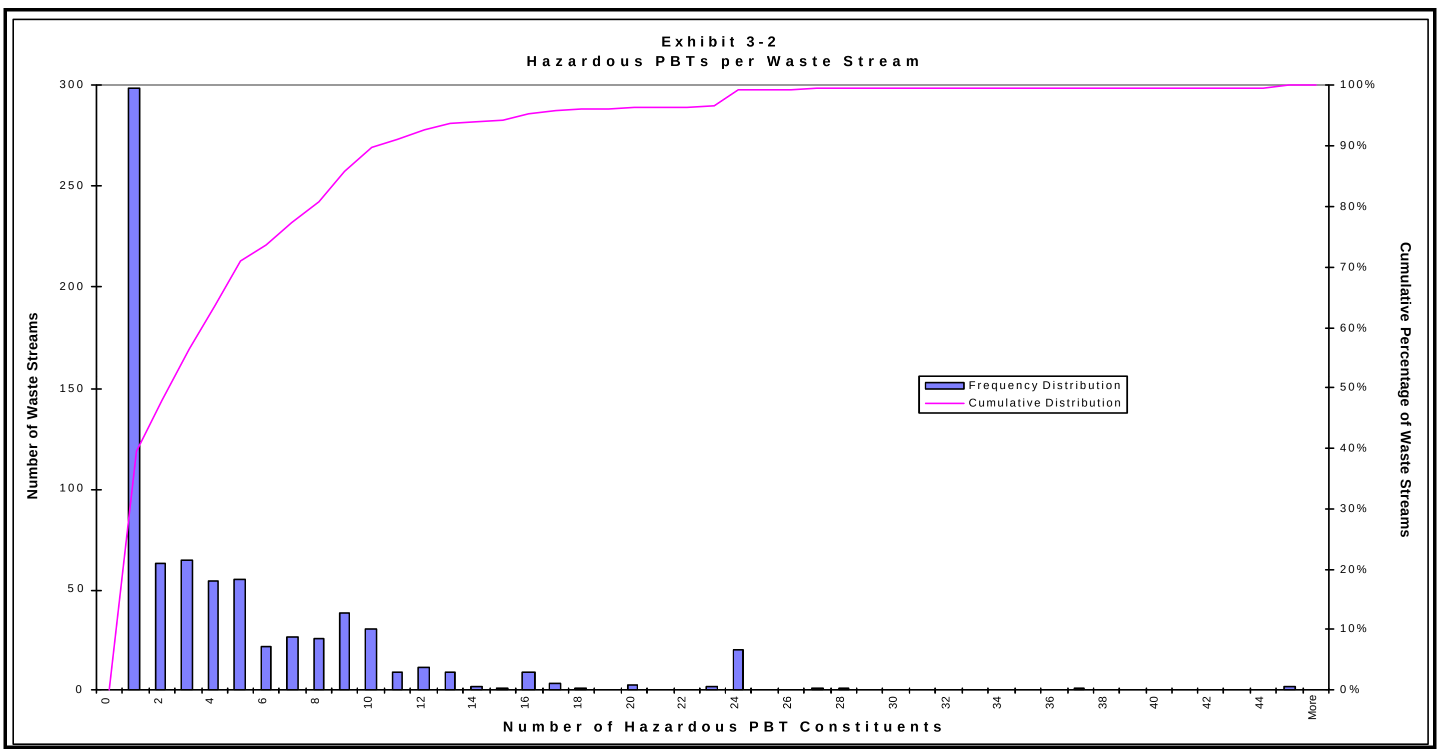
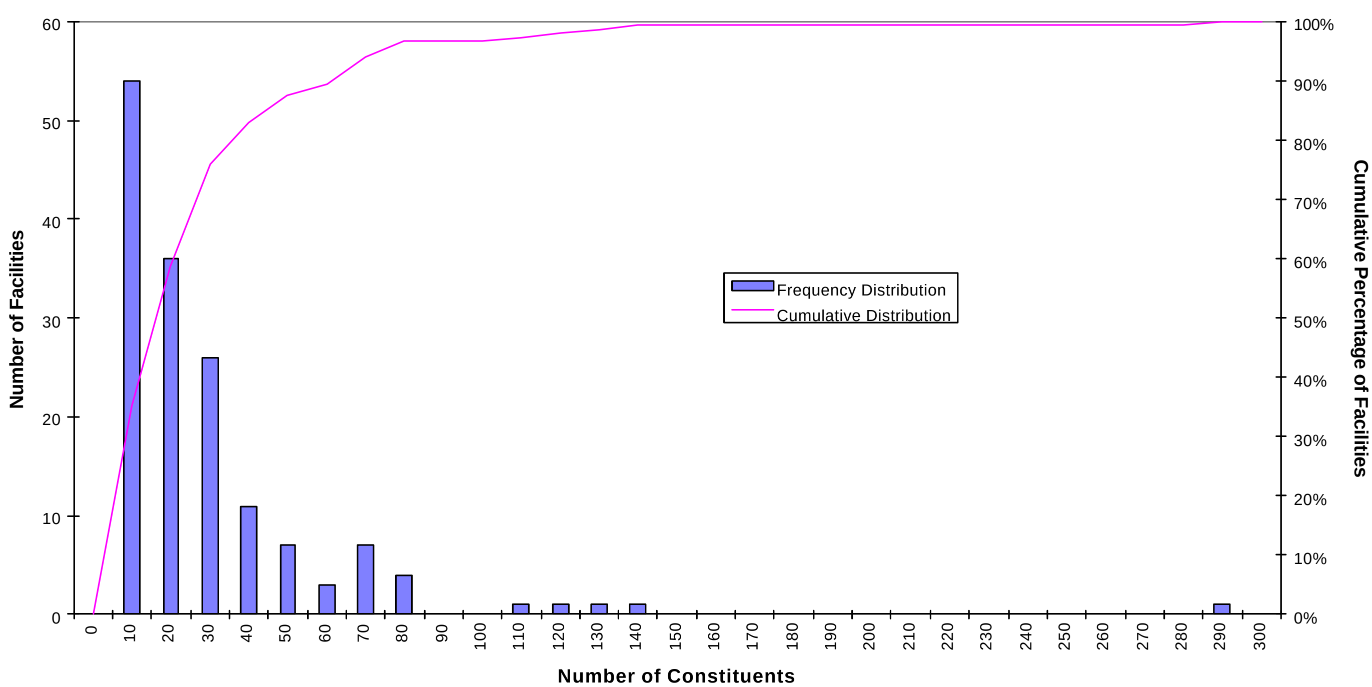


Exhibit 3-2
Hazardous PBTs per Waste Stream
Frequency Distribution
Cumulative Distribution
Number of Waste Streams
Cumulative Percentage of Waste Streams
Number of Hazardous PBT Constituents

The distribution of constituent occurrences on a facility basis reflects a similarly skewed pattern. Exhibit 3-3 shows that out of 153 facilities reporting constituent data, ninety percent of facilities report that between 10 and 60 hazardous constituents are present in their wastes. Over one-third of all facilities report between 10 and 20 constituent occurrences. The highest number of constituent occurrences reported by a single facility is 287. This pattern suggests that most large facilities must address a relatively high number of hazardous constituents in developing their waste management approaches, which may limit the potential for HWIR exemptions.

Exhibit 3-3
Constituents Per Facility



NATIONAL CONSTITUENT PREVALENCE

Our analysis of constituent prevalence suggests that, although the universe of hazardous wastes includes over 200 hazardous constituents, a small number of constituents account for a large proportion of overall occurrences.[2] Waste streams reported in the Survey carry 724 different constituents.[3,4]

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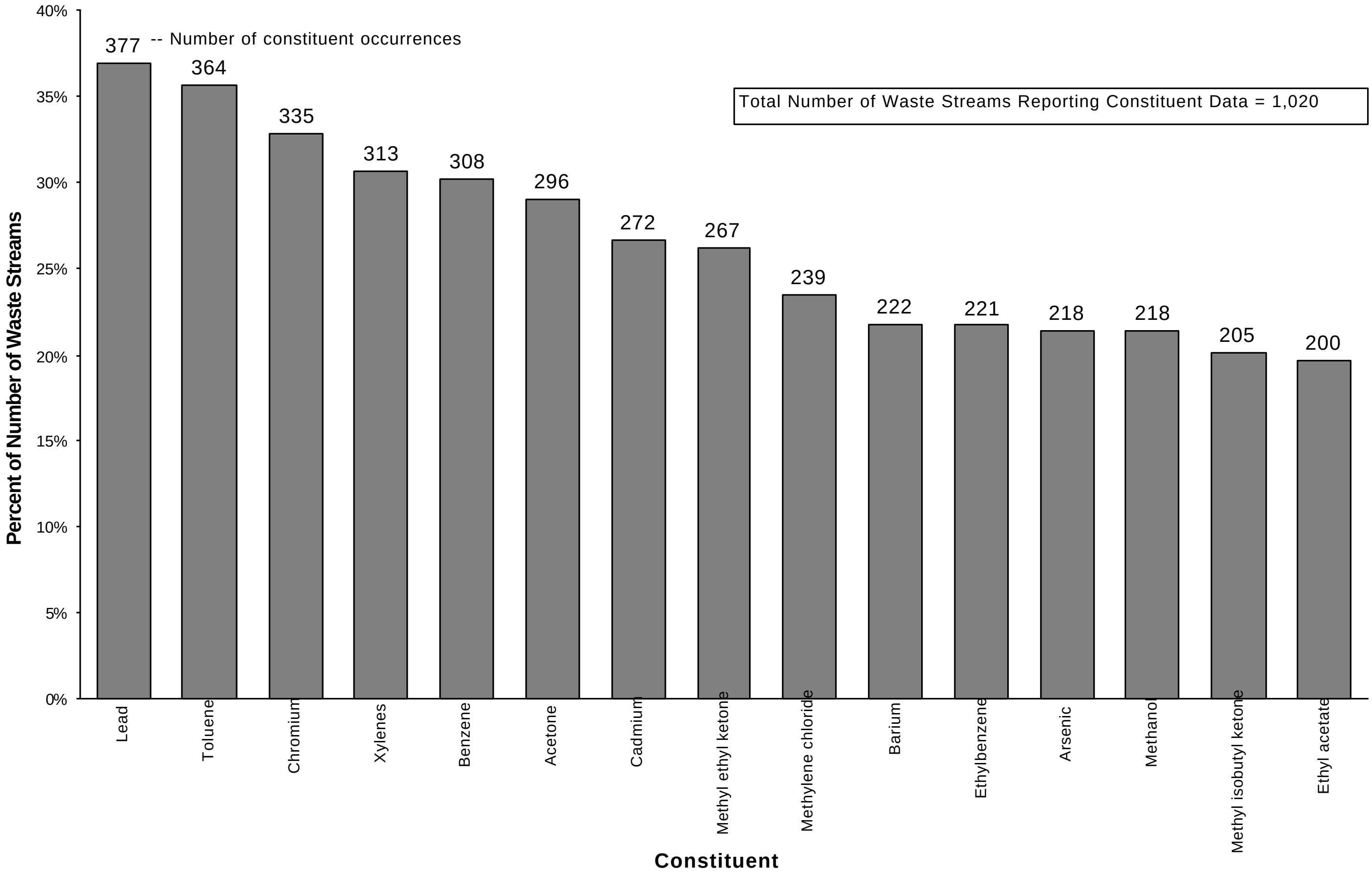
[2] Occurrences refer to the number of times the constituent is reported in the database (i.e., the number of waste streams that contain the constituent).

[3] The total number of unique constituents in the NHWCS (724) is based on analysis of the database done by Larry Rosengrant, Office of Solid Waste. This figure includes some constituents not regulated as hazardous by the EPA under RCRA.

Exhibit 3-4 illustrates the number of constituent occurrences for each of the fifteen most prevalent constituents in the NHWCS database. These fifteen are almost evenly split between metals and organics. Lead is the most prevalent constituent overall, occurring in more than 35 percent of waste streams. Toluene, chromium, benzene, and xylenes are also highly prevalent — each appears in more than 30 percent of the NHWCS waste streams. All of the highly prevalent constituents occur at least 20 percent of the time, suggesting a high degree of co-occurrence between these constituents.

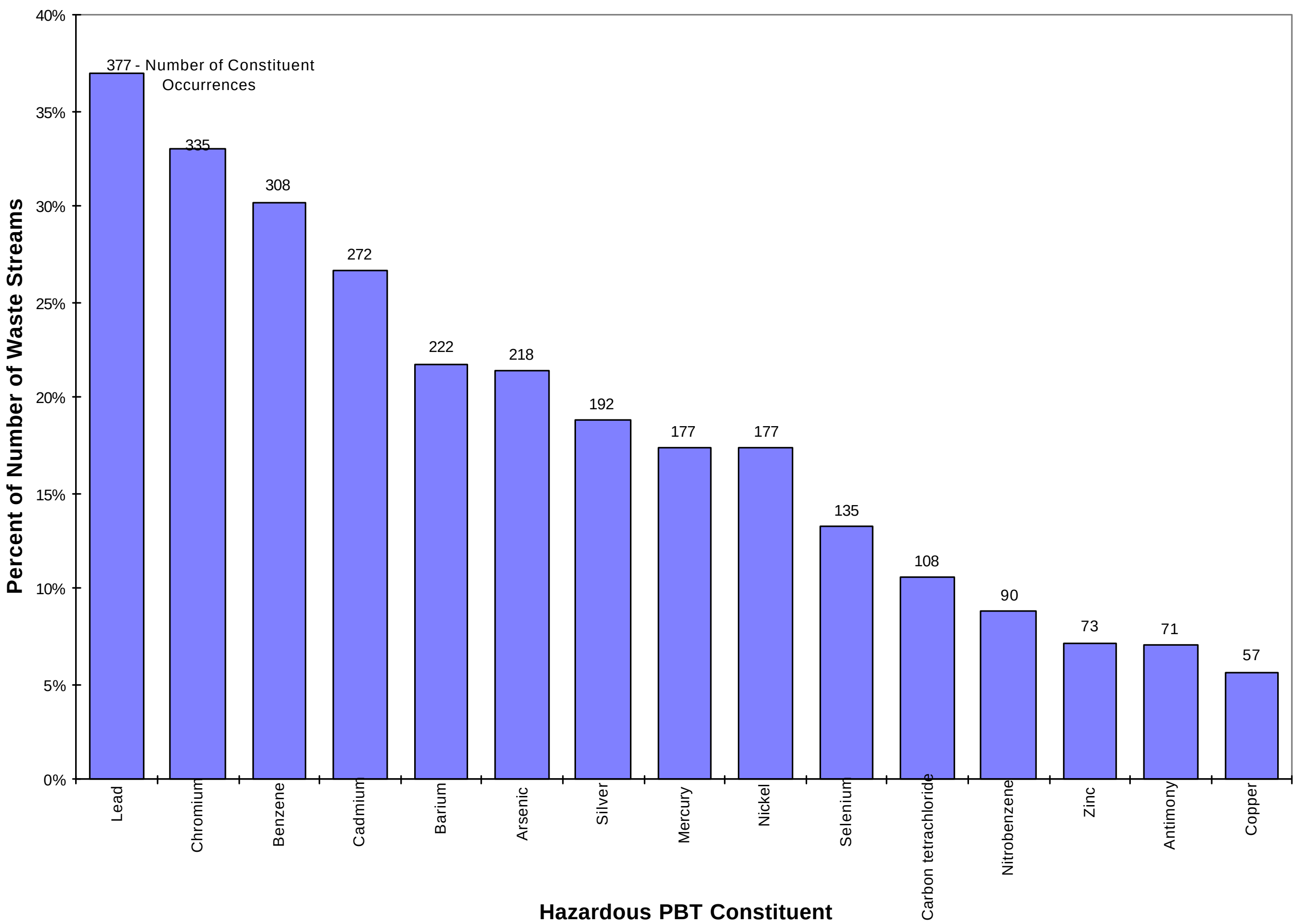
Exhibit 3-4
Constituent Prevalence: Number of Occurrences



There is significant overlap between a number of highly prevalent NHWCS constituents and the most prevalent constituents reported in the 1986 Generator Survey database. A comparison of prevalent constituents in both of these databases indicates that eleven of the fifteen highly prevalent constituents in NHWCS are also among the most prevalent constituents in the Generator Survey These two databases differ significantly because they applied different reporting techniques to measure hazardous waste, and because both are "snapshots" taken at different points in time, and thereby represent different segments of the hazardous waste universe. Prevalent metals which appear in both databases include arsenic, barium, cadmium, chromium, and lead. Prevalent non-metals appearing in both are acetone, methylene chloride, methyl ethyl ketone, methyl isobutyl ketone, toluene, and xylene

Of 267 total hazardous PBT constituents, 93 appear in the NHWCS data set. Exhibit 3-5 displays the 15 most prevalent. Whereas the list of highly prevalent constituents in the entire NHWCS included many organics, metals dominate the hazardous PBT category -- 12 of the 15 most prevalent are metals or semi-metals. Lead, chromium, and cadmium are particularly prevalent, each appearing in over 30 percent of all waste streams. As stated above, benzene is also highly prevalent.

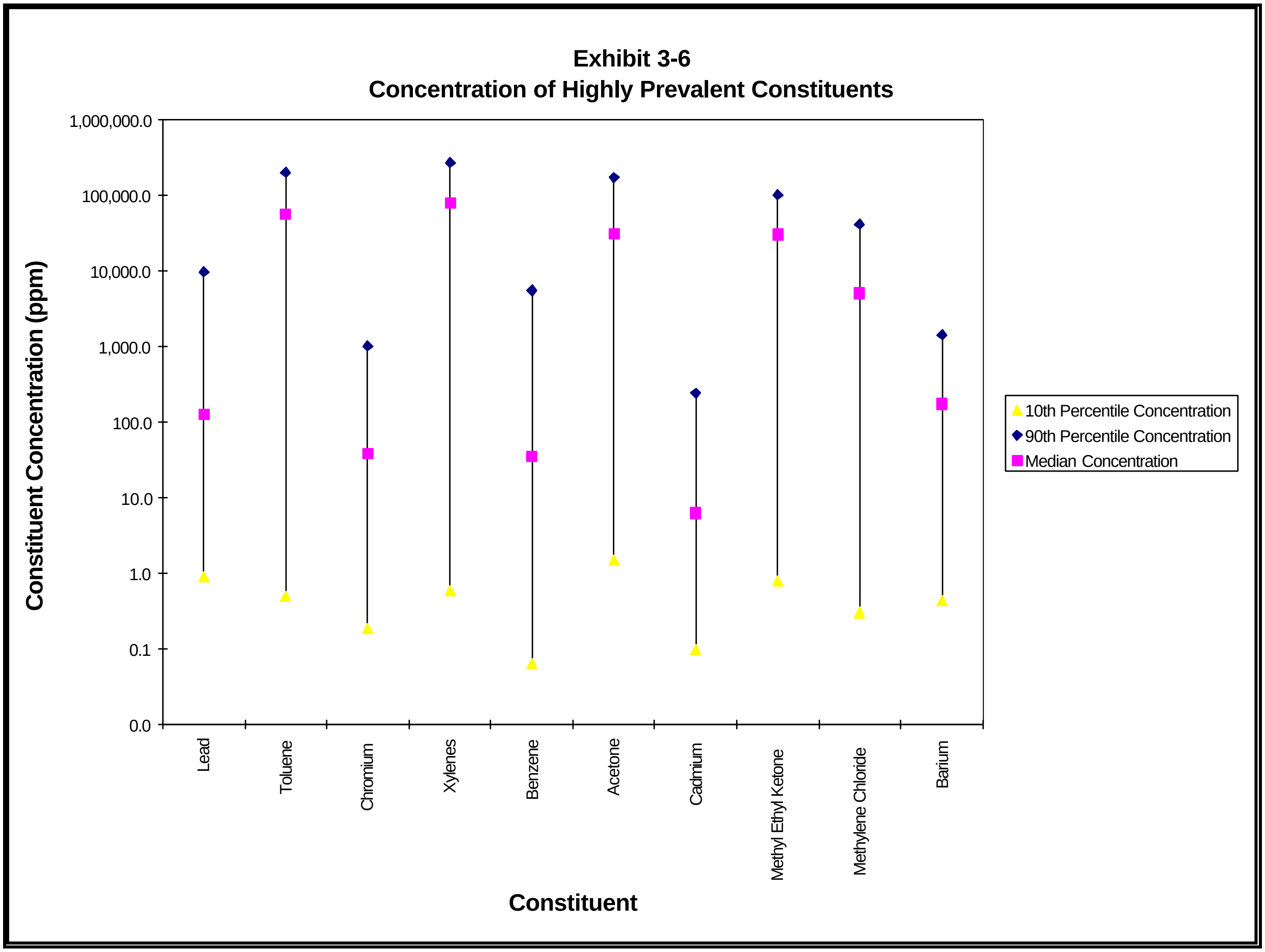
Exhibit 3-5
Prevalence of Hazardous PBTs



CONCENTRATIONS OF HIGHLY PREVALENT CONSTITUENTS

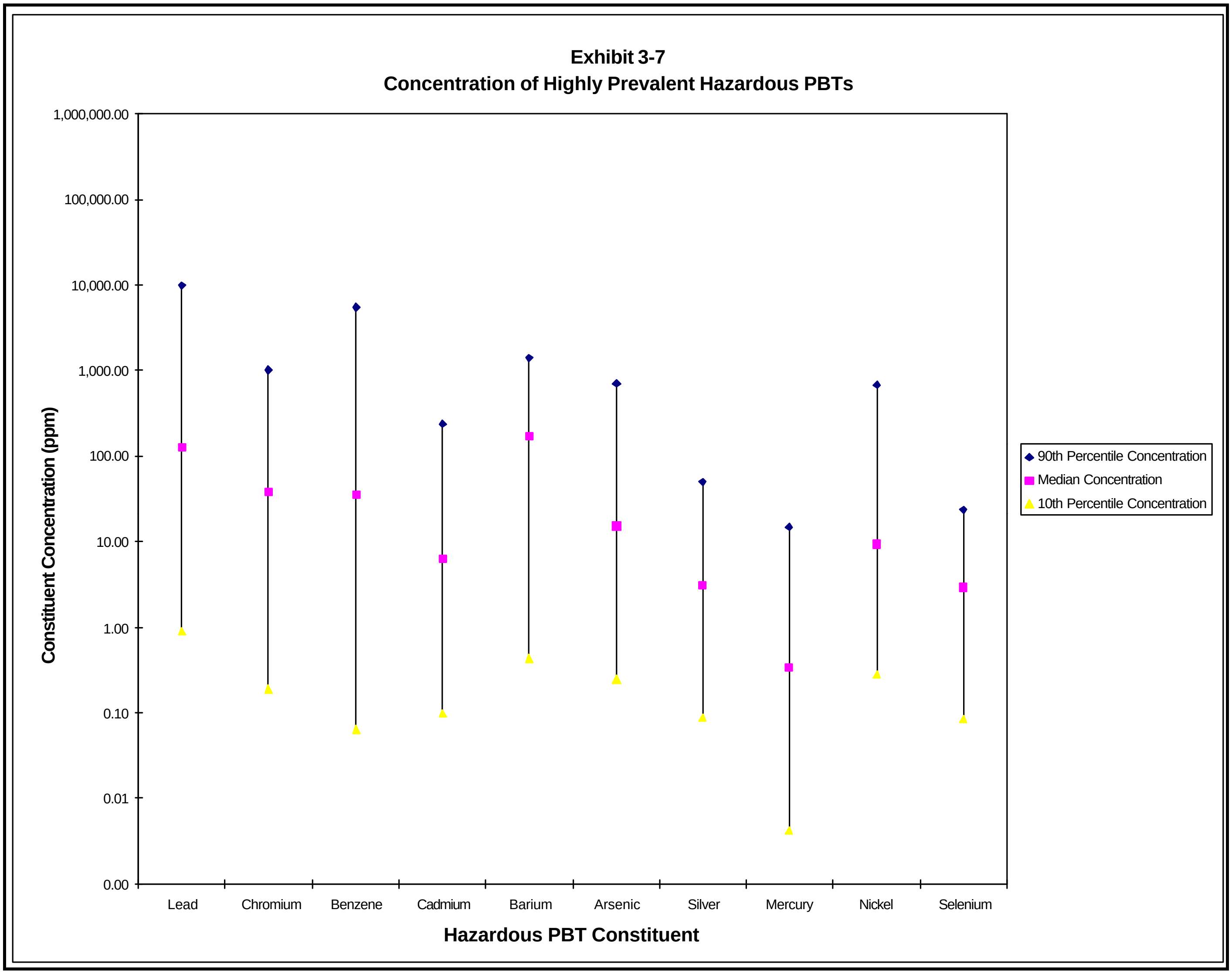
Analysis of concentrations of highly prevalent constituents, concluded that concentrations of prevalent organics and inorganics are significantly higher than those reported for prevalent metals. Exhibit 3-6 illustrates the median, 10th percentile, and 90th percentile concentrations of the ten most highly prevalent NHWCS constituents. The median concentration of five of the prevalent non-metals — toluene, xylene, acetone, methyl ethyl ketone, and methylene chloride — is between 10,000 and 100,000 parts per million (ppm). Benzene is the only non-metal with a median concentration below

100 ppm. Median concentrations of three of four prevalent metals — lead, chromium, cadmium, and barium — are over an order of magnitude lower, ranging between 1 and 200 ppm. Also, for the metals and benzene, the median concentrations are much closer to the mid-point of the range than for the non-metals, which lie much closer to the 90th percentile values, which implies a more balanced distribution of concentrations.



Note: Constituents above are ranked in order according to Exhibit 3-4.

As illustrated in Exhibit 3-7 below, highly prevalent hazardous PBTs, on average, occur at much lower concentrations. Of these ten metal constituents, only lead and barium have median concentrations higher than 100 ppm. Cadmium, silver, mercury, and nickel all have median concentrations less than ten ppm; mercury has the lowest median concentration, at 0.3 ppm. Of the prevalent hazardous PBTs, lead is the only constituent that has a 90th percentile concentration above 10,000 ppm.



<u>Note:</u> Constituents above are ranked in order according to Exhibit 3-5.

A primary focus of the *National Hazardous Waste Constituent Survey* (NHWCS) was the collection of information on the quantity of hazardous constituents in regulated waste streams. The previous chapter addressed the prevalence of constituents in wastes, but by itself this information provides only one dimension of the hazardous constituent picture. To set effective regulatory priorities for managing hazardous waste and reducing associated health and ecological risks, EPA also needs information on individual constituent quantities and their overall contribution to total hazardous constituent quantities. For example, recent data indicating which persistent, bioaccumulative and toxic (PBT) constituents occur in the greatest quantities have not been available on a waste stream basis, hindering efforts to develop appropriate measures for reducing the occurrence of these constituents. In this chapter the term constituents refers to hazardous chemicals constituents no the more general meaning of the term constituents which refers to all non-hazardous and hazardous materials.

Using data from the NHWCS, we calculate the total quantity of individual constituents in RCRA wastes as the product of individual waste stream quantities times the concentration of each constituent, summed across all waste streams. These results allow more accurate and direct analysis of the constituents in waste that pose environmental hazards, both in aggregate and at the individual constituent level. For example, EPA may now be able to better differentiate the relative contributions of lead in wastewaters versus non-wastewaters, and in characteristic versus listed wastes. The Survey provides much-improved constituent concentration and quantity information to EPA when compared with the 1986 Generator Survey, the only other significant source of constituent information in RCRA wastes. In particular, estimates of constituent quantity in NHWCS are generally more precise than in the Generator Survey, which were based upon very wide ranges (i.e., order-of-magnitude) for estimates of constituent concentrations.

The remainder of this chapter addresses a variety of general questions about the quantities of hazardous constituents in listed and characteristic RCRA wastes.

- What is the total quantity of hazardous constituents in RCRA waste? What is the total quantity of the hazardous PBT constituents?

- In which regions of the country are the majority of these constituent quantities managed? In which regions are the majority of hazardous PBTs managed?

- What are typical concentrations of hazardous constituents in individual waste streams? How are these concentrations distributed across waste streams?

C What individual constituents are managed in the greatest quantities? What are the typical concentrations of these high-quantity constituents?

As in the previous chapter, we will conduct these analyses for all NHWCS constituents, as well as for the subset of hazardous constituents on the Agency's current PBT list.

NATIONAL HAZARDOUS CONSTITUENT QUANTITIES

Our analysis of national quantities suggests that hazardous constituents represent a relatively small portion of the total quantity of RCRA waste. As illustrated in Exhibit 4-1, the total quantity of all NHWCS hazardous constituents is approximately 2.1 million tons, based on constituent information for 1,020 waste streams provided by 153 responding facilities. This sum represents about two percent of the total quantity of waste generated by these facilities**.** Non-wastewater waste streams, which make up the majority of waste streams from responding facilities, contain nearly 70 percent (1.4 million tons) of the reported hazardous constituent quantity.

The distribution of constituent quantities across waste types suggests that characteristic wastes are the dominant contributor of hazardous constituents. Over half of all hazardous constituent quantity (1.1 million tons) occurs in wastes that are hazardous solely due to the presence of an ignitable, corrosive, reactive, or toxicity characteristic. Of the remaining constituent quantities, the majority occurs in mixtures of listed and characteristic waste (0.7 million tons). Waste that is listed but not characteristic represents 0.2 million tons, roughly 10 percent of all hazardous constituent quantity.

When we focus only on hazardous PBT constituents, their quantities decrease by about 90 percent. The quantity of hazardous PBT constituents is approximately 240,000 tons, just over 10 percent of the total hazardous constituent quantity of the NHWCS, and approximately 0.1 percent of total RCRA waste quantity. These constituents are present in 756 NHWCS waste streams that contain at least one hazardous PBT constituent. Ninety-six percent of this hazardous PBT quantity occurs in non-wastewater waste streams, which represent the majority of waste streams containing hazardous PBT constituents.

As was true for all NHWCS constituents, characteristic wastes also are the most important contributor of hazardous PBT constituents, although this tendency is much more pronounced for the PBTs. Almost 90 percent of the quantity of hazardous PBTs (about 207,000 tons) is found in characteristic waste streams, with the remainder of the constituent quantity of hazardous PBTs (about 33,000 tons) distributed across listed only and listed and characteristic waste streams.

We also analyzed the NHWCS database to provide information about the distribution of constituent quantities across each of the ten EPA regions, based on constituent concentration data from 153 responding facilities. As one might expect from a review of the waste management data, EPA Regions 5 and 6 account for approximately 75 percent of all hazardous constituent quantity managed in the U.S., as shown in Exhibit 4-2. This is due to the large number of generators and waste management facilities located in these areas.

Exhibit 4-1
CONSTITUENT QUANTITIES: ALL NHWCS CONSTITUENTS AND HAZARDOUS PBTs

		CONSTITUENT QUANTITY (tons)			
		Listed Only	Characteristic Only	Listed and Characteristic	Total
Constituent Quantity: All Constituents	Wastewaters	65,747 (28 streams)	415,574 (54 streams)	161,779 (19 streams)	643,100 (101 streams)
	Non-wastewaters	183,211 (226 streams)	658,959 (341 streams)	572,360 (352 streams)	1,414,530 (919 streams)
Total		**248,958 (254 streams)**	**1,074,533 (395 streams)**	**734,139 (371 streams)**	**2,057,630 (1,020 streams)**
Constituent Quantity: Hazardous PBTs	Wastewaters	140 (23 streams)	8,962 (46 streams)	1,296 (18 streams)	10,399 (87 streams)
	Non-wastewaters	19,080 (159 streams)	198,496 (280 streams)	12,639 (230 streams)	230,215 (669 streams)
Total		**19,220 (182 streams)**	**207,458 (326 streams)**	**13,935 (248 streams)**	**240,614 (756 streams)**

Notes:
(1) Columns and rows may not sum to totals due to rounding.
(2) Constituent quantities for all constituents based on constituent information from 1,020 waste streams.
(3) Constituent quantities for hazardous PBTs based on constituent information from 756 waste streams.

Region 6 alone contains fully a third of all facilities responding to the Survey. Facilities in Texas and Louisiana, in particular, manage the largest proportion of total hazardous constituent quantity (almost 50 percent). One Louisiana facility, for example, manages over 600,000 tons of hazardous constituents.

We conducted a similar analysis for the hazardous PBT constituents, and the results show a somewhat different pattern of regional management (Exhibit 4-3). Facilities in Region 5 manage the majority of hazardous PBT quantities (133,000 tons). Somewhat surprisingly, Region 2 manages the second largest amount of PBT constituents (over 60,000 tons). In both these regions, large-quantity waste streams associated with lead acid battery and battery scrap reclamation account for most of the quantity of hazardous PBTs. One Indiana facility (Region 5) manages a single lead-bearing waste stream containing 77,000 tons of lead, and, in Region 2, a single New York facility manages 57,000 tons of lead.

By comparison of waste stream content, Region 6 is of lesser importance in management of hazardous PBT constituents (only 17,650 tons). Given the number of large general and specialty constituents producers, petroleum refineries, and waste management facilities in Region 6, this is a somewhat surprising result. However, as described above, lead-bearing waste streams from lead acid battery and battery scrap wastes dominate the PBT analyses, and Region 6 does not appear to have as much secondary smelting capacity as the other regions.

Exhibit 4-2
Total Constituent Quantity Managed by EPA Region
(tons)

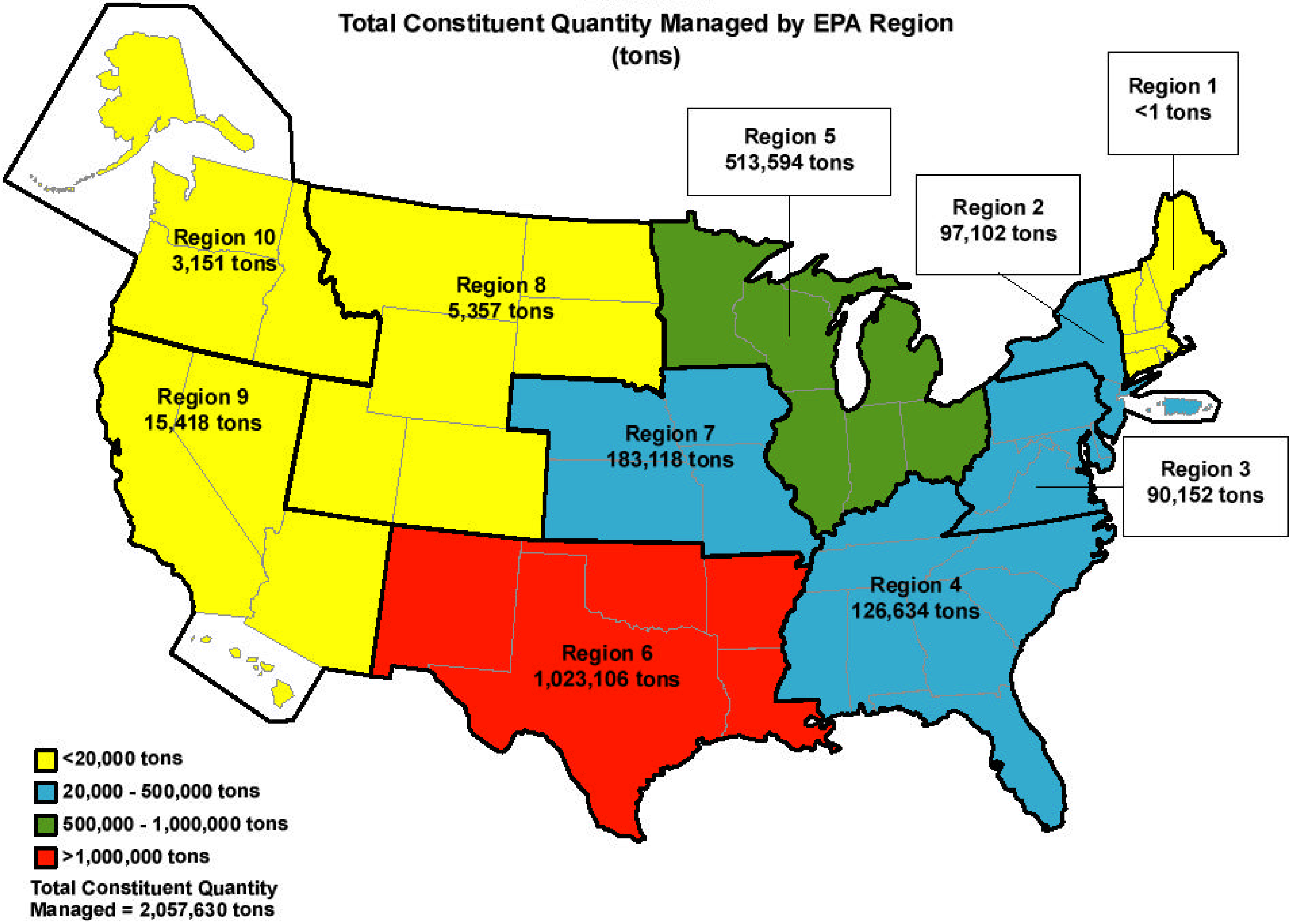
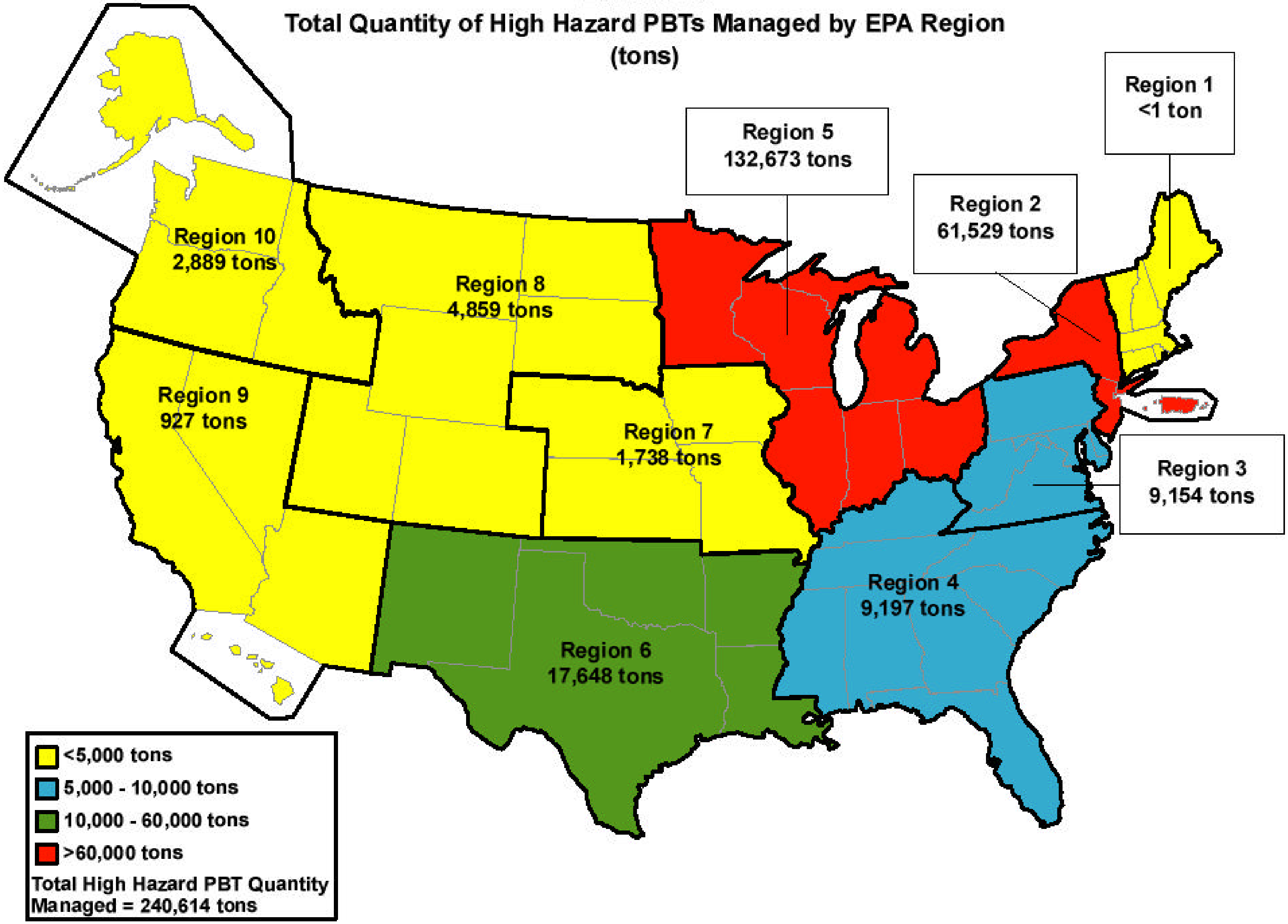
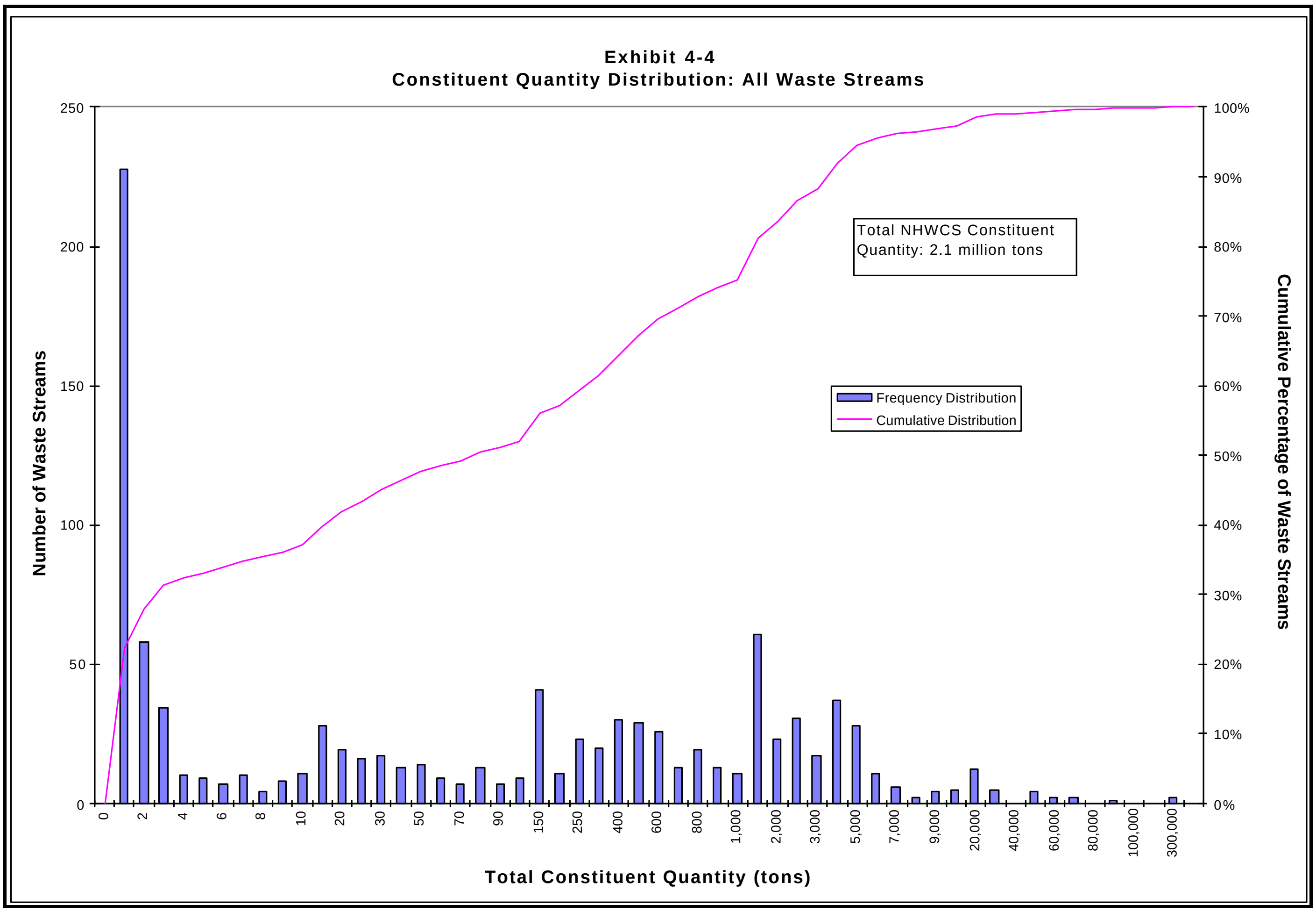


Exhibit 4-3
Total Quantity of High Hazard PBTs Managed by EPA Region
(tons)



WASTE STREAM CONSTITUENT QUANTITIES

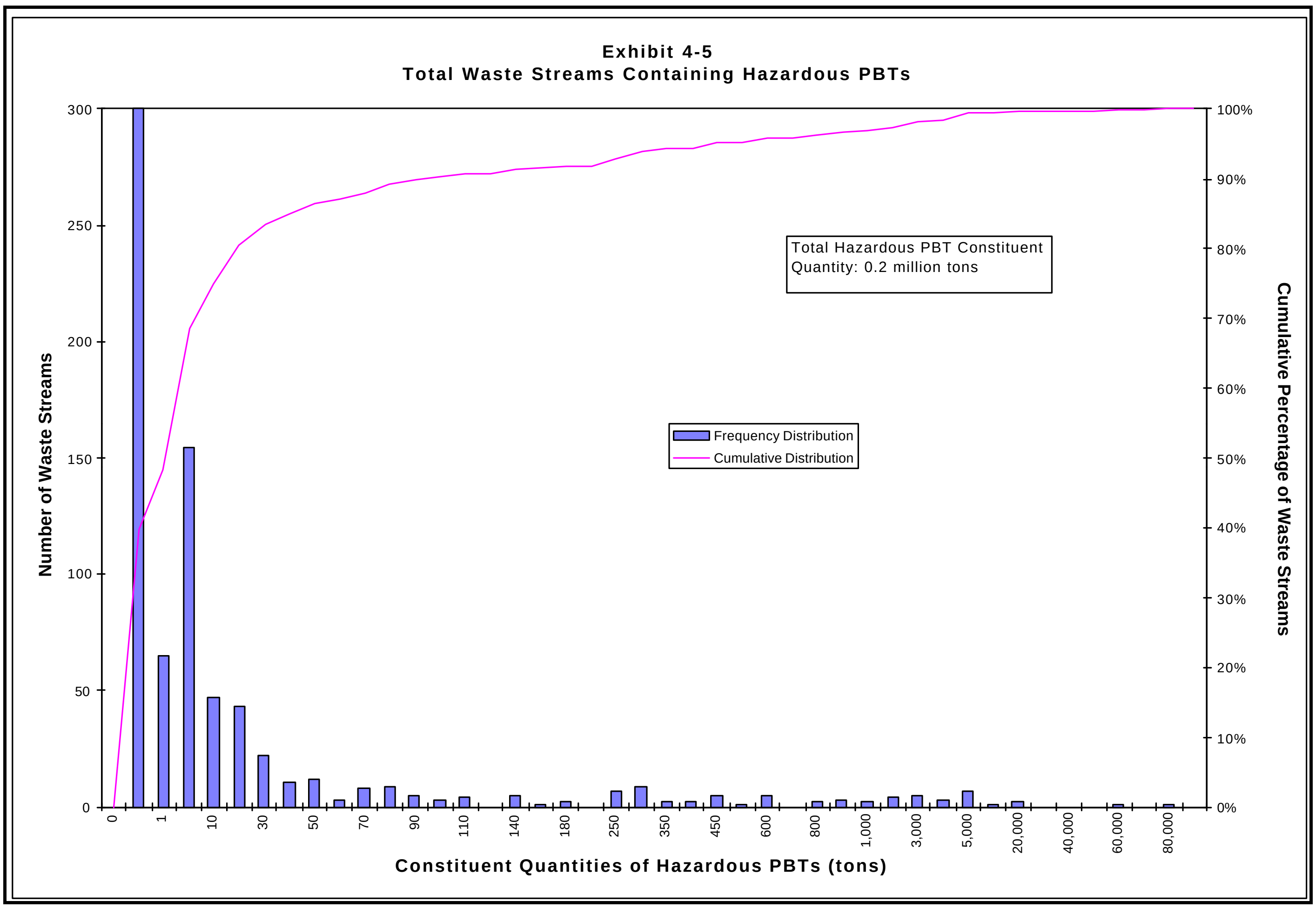
The NHWCS provides detailed information to support the analysis of constituent quantities in more than 1,000 individual RCRA waste streams. Through this analysis we found that similar to the distribution of waste stream quantities, the distribution of hazardous constituent quantities across waste streams is highly skewed. As Exhibit 4-4 illustrates, for the majority of major waste streams, that hazardous constituent quantities are relatively small -- approximately 50 percent of surveyed waste streams contain less than 50 tons of hazardous constituent quantity. Conversely, a very small number of waste streams contain more than 10,000 tons. These large streams, however, account for more than 60 percent of total hazardous constituent quantity in NHWCS. The composition of these high-constituent quantity streams is primarily spent acids, solvents, and lead acid batteries.



In contrast to the distribution of total NHWCS constituent quantity, a large number of streams containing small constituent quantities dominate the distribution of waste streams containing hazardous PBTs. As shown in Exhibit 4-5, approximately 80 percent of waste streams with hazardous PBT constituents contain 10 tons or less of PBT constituent quantity, and almost half contain less than one ton. As is the more general case for hazardous constituents, a small number of waste streams account for a very large proportion of the constituent quantity of hazardous PBTs. Again, these waste streams are largely made up of lead acid batteries and other lead scrap destined for secondary smelters.

QUANTITIES OF INDIVIDUAL CONSTITUENTS

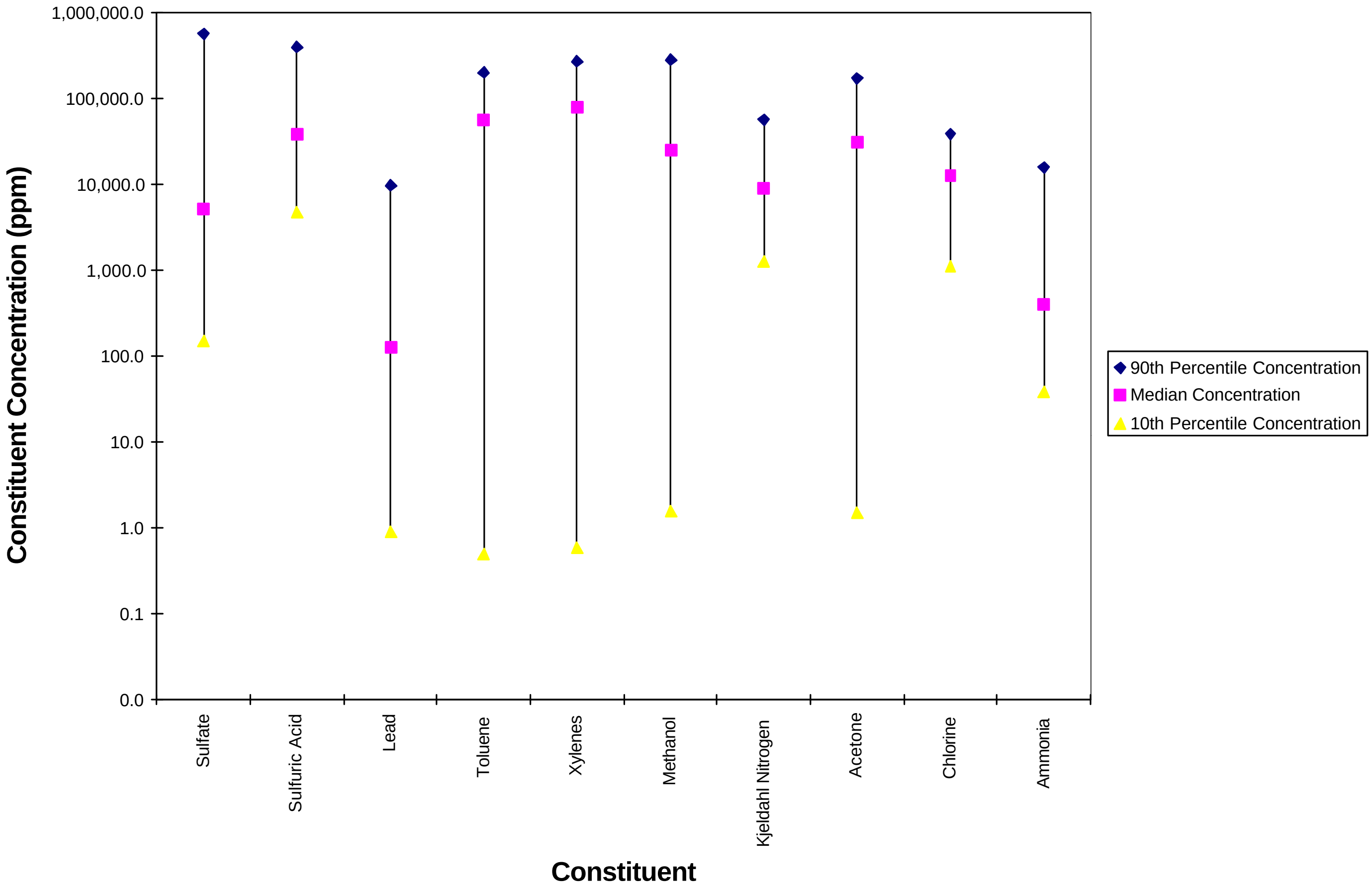
When considered in aggregate, it is apparent that a relatively small number of constituents account for most of the constituent quantities in NHWCS. Exhibit 4-6 shows the fifteen constituents with the greatest quantity. These fifteen constituents collectively make up 62 percent of total constituent quantities in the Survey. Sulfate, sulfuric acid, lead, and toluene have the largest total quantities in the NHWCS data set, together composing almost 40 percent of all constituent quantity. For 10 of these high-quantity constituents, the results are attributable to a small number of large waste streams in which these constituents appear at extremely high concentrations. Sulfate and sulfuric acid, for example, occur in only nine and eight waste streams, respectively. However, both occur at very high concentrations in these waste streams, which are spent acids from methyl methacrylate production. Also, although lead is also a highly prevalent constituent, only nine waste streams (containing spent lead batteries) account for almost 90 percent of its total constituent quantity.



Of the highly prevalent constituents, only six (lead, toluene, xylenes, methanol, acetone, and methyl ethyl ketone) are also among the fifteen highest quantity constituents. Other highly prevalent constituents occur in small waste streams or at low concentrations, and therefore do not account for large proportions of hazardous constituent quantity. In general, organics and non-metal inorganics dominate hazardous constituent quantities in the Survey. Prevalent metals, such as chromium, cadmium, and barium, are noticeably absent from the list of the highest quantity constituents.

For the most part, high-quantity constituents tend to occur at higher concentrations than highly prevalent constituents. Exhibit 4-7 shows the concentrations of the ten constituents with the greatest constituent quantity. Many of these high-quantity constituents, particularly organics and lead, exhibit a wide range of reported concentrations, sometimes spanning as many as five orders of magnitude. In general, however, the median concentrations of the high-quantity constituents are higher than the median concentrations of highly prevalent constituents. Moreover, for the organics in particular, the median concentrations are much closer to the high end of the range than they are to the mid-points. It also appears that the non-metal inorganics exhibit a narrower range of concentrations than metals and organics. This probably reflects the fact that these are somewhat less prevalent in the Survey, appearing in a fewer number of waste streams at a more limited range of concentrations. Constituents that show a narrow concentration range, such as sulfate, sulfuric acid, and chlorine, appear in a small number of waste streams at very high concentrations.

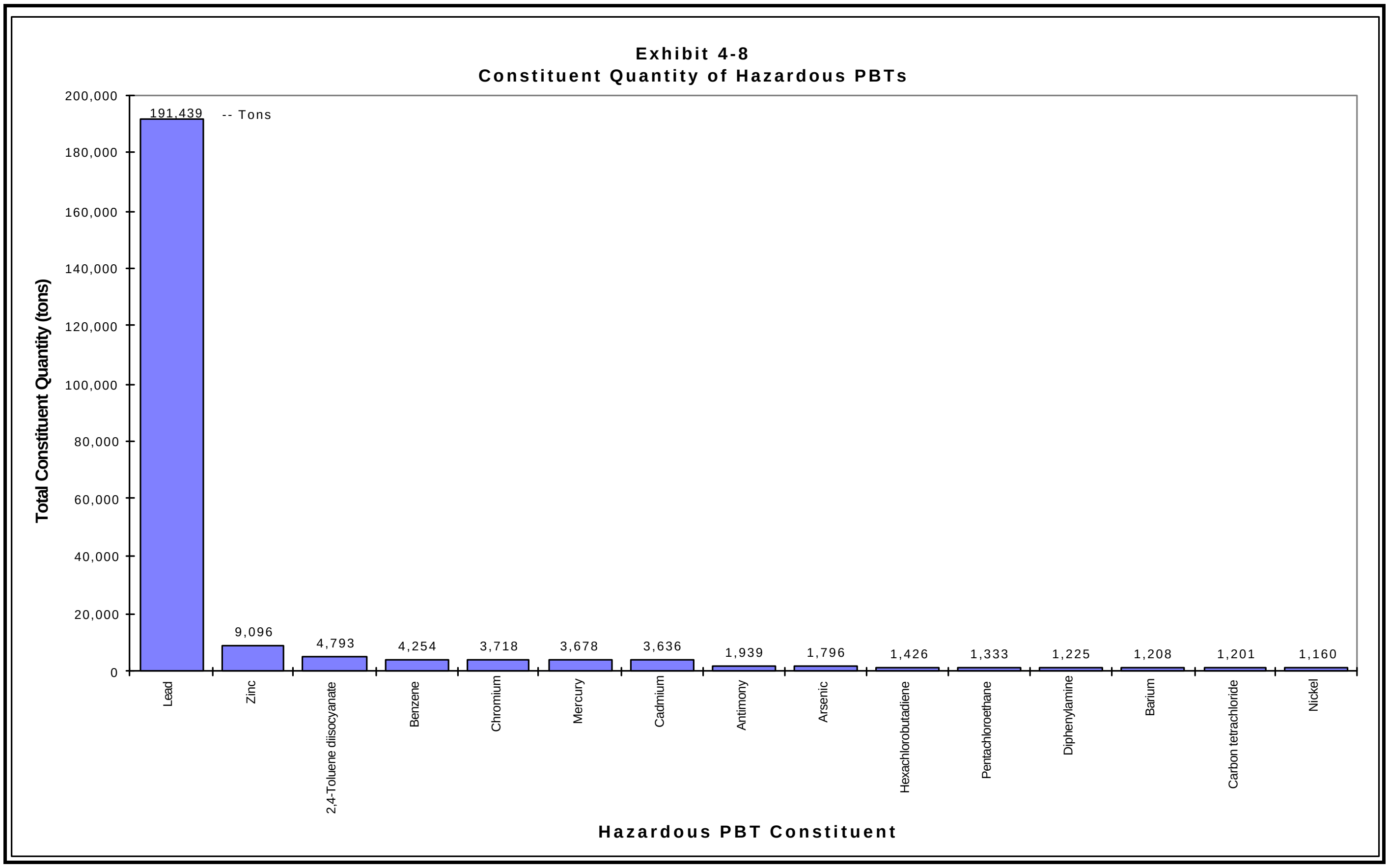
Exhibit 4-7
Concentration of High-Quantity Constituents



As is the case with all constituents, a small number of constituents dominate the constituent quantities of hazardous PBTs. Exhibit 4-8 shows the fifteen hazardous PBTs with the greatest constituent quantity. These fifteen account for 96 percent of all PBT quantity.

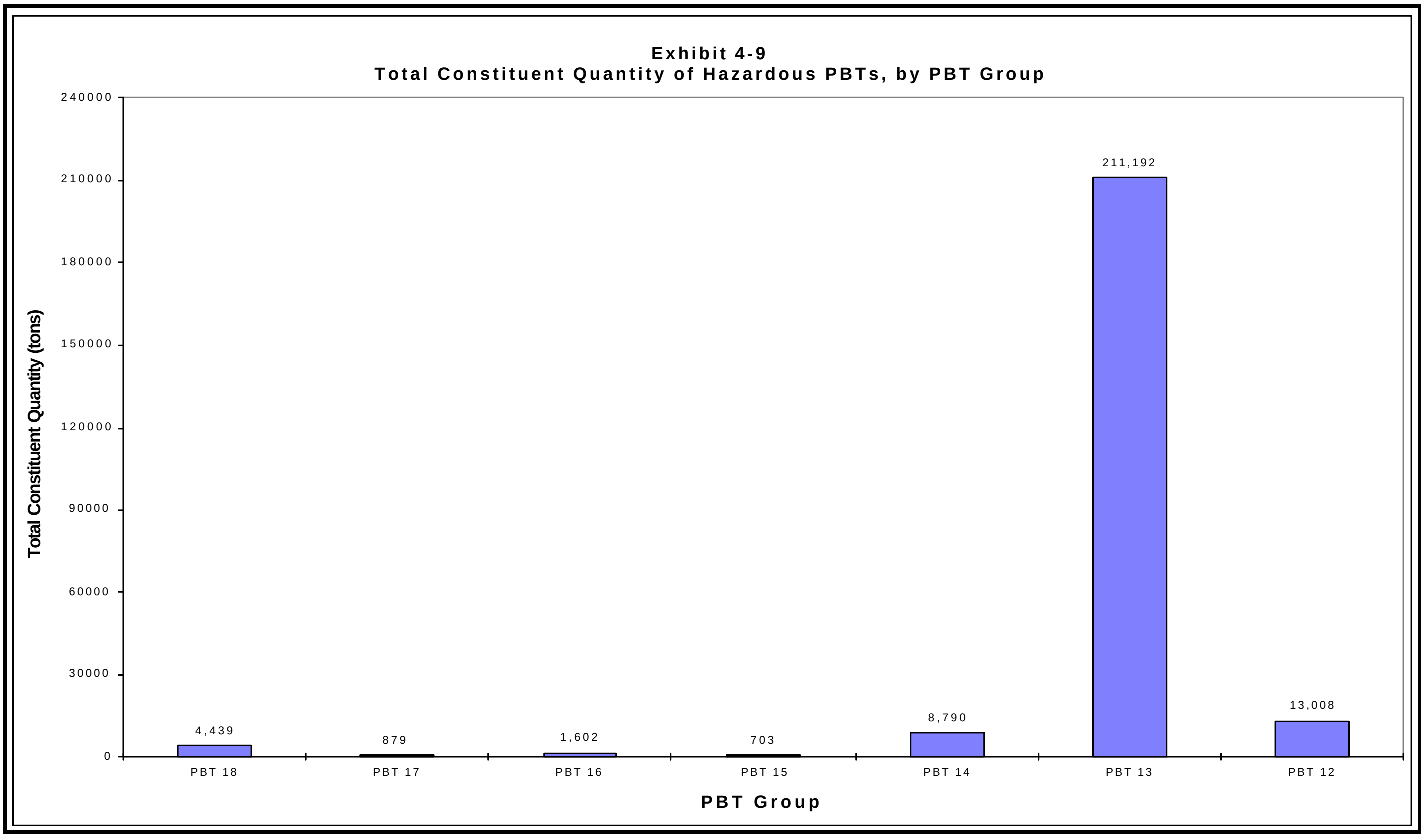
Lead is, by far, the hazardous PBT constituent with the greatest constituent quantity, accounting for 80 percent of all PBT quantity reported by Survey respondents. Exhibit 4-9 further illustrates the overall dominance of lead, which has a PBT hazard score of 13. The category of PBTs with this hazard score completely dominates the contributions of the other PBT categories. Consequently, most of the remaining PBT constituents of concern reported in the Survey appear in relatively small quantities. Almost half of them account for less than 10 tons of total constituent quantity each.

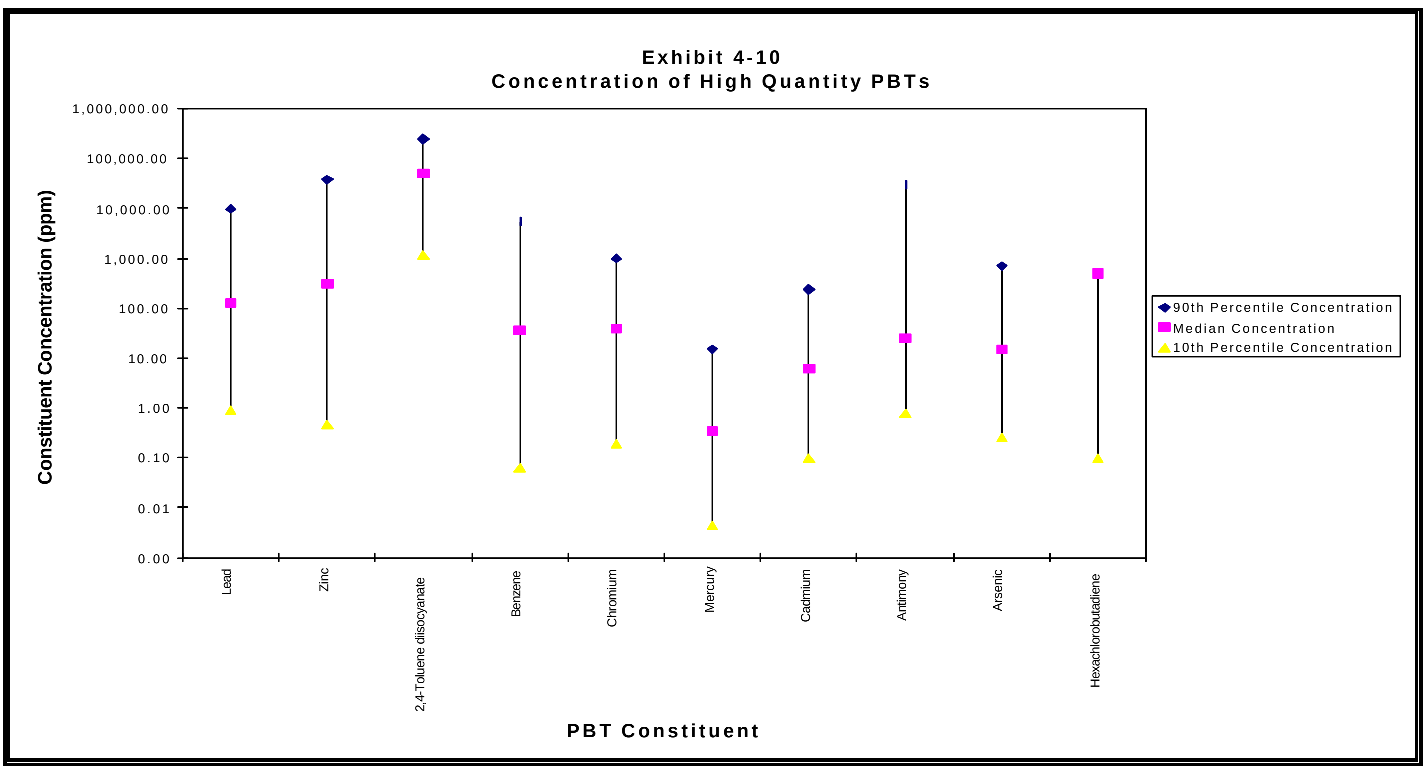
Metals are more predominant in the list of large-quantity PBTs than among all large-quantity



constituents. This is an interesting result, considering that metals make up only 17 percent of the 93 hazardous PBT constituents appearing in the NHWCS. These metals are also highly prevalent. For nearly all fifteen large-quantity PBT constituents, a very large fraction of quantity is supplied by 10 or fewer relatively large waste streams in which the PBTs appear at very high concentrations. In an extreme case, one wastewater waste stream of almost 500,000 tons contains approximately 94 percent of the total constituent quantity of mercury in the Survey.

Overall, the largest quantity PBT constituents occur at much lower concentrations than other high-quantity constituents. As illustrated by Exhibit 4-10, median concentrations for PBT constituents are generally between 0.1 and 1,000 parts per million. One notable exception is 2,4-toluene diisocyanate, which has a median concentration of almost 50,000 parts per million and appears in only four waste streams. Also, median concentrations of PBT constituents usually occur closer to the middle of concentration ranges, indicating a more even distribution of concentrations.





<u>Note:</u> Constituents above are ranked in order according to Exhibit 4-8.

A key objective of the *National Hazardous Waste Constituent Survey* (NHWCS) is to allow EPA to improve the understanding of the linkages between waste treatment and management practices and constituent concentrations and quantities. Consequently, the NHWCS data will be useful to EPA in assessing the fate of hazardous constituents by helping the Agency determine whether these constituents are reused, recycled, neutralized, destroyed, or disposed of on land. Because methods used to manage constituents are an important determinant of risk, this assessment also will enable EPA to better gauge potential risks posed by hazardous waste to human health and environment.

As an example of how the NHWCS data have already proven useful in understanding treatment and management practices, we used analyses of constituent management to assess the impact of the comparable fuels exclusion in the Combustion MACT standards. The purpose of the comparable fuels exclusion is to classify as nonhazardous waste that is combusted and similar to fossil fuels in its hazardous characteristics. EPA used data from NHWCS to identify constituents that are managed through incineration or energy recovery, to determine which waste streams have constituent concentrations that meet the requirements of the exclusion, and to estimate the total quantity of comparable fuels in the waste universe.

To provide an overview of how hazardous constituents are managed, this chapter presents and describes analyses of the types and methods of management for constituents in NHWCS, including the hazardous persistent, bioaccumulative, and toxic (PBT) constituents on the Agency's current Chemical Prioritization List. To conduct this analysis, we used management system type data provided in the NHWCS and then calculated total constituent quantity and constituent composition by management method. Because the focus of this analysis is on constituent management, only data for the respondent population was used (i.e., those that submitted constituent information). The remainder of this chapter answers key questions about the management of hazardous wastes and constituents, including the following:

- Are most hazardous constituents managed on-site by the generator or sent off-site to a treatment, recycling or disposal facility?
- What percentage of total hazardous constituent quantity in NHWCS is managed by each major management method? What percentage of hazardous PBTs are managed by each management method?
- For the high-quantity constituents, what are the most common management methods used? What are the concentrations of these constituents?

- C What percentage of total hazardous constituent quantity is as-generated waste?

- C How effectively are highly prevalent NHWCS constituents treated? How effectively are high-quantity NHWCS constituents treated?

- C What percentage of total hazardous constituent quantity is managed in RCRA-exempt units? What percentage is residuals from waste treatment?

ON-SITE VERSUS OFF-SITE MANAGEMENT

As shown in Exhibit 5-1, most of the quantity of hazardous constituents in NHWCS (60 percent or 1.2 million tons) is managed on-site by large generators. This suggests that it is often economic for facilities that generate process waste streams with large quantities of hazardous constituents to invest in on-site waste management facilities. On the other hand, facilities that generate smaller quantities of hazardous constituents are more likely to send their waste off-site for disposal via a variety of management methods. With regard to waste stream distribution, a majority of the waste streams (72 percent, or 737 streams) are managed off-site. As expected, these waste streams are generally smaller (median equal to 42 tons) than waste streams managed on-site (median equal to 214 tons).

In terms of allocation by waste form there is an approximately even split of on-site constituent quantity between wastewaters (643,000 tons) and non-wastewaters (600,000 tons). None of the constituents managed off-site are wastewaters; this is likely the case because it is usually not cost-effective to transport large streams off-site. Most generators discharge the non-hazardous wastewater component of large wastewater waste streams to POTWs or waterways under NPDES Clean Water Act permits.[1]

Exhibit 5-1
CONSTITUENT MANAGEMENT REPORTED IN NHWCS: ON-SITE VS. OFF-SITE

	Wastewater Constituent Quantity (tons/yr)	Non-wastewater Constituent Quantity (tons/yr)	Total (tons/year)
Managed Onsite	643,100 (100 streams)	606,461 (183 streams)	1,249,561 (283 streams)
Managed Offsite	--- (1 stream)	808,069 (736 streams)	808,069 (737 streams)
Total Constituent Quantity	643,100 (101 streams)	1,414,530 (919 streams)	2,057,630 (1,020 streams)

Note: The survey includes constituent data for 1,020 of the 1,760 survey wastestreams.

In contrast to the findings discussed above, a significant majority (87 percent or 210,000 tons)

[1] Hazardous sludge residuals from wastewater treatment systems are generally managed separately from the wastewater component of these systems.

of the quantity of hazardous PBT constituents is managed off-site. As discussed below, most of this waste is from lead-acid battery recycling. Of the wastes that contain hazardous PBTs and that are managed on-site, 67 percent of the constituent quantity is in non-wastewater form and 33 percent is in wastewater form. As with total constituent quantity, all of the constituent quantity of hazardous PBTs managed off-site is non-wastewater.

Exhibit 5-2
MANAGEMENT OF HAZARDOUS PBTS: ON-SITE VERSUS OFF-SITE

	Wastewater High Hazardous PBT Quantity (tons/yr)	Non-wastewater Hazardous PBT Quantity (tons/yr)	Total Quantity of Hazardous PBTs (tons/yr)
Quantity Managed On-site	10,399 (86 streams)	20,778 (115 streams)	31,177 (201 streams)
Quantity Managed Off-site	-- (1 stream)	209,437 (554 streams)	209,437 (555 streams)
Total Quantity of Hazardous PBTs	10,399 (87 streams)	230,215 (669 streams)	240,614 (756 streams)

As noted above, a large majority of the constituent quantity of hazardous PBTs (80 percent) is comprised of lead destined for recycling. Because such recycled wastes may pose less serious risks to human health and the environment, it is also useful to assess the constituent quantity of hazardous PBTs after removing the recycled lead. An assessment of the management of hazardous PBTs without lead, for example, illustrates that quantities managed off-site fall to approximately 40,500 tons, or approximately 20 percent of the original total. Using this estimate, the total quantity of hazardous PBTs decreases to approximately 70,000 tons and the distribution of constituent quantity between on-site and off-site management is nearly equal.

MANAGEMENT METHODS FOR NHWCS WASTE

The distribution of hazardous constituent quantities in NHWCS across management methods is highly skewed. As shown in Exhibit 5-3, the top five management methods account for nearly 70 percent of the total hazardous constituent quantity in NHWCS. These methods include underground injection, energy recovery, fuel blending, incineration, and metals recovery. When the broader category 'other treatment methods' is also included, total constituent quantity managed by the top methods rises to almost 85 percent. Recycling, which includes metals recovery, solvents recovery, and other recovery, accounts for approximately 14 percent of total hazardous constituent quantity.

Management techniques that do not recycle, reuse, or destroy hazardous properties continue to play a significant role in the management of hazardous constituents. Land disposal methods account for approximately 23 percent of hazardous constituent quantity, indicating that significant quantities of hazardous constituents are not completely recycled or destroyed during management.

Exhibit 5-3
CONSTITUENT MANAGEMENT, BY MANAGEMENT METHOD

Management Method	Constituent Quantity (tons per year)		
	Wastewater	**Non-wastewater**	**Total**
Deepwell/Underground Injection	399,430	212	399,642
Other Treatment	83,301	243,840	327,141
Energy Recovery	0	298,220	298,220
Fuel Blending	0	261,703	261,703
Incineration	34,292	191,421	225,713
Metals Recovery	0	206,881	206,881
Aqueous Inorganic and Organic Treatment	110,025	0	110,025
Solvents Recovery	0	57,323	57,323
Landfill	0	47,532	47,532
Stabilization	0	42,243	42,243
Other Recovery	0	26,917	26,917
Other Disposal	294	19,814	20,108
Transfer Facility Storage	0	15,186	15,186
Aqueous Organic Treatment	12,597	194	12,791
Aqueous Inorganic Treatment	2,909	45	2,954
Surface Impoundment	251	2,575	2,827
Land Treatment	0	321	321
Sludge Treatment	0	103	103
Total	**643,100**	**1,414,530**	**2,057,630**

Note: Columns may not sum to totals due to rounding.

As shown in Exhibit 5-4, for the hazardous PBTs, the management method used to handle the largest PBT quantity is metals recovery, which is used to manage 80 percent (190,000 tons) of these quantities. However, if lead from battery recycling is not considered, the total hazardous PBT quantity managed through metals recovery decreases to approximately 30 percent (21,500 tons). Following metals recovery in terms of total PBT quantity is stabilization (5 percent). This high ranking is somewhat misleading, however, because stabilization is typically used to treat wastes prior to land disposal.[2]

Exhibit 5-4
MANAGEMENT OF HAZARDOUS PBTS, BY MANAGEMENT METHOD

Management Method	Quantity of Hazardous PBTs (tons/yr)		
	Wastewater	Non-wastewater	Total
Metals Recovery	0	190,426	190,426
Stabilization	0	11,157	11,157
Incineration	1,057	10,342	11,399
Energy Recovery	0	7,633	7,633
Landfill	0	6,982	6,982
Other Treatment	6,027	134	6,161
Surface Impoundment	234	2,511	2,745
Deepwell/Underground Injection	1,214	9	1,223
Aqueous Inorganic Treatment	1,159	45	1,204
Aqueous Organic Treatment	479	0	479
Other Recovery	0	384	384
Aqueous Inorganic and Organic Treatment	229	0	229
Land Treatment	0	180	180
Fuel Blending	0	160	160
Sludge Treatment	0	100	100
Other	0	151	151
Total	**10,399**	**230,214**	**240,614**

Note: Columns may not sum to totals due to rounding.

Alternatively, stabilization may be used to decharacterize waste that are hazardous solely due to the presence of a characteristic; these waste streams may then be eligible for disposal in non-hazardous Subtitle D units. If we do not include metals recovery for lead batteries, just over 40 percent of hazardous PBT quantity is recycled.

[2] Although the NHWCS asked respondents to report all of the management methods for each waste stream, facilities usually only reported one management method per waste stream. It is not clear to what extent these stabilized materials are ultimately disposed in Subtitle C landfills.

The relative importance of management methods changes significantly if only hazardous PBTs are considered. Underground injection, for example, represents 19 percent of total hazardous constituent quantity but less than one percent of hazardous PBT quantity. In contrast, there are management methods that are more common for hazardous PBTs than for other hazardous constituents. Stabilization, for instance, ranks as the tenth most common method of managing all constituents, but as the second most common for hazardous PBTs. This difference is not surprising because stabilization is much more effective for wastes that can be easily bound, such as metals and other inorganic materials, than organic wastes with diverse properties. After wastes are stabilized, they are often disposed of in landfills. Accordingly, as is the case for stabilization, landfills and surface impoundments constitute a higher percentage of the quantity of hazardous PBTs (14 percent of total) than total constituent quantity (two percent of total).

Analysis of management methods for the high quantity constituents can also provide valuable insights for RCRA risk assessment and policy development. Exhibit 5-5 presents this information for the ten largest quantity constituents identified in Chapter 4. In general, the NHWCS data suggest that for inorganic constituents (i.e., sulfates, sulfuric acid, ammonia, kjeldahl nitrogen), land disposal in the form of deepwell injection is the predominant approach.[3] Chlorine is managed primarily via aqueous organic and inorganic treatment. Not surprisingly, combustion methods are used to treat most of the organics, although some solvent recovery is conducted for methanol and xylenes. Lead, the only metal in the ten highest quantity wastes, is managed almost exclusively through metals recovery.

As shown in Exhibit 5-6, the frequency of management methods for hazardous PBTs varies significantly from the techniques used for non-PBT constituents in NHWCS. Metals recovery, for example, is a common management method for six of ten high-quantity PBTs. Other common management methods for these constituents are land disposal, stabilization, incineration, and recovery. Land disposal through landfills or surface impoundments is slightly more common for toxics, where it occurs among the top management methods for seven of the top ten hazardous PBTs, as opposed to the broader list of high-quantity constituents (Exhibit 5-5), where land disposal is among the top management methods for five of the top ten constituents.

With regard to concentrations, most hazardous PBTs that have low concentrations are stabilized and landfilled. This scenario likely occurs because it is typically not economic to recover these low concentration metals, and treatment-based standards in the Land Disposal Restrictions require stabilization of these wastes. In contrast, metals recovery is typically used for PBTs exhibiting high concentrations, which is in accordance with the fact that constituents are frequently not mixed with other wastes prior to metals recovery.

[3] Three of these constituents (sulfate, sulfuric acid, and Kjeldahl nitrogen) are generated by the same facility, and appear to undergo "Other Treatment" prior to underground injection. However, since the two waste streams are reported separately, we have no way of confirming this from analysis of the Survey.

Exhibit 5-5

MOST PREVALENT MANAGEMENT METHODS FOR HIGH-QUANTITY CONSTITUENTS

Constituent	Management Method	Total Constituent Quantity (tons)	Percent of Total Quantity for Constituent	Median Constituent Concentration (ppm)
Sulfate	Other Treatment	154,823	50%	25,447
	Deepwell/Underground Injection	154,823	50%	25,447
	Landfill	21	<1%	5,050
Sulfuric Acid	Other Treatment	96,620	46%	202,663
	Deepwell/Underground Injection	96,620	46%	202,663
	Metals Recovery	16,401	8%	65,000
Lead	Metals Recovery	183,111	96%	400,250
	Landfill	4,320	2%	16
	Stabilization	2,651	1%	98
Toluene	Fuel Blending	40,658	41%	144,000
	Energy Recovery	37,574	38%	100,000
	Incineration	10,356	10%	47,000
Xylenes	Fuel Blending	45,330	50%	164,000
	Energy Recovery	29,791	33%	114,400
	Solvents Recovery	3,830	4%	100,000
Methanol	Incineration	33,036	45%	53,450
	Energy Recovery	17,628	24%	50,000
	Solvents Recovery	10,454	14%	70,000
Kjeldahl Nitrogen	Deepwell/Underground Injection	22,507	50%	9,038
	Other Treatment	22,507	50%	9,038
Acetone	Fuel Blending	13,065	33%	32,000
	Energy Recovery	9,461	24%	40,000
	Incineration	9,080	23%	50,000
Chlorine	Aqueous Organic & Inorganic Treatment	33,374	95%	4,843
	Energy Recovery	1,644	5%	13,785
	Incineration	3	<1%	3,400
Ammonia	Other Treatment	17,438	50%	394
	Deepwell/Underground Injection	17,109	49%	394
	Aqueous Organic & Inorganic Treatment	115	<1%	8

Exhibit 5-6
MANAGEMENT METHODS FOR HAZARDOUS PBTS

Hazardous PBT	Management Method	Total PBT Quantity (tons)	Percent of Total Quantity for PBT	Median PBT Concentration (ppm)
Lead	Metals Recovery	183,111	96%	400,250
	Landfill	4,320	2%	16
	Stabilization	2,651	1%	98
Zinc	Stabilization	4,792	53%	810
	Surface Impoundment	2,169	24%	5,820
	Metals Recovery	1,047	12%	35,000
2,4-Toluene diisocyanate	Incineration	3,280	68%	3,900
	Energy Recovery	1,514	32%	94,500
Benzene	Energy Recovery	2,583	61%	5,000
	Other Treatment	446	10%	.5
	Incineration	335	8%	375
Chromium	Metals Recovery	2,341	63%	68,363
	Other Treatment	463	12%	5
	Deepwell/Underground Injection	349	9%	5
Mercury	Other Treatment	3,583	97%	296
	Aqueous Inorganic Treatment	33	0%	0
	Landfill	30	0%	.1
Cadmium	Stabilization	2,413	66%	1
	Metals Recovery	756	21%	400
	Surface Impoundment	245	7%	41
Antimony	Metals Recovery	1,900	98%	30,500
	Landfill	22	1%	1
	Surface Impoundment	6	0%	15
Arsenic	Landfill	1,492	83%	6
	Metals Recovery	176	10%	2,000
	Stabilization	108	6%	5
Hexachlorobutadiene	Incineration	1,413	99%	47,000
	Energy Recovery	10	1%	500
	Unspecified	2	0%	500

Note: Whole waste concentration used to calculate median concentration. Where whole waste concentration was not reported for a waste stream, we multiply leachate concentration by 20 (Westat, 1998).

EFFECTIVENESS OF WASTE TREATMENT

Unlike the Generator Survey, NHWCS, in addition to reporting many waste streams at the point of generation, contains data characterizing waste streams that are residuals of waste treatment. By comparing constituent concentrations in as-generated waste streams versus those in treated waste, analysts can use NHWCS to evaluate the effectiveness of the waste treatment and management methods described in the previous section. For example, analyses can show how well these methods may reduce hazardous properties and relative toxicities of hazardous waste streams before their ultimate disposition in a landfill or other disposal unit. NHWCS may be especially useful for determining how effective the Land Disposal Restrictions are in reducing risks posed by waste disposed on or in land-based disposal units.

Because NHWCS includes waste streams generated and managed on-site as well as waste received from off-site by TDRs and other waste intermediaries, discerning waste streams at the point of generation (i.e., as-generated) from treatment residuals requires a number of analytical steps. For waste streams generated and managed on-site ('GM' waste streams), we used BRS Origin Codes and Source Codes in conjunction with Form Codes that corresponded either directly or indirectly with as-generated waste streams or with treatment residuals.[4]

To identify as-generated waste streams and treatment residuals among waste received by commercial TDRs from offsite ('WR' waste streams), we relied primarily on descriptions of waste provided by respondents. In addition, we removed both remediated waste and waste received from or sent to fuel builders (or other waste intermediaries), since these are not process waste streams subject to typical hazardous waste treatment technologies.

<u>Treatment Status of NHWCS Constituent Quantities</u>

Since many treatments reduce overall quantities as well as toxicities of hazardous constituents (e.g., through destruction), the change in constituent quantity between waste at the point of generation and treatment residuals is a key indicator of how effectively treatments address RCRA constituents. In NHWCS, there is a total of 1.7 million tons of constituent quantity in waste streams identified as either as-generated or as treatment residuals.

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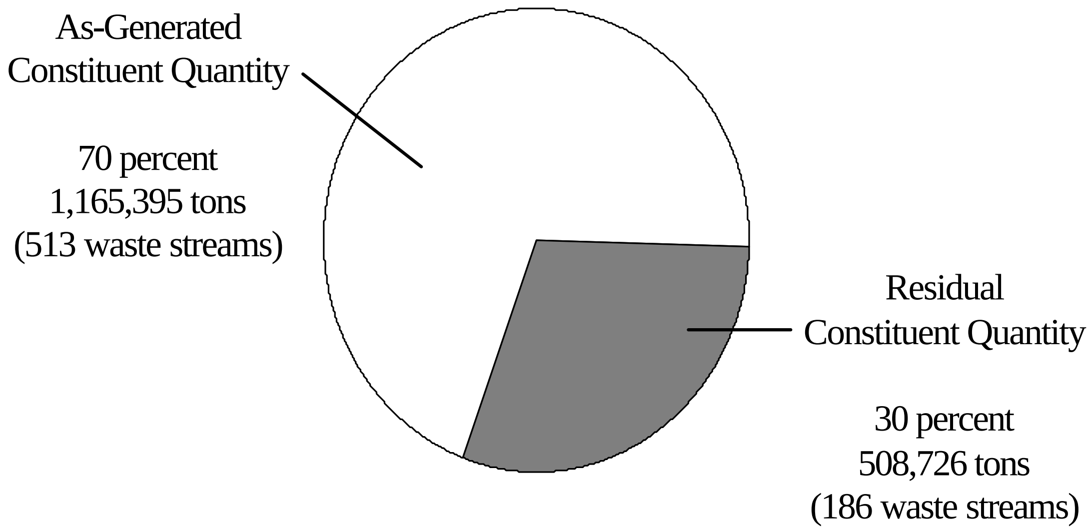
[4] For example, a BRS Origin Code of 1 clearly indicates that a reported waste stream is generated from a production process, whereas an Origin Code of 5 definitively indicates that a waste stream is a treatment residual. We also inferred that certain Form Codes identify waste streams that are treatment residuals. We assume the Form Code for incineration ash (i.e., B303), for example, designates a waste stream that has already been treated by incineration.

Exhibit 5-7

TOTAL CONSTITUENT QUANTITIES IN AS-GENERATED AND RESIDUAL WASTE STREAMS



Note: Based on 699 waste streams that reported constituent information and that were identified as as-generated waste or as a treatment residual.

- As shown in Exhibit 5-7, the majority of NHWCS constituent quantities, or 1.2 million tons out of 1.7 million tons (70 percent), are found in as-generated waste. Treatment residuals account for 30 percent of total constituent quantity, or 0.5 million tons. While as-generated waste and treatment residuals represented in NHWCS are associated with different waste streams, these data reflect a general trend of reducing hazardous constituent quantities through waste treatment.

Effectiveness of Treatment

In addition to reducing overall regulated waste quantities, the effectiveness of treatments applied to RCRA waste can be measured by how effectively they address hazardous properties inherent to these wastes (e.g., toxicity, ignitability). Higher constituent concentrations in waste usually reflect relatively greater hazards, so treatments that reduce concentrations significantly are more effective at reducing risks posed by these wastes.[5]

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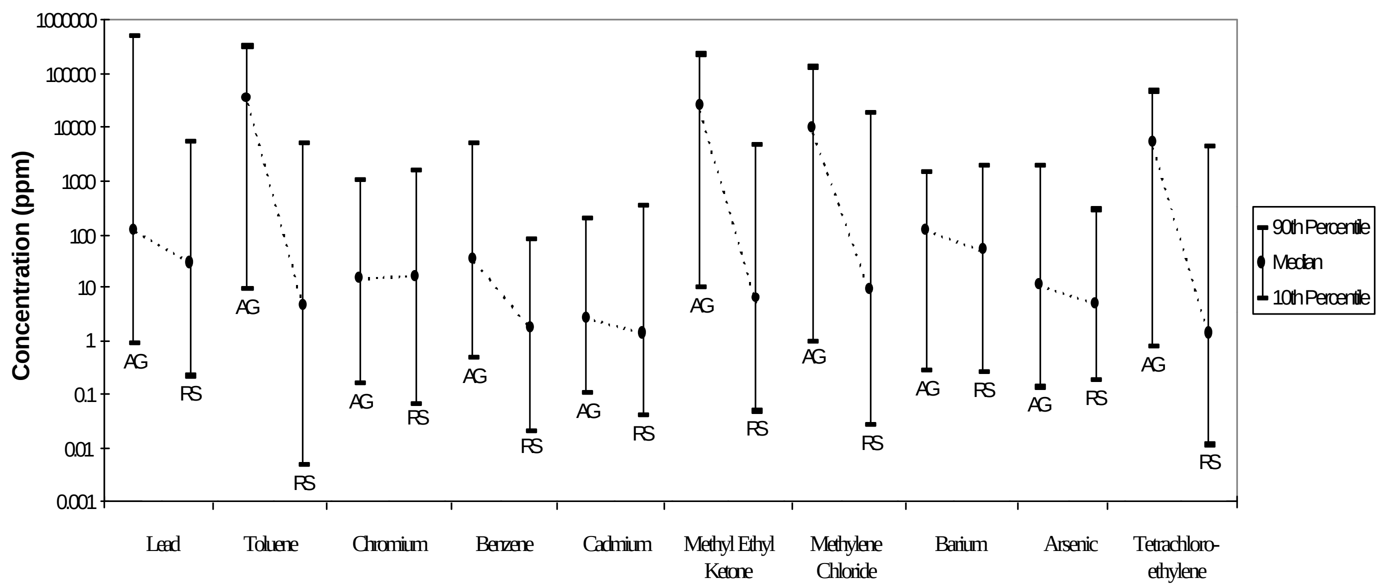
[5] It is important to note that the as-generated waste and treatment residuals reported in the NHWCS are generally not associated with one another, i.e., they do not represent pre-treatment and post-treatment versions of the same waste.

Of the ten most prevalent constituents shown in Exhibit 5-8, most exhibit concentrations as-generated and after treatment that span a broad range (i.e., four orders of magnitude). Concentration data for these constituents provide the following results:

C In general, for highly prevalent constituents, treatment is most effective in reducing concentrations of organics. As shown in Exhibit 5-8, with the exception of benzene, median concentrations in prevalent organics at the point of generation are 10,000 ppm or higher. Median concentrations of prevalent organics in treatment residuals are over three orders of magnitude lower, at approximately 10 ppm.

C Concentrations of five highly prevalent metals (lead, chromium, cadmium, barium, and arsenic) do not differ significantly after treatment from concentrations in as-generated waste streams. Concentrations of these metals in treatment residuals are generally less than one order of magnitude lower than those in as-generated waste. However, the median concentrations of metals in waste as-generated are also much lower (i.e., under 100 ppm) than concentrations of organics as-generated. This suggests that treatment of hazardous metals may not be less effective at reducing concentrations to relatively low levels than treatments applied to organics.

Exhibit 5-8
Concentrations of Most Prevalent Constituents in As-Generated (AG) and Residual (RS) Waste Streams

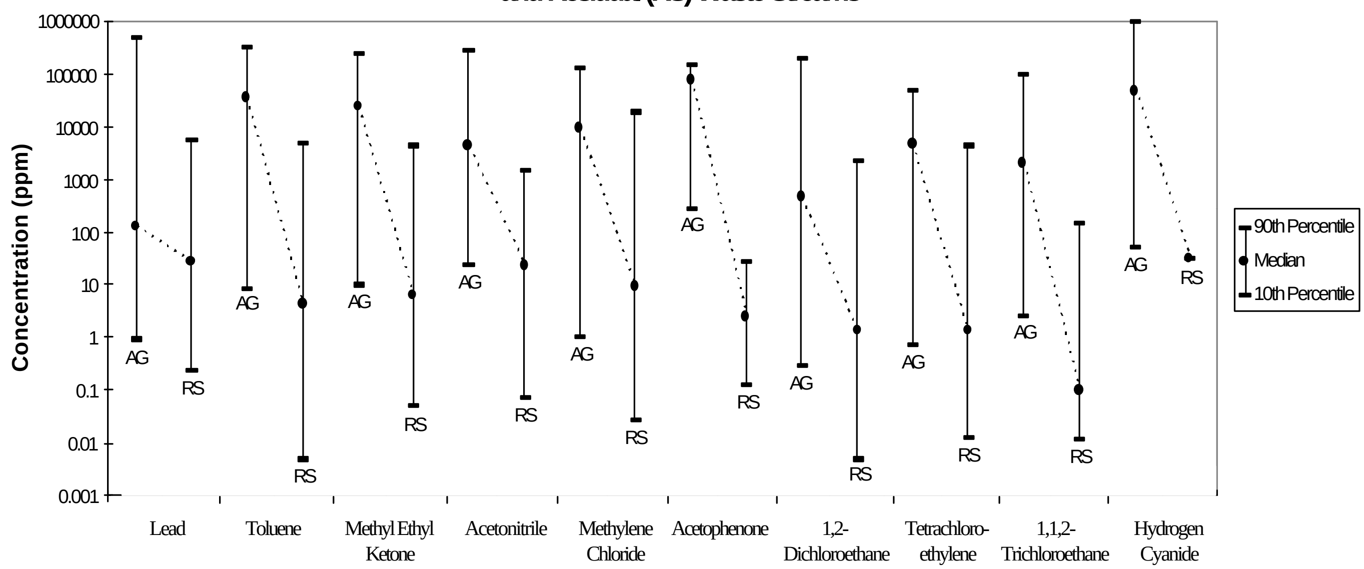


High-quantity RCRA constituents consist of nine organics, as well as lead. As Exhibit 5-9 displays, median as-generated concentrations of these constituents generally exceed those of highly prevalent constituents. For these constituents, we provide the following results:

- For five high-quantity organics (toluene, methyl ethyl ketone, methylene chloride, acetophenone, and hyrdrogen cyanide), reported median concentrations in as-generated waste are equal to or over 10,000 ppm. For three others (acetonitrile, tetrachloroethylene, and 1,1,2-trichloroethane), as-generated concentrations are over 1,000 ppm. As is the case with prevalent organics, treatment seems to address these hazardous constituents effectively -- median concentrations for all eight organics in treatment residuals are under 100 ppm.

- For lead, the only metal among high-quantity RCRA constituents, relatively low concentrations are reported in both as-generated waste (over 100 ppm) and in treatment residuals (between 10 and 100 ppm). Most highly concentrated lead in as-generated waste (e.g., lead acid batteries) is recovered. As a result, treatments other than metals recovery are probably applied to waste bearing lower concentrations of lead. In NHWCS waste, lead concentrations in treatment residuals are lower than those in as-generated waste by about one order of magnitude.

Exhibit 5-9
Concentrations of High-Quantity RCRA Constituents in As-Generated (AG) and Residual (RS) Waste Streams



Note: This exhibit displays only high-quantity RCRA constituents. Other presentations of high-quality constituents include constituents not regulated under RCRA.

MANAGEMENT IN EXEMPT UNITS

Most of the wastes included in the NHWCS are managed in units subject to RCRA permitting.[6] There is a portion of the total constituent quantity (22 to 27 percent), however, that is managed in units exempt from RCRA.[7] By examining the constituent characteristics and concentrations in these wastes, EPA can assess whether wastes managed in exempt units pose a serious human health or ecological risk.

Overall, only four percent of the waste streams in NHWCS are managed in exempt units.[8] Approximately 17 percent of the facilities in NHWCS (27 facilities) manage at least one of these waste streams. While these figures indicate that waste streams managed in exempt units constitute a small percentage of total waste streams, they do suggest that almost one of five facilities in NHWCS use them. With regard to constituents, approximately 20 percent of the NHWCS constituents are found in at least one waste stream managed in exempt units. A large percentage of the waste streams managed in exempt units are industrial wastewaters and contaminated groundwater. As Exhibit 5-10 indicates, other interesting findings from wastes managed in exempt units include:

- Benzene is the most common constituent managed in exempt units, occurring in 19 of 43 waste streams; also relatively prevalent are chromium (13 streams), toluene (12 streams), and cyanides (11 streams).

- For some constituents, a large proportion of their total quantity is managed in exempt units as opposed to RCRA-permitted units. For example, 36 percent of the total quantity of cyanides and 19 percent of pyridine are managed in exempt units.

- The constituents with the highest median concentrations in exempt units are ammonia (367 parts per million), phenol (103 ppm), and cyanides (55 ppm).

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[6] Units that are exempt from RCRA permitting requirements are described in 40 *CFR,* Parts 264, 265, and 266.

[7] We present a range for total constituent mass managed in exempt units because, for approximately five percent of the total constituent mass, respondents did not indicate whether the waste was managed in an exempt unit. In terms of toxic quantity, between zero and 24 percent of PBT 12-18 toxic mass is managed in exempt units.

[8] To determine exempt status, the NHWCS questionnaire asked respondents: "Is this waste stream managed exclusively in units exempt from RCRA permitting requirements?" We examined the constituents for waste streams where "Yes" was the answer to this question.

Exhibit 5-10

PREVALENT CONSTITUENTS MANAGED IN EXEMPT UNITS

Constituent	Number of Constituent Occurrences	Average/Median Constituent Concentration (ppm)	Constituent Quantity (tons)	Percent of Total Quantity for Constituent
Benzene	19	7 ppm/0 ppm	444	10%
Chromium	13	43 ppm/1 ppm	12	0%
Toluene	12	4 ppm/1 ppm	19	0%
Cyanides	11	2,363 ppm/55 ppm	737	36%
Acetone	10	104 ppm/6 ppm	340	1%
Lead	10	322 ppm/3 ppm	159	0%
Pyridine	9	65 ppm/25 ppm	227	19%
Chlorobenzene	8	20 ppm/0 ppm	202	7%
Cadmium	8	20 ppm/0 ppm	3	0%
Ammonia	8	2,275 ppm/367 ppm	8,494	24%
Nickel	8	10 ppm/2 ppm	4	0%
Zinc	7	4,118 ppm/0 ppm	243	3%
Barium	7	2 ppm/0 ppm	1	0%
Methanol	7	2,008 ppm/51 ppm	3,477	5%
Carbon tetrachloride	7	0 ppm/0 ppm	1	0%
Phenol	7	414 ppm/103 ppm	80	1%
1,1,1-Trichloroethane [Methyl chloroform]	7	0 ppm/0 ppm	1	0%
Acrylonitrile	6	73 ppm/5 ppm	220	15%
Trichlorofluoro-methane [CFC-11]	6	1 ppm/0 ppm	1	1%
Arsenic	6	0 ppm/0 ppm	1	0%

Notes:

- Based on information from 43 waste streams managed exclusively in units exempt from RCRA permitting requirements that also report constituent data.
- The constituents in this table are those that are most prevalent, and not necessarily the high-quantity constituents, managed in exempt units.

In previous chapters of this report, we focus on the constituent characteristics of waste and methods of management as reported by management facilities. The NHWCS, however, is also a useful tool for identifying important trends in constituent generation and management by industry sector. Using the Standard Industrial Classification (SIC) code field, we grouped waste streams reported by responding facilities according to the industry sector that generated the waste.[1,2] As before, we examine total constituent quantity as well as PBT quantity for the constituents that make up the top one-third of the Agency's PBT list. The NHWCS improves upon the Generator Survey data for analysis of industry behavior because the Survey provides more precise estimates of constituent concentration and quantity. In our analysis, we identify the ten industry sectors that generate the greatest constituent quantities, as well as the ten industry sectors associated with the largest quantities of hazardous PBTs.

The results of the analysis in this chapter provide answers to the following questions:

- What industry sectors account for the greatest constituent quantity? How closely do these mirror industry patterns in overall waste generation?
- How many different constituents does each industry sector generate? What are the principal constituents generated by each industry sector?
- What is the distribution of hazardous PBTs among industry sectors?
- How does constituent generation differ by wastewaters and non-wastewaters within industry sectors?
- What are the principal methods of management used by each major industry

[1] To obtain the SIC code of generators that shipped waste off-site to TDRs represented in NHWCS, and for generators represented in the Survey that did not provide a SIC code, programming was done to extract the appropriate SIC code from the following databases: FINDS/RCRIS, 1991 BRS, 1993 BRS, and 1995 BRS. If a facility was not present in these four databases or if the site failed to report a SIC code, then the final SIC code was left blank.

[2] "Industry sector" refers to industries grouped using the two-digit Standard Industrial Classification (SIC) codes used to classify industrial facilities established in: *Standard Industrial Classification Manual*, Executive Office of the President, Office of Management and Budget, 1987.

sector? How do each of these industries manage the constituents of greatest concern?

Results from these analyses may allow EPA to create more effective regulatory initiatives and enforcement policies by tailoring them to specific industry sectors whose RCRA wastes present the greatest risks to human health and the environment. The ability to highlight industry sectors may be particularly useful for regulating the generation and management of hazardous PBTs, as the EPA is currently refining the Waste Minimization Prioritization Tool, designed to assist industry with targeting high priority constituents.

CONSTITUENT GENERATION BY INDUSTRY SECTOR

When considering total constituent quantity, four major industry sectors account for 90 percent of the total constituent quantity in the NHWCS. Furthermore, ten industry sectors generate 96 percent of the total constituent quantity. As shown in Exhibit 6-1, chemicals (SIC 28) is the dominant industry sector, by itself accounting for 65 percent (1,340,000 tons) of the total constituent quantity. The stone, clay, and glass products industry (SIC 32), together with the electric, gas, and sanitary services industry (SIC 49) contribute another seven percent to the total constituent quantity. Approximately 18 percent of the total constituent quantity is generated by industries for which SIC codes were either unavailable (unspecified 13 percent) or for industry classifications that are very broad (business services, not elsewhere classified). Analysis of the constituent quantity information for these two sectors, however, reveals that nearly 70 percent of the unspecified material is lead waste. Lead acid battery waste streams make up a large percentage of this lead, suggesting that car battery replacement and collection may account for most of the unspecified constituent mass.

When wastewaters and non-wastewaters are analyzed separately, the distribution of constituent quantity by primary generating industry sectors changes somewhat. As Exhibit 6-2 illustrates, the contribution to total constituent quantity by the chemical industry falls to 36 percent of the total (approximately 700,000 tons) when only non-wastewaters are considered. For the remaining industry sectors, there is no change in the percentage contribution to total constituent quantity when only non-wastewaters are considered. In comparison to the other industry groupings, wastewaters account for a significantly higher portion of the constituent quantity generated by the chemicals and allied products industry sector.

Within individual industry sectors, a relatively small number of facilities dominate generation of constituent quantities. Within the chemicals industry, five facilities account for 43 percent of the constituent quantity. Furthermore, the top three of these facilities generate 37 percent of the total constituent quantity. This pattern is less skewed for non-wastewaters, however, as the top three facilities generate only 17 percent of the non-wastewater constituent quantity within the constituents industry.

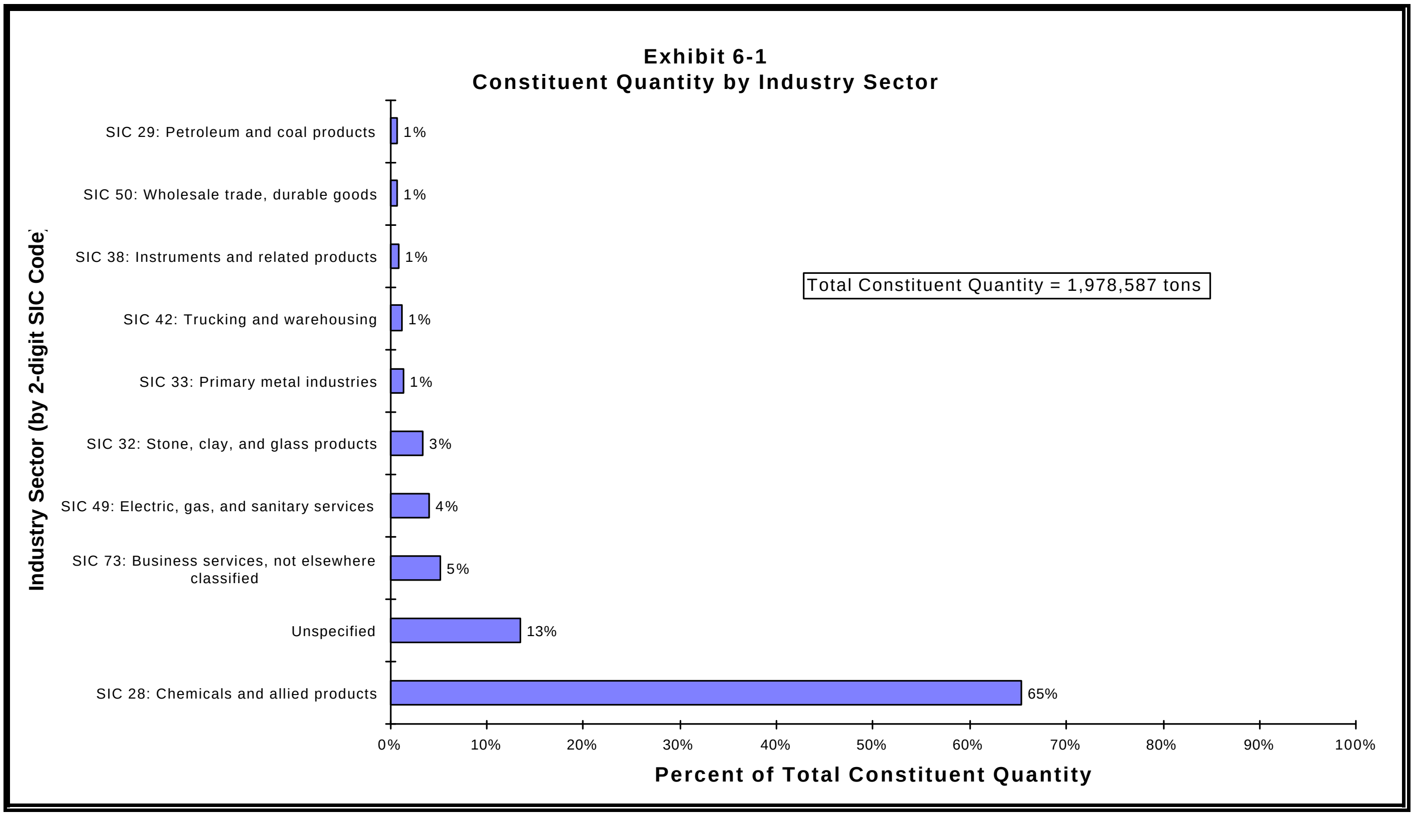


Exhibit 6-1
Constituent Quantity by Industry Sector
Industry Sector (by 2-digit SIC Code)
SIC 29: Petroleum and coal products
1%
SIC 50: Wholesale trade, durable goods
1%
SIC 38: Instruments and related products
1%
SIC 42: Trucking and warehousing
1%
SIC 33: Primary metal industries
1%
SIC 32: Stone, clay, and glass products
3%
SIC 49: Electric, gas, and sanitary services
4%
SIC 73: Business services, not elsewhere classified
5%
Unspecified
13%
SIC 28: Chemicals and allied products
65%
Total Constituent Quantity = 1,978,587 tons
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Total Constituent Quantity

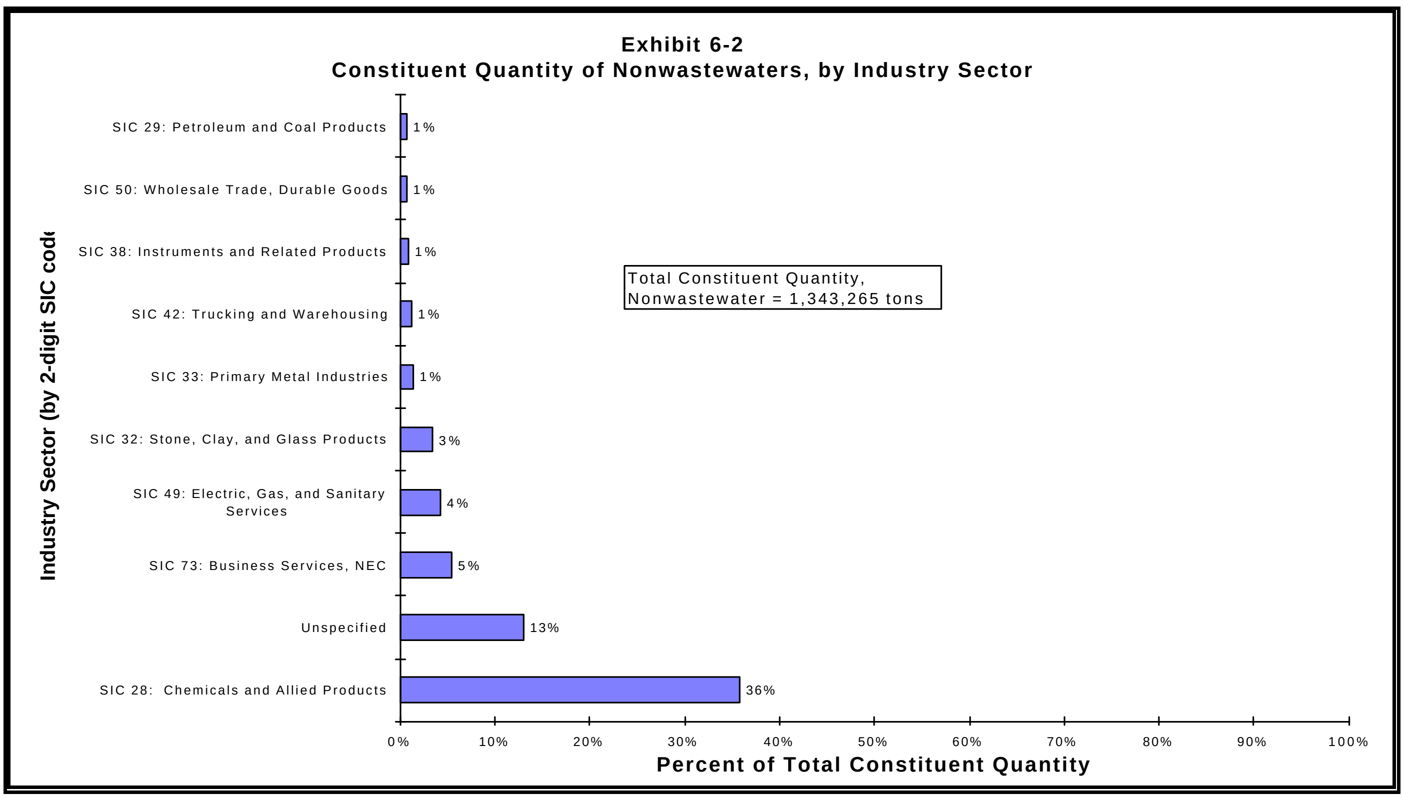


Exhibit 6-2
Constituent Quantity of Nonwastewaters, by Industry Sector
Industry Sector (by 2-digit SIC code
SIC 29: Petroleum and Coal Products
1%
SIC 50: Wholesale Trade, Durable Goods
1%
SIC 38: Instruments and Related Products
1%
SIC 42: Trucking and Warehousing
1%
SIC 33: Primary Metal Industries
1%
SIC 32: Stone, Clay, and Glass Products
3%
SIC 49: Electric, Gas, and Sanitary Services
4%
SIC 73: Business Services, NEC
5%
Unspecified
13%
SIC 28: Chemicals and Allied Products
36%
Total Constituent Quantity, Nonwastewater = 1,343,265 tons
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Percent of Total Constituent Quantity

Shifting the focus to hazardous PBTs causes a significant change in the key generating industries. Here, dominance shifts dramatically to the primary and fabricated metal industries (SIC 33 and SIC 34), largely accounted for by battery scrap and spent lead acid batteries. As illustrated in Exhibit 6-3, industries without an assigned SIC code (unspecified) account for the majority of the hazardous PBT quantity. Of this unspecified total, 80 percent is lead acid batteries and lead battery scrap. Primary metals constitute another nine percent of the total PBT quantity, bringing the total contribution of metal industries to the total quantity of hazardous PBTs to 89 percent. Interestingly, the chemicals industry, which dominates total constituent quantity, accounts for only nine percent of hazardous PBT constituent quantity.

Non-wastewater streams account for almost all of the PBT quantity within the top ten industries. As shown in Exhibit 6-4, the percentage of the total PBT quantity for each industry sector changes only marginally when considering just non-wastewater streams. This suggests that the majority of hazardous PBTs are found in fairly concentrated non-wastewater streams.

As with total constituent quantity, relatively few facilities generate a large proportion of PBT quantity. Further analysis of the three most significant industries reveals that, of the hazardous PBT quantity not classified by SIC code, 80 percent (143,000 tons) is generated by only four facilities. Similarly, 81 percent (17,500 tons) of the hazardous PBT quantity associated with the primary metals industry sector is generated by only six facilities. Only four facilities contribute nearly 55 percent (11,700 tons) of the total PBT quantity generated by the constituents and allied products sector.

Overall, analysis of constituent generation by industry sector reveals that a few industry sectors are the prime contributors to total constituent quantity and hazardous PBT quantity. Although total constituent quantity is highly concentrated in the chemicals industry, the primary and secondary metals industry (SIC 33) dominates hazardous PBT quantity generation to an even greater extent. These patterns suggest that policies focused on a relatively small number of industry sectors may address a significant proportion of RCRA hazardous constituent generation.

INDIVIDUAL CONSTITUENTS BY INDUSTRY SECTOR

Analysis of constituent prevalence also provides important insights into waste generation by industry sector. Identifying highly prevalent constituents and other trends in industry processes may allow the EPA to develop policies that target specific processes and constituents. A major finding is that while each of the dominant industry sectors is responsible for a relatively large number of constituents, a small number of these constituents account for a very large proportion of the total constituent quantity.

As with total constituent quantity, the chemicals industry accounts for the vast majority of constituent occurrences. Exhibit 6-5 illustrates the distribution of the five highest-quantity constituents within the ten industries accounting for the highest constituent quantity. Of 724 reported NHWCS constituents, the chemical industry generates 624 unique constituents. The range of unique constituents generated by the remaining nine industry sectors is between 61 and 213 constituents. The total unique count of constituents generated by the ten industry sectors is 684, illustrating that 95 percent of the constituents in the entire NHWCS database are present in the waste generated by these ten industries.

Exhibit 6-3
Hazardous PBT Constituent Quantity, by Industry Sector

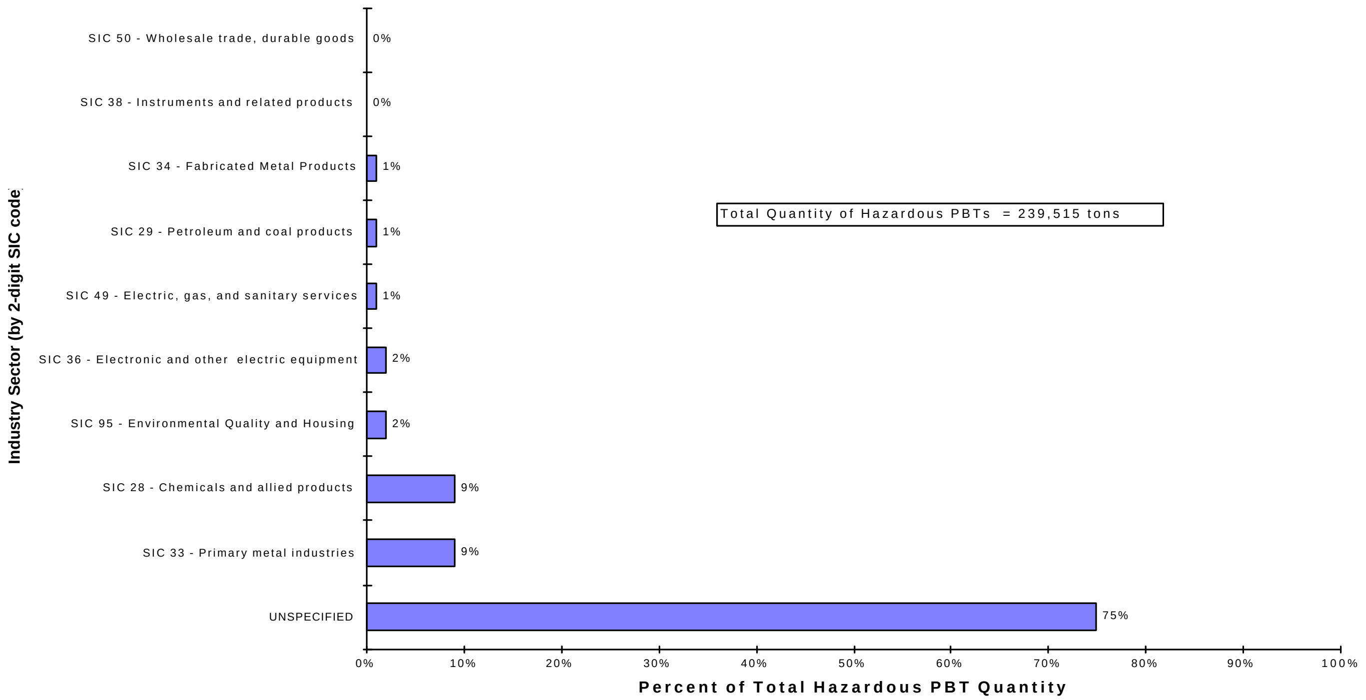
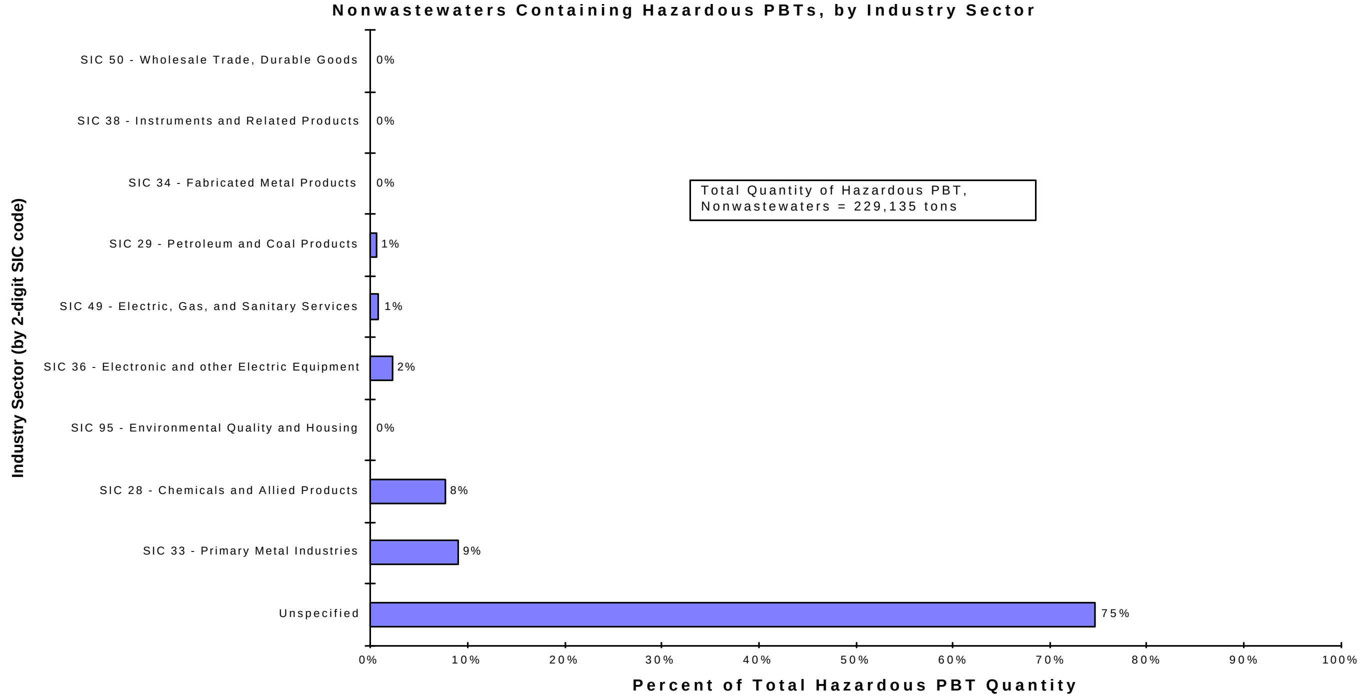


Exhibit 6-4
Nonwastewaters Containing Hazardous PBTs, by Industry Sector



Considering the contribution of different constituents to the total constituent quantity within each industry sector, this analysis confirms that a relatively small number of constituents account for a high proportion of the constituent quantity. As shown in Exhibit 6-5, five high-quantity constituents in the chemicals industry account for 51 percent of the total constituent quantity for this sector. Total constituent quantity for other industry sectors shows an even greater domination by a few constituents. For example, the top five constituents make up 87 percent of the constituent quantity for wholesale goods (SIC 50), 75 percent for trucking and warehousing (SIC 42), 72 percent for primary metals (SIC 33), and 71 percent for instruments and related products (SIC 38).

Exhibit 6-5
CONSTITUENT GENERATION BY INDUSTRY SECTOR

SIC Code	Industry Sector	Constituent quantity (tons)	Total Waste Quantity (tons)	Number of Constituents	Top Five Constituents by Quantity	Quantity of Top Five Constituents (tons)	Quantity of Top 5 as a Percent of Industry Total
28	Constituents and allied products	1,342,678	121,481,734	624	Sulfate, sulfuric acid, sodium chloride, methanol, kjeldahl nitrogen	683,205	51 percent
- -	Unspecified	275,897	921,314	127	Lead, xylenes, sulfuric acid, toluene, 2,6-Di-tert-butyl-p-cresol	225,092	82 percent
73	Business services, not elsewhere classified	106,760	421,072	134	Toluene, xylenes, alkyl benzenes, methyl ethyl ketone, naphtha	55,563	52 percent
49	Electric, gas, and sanitary services	84,458	1,271,100	197	Toluene, n-hexane, xylenes, methyl ethyl ketone, acetone	43,798	52 percent
32	Stone, clay, and glass products	68,196	135,695	213	Toluene, C6-C12 aliphatics, xylenes, ethyl benzene, C9-C10 alkyl benzenes	46,829	69 percent
33	Primary metal industries	28,126	2,515,154	73	Lead, zinc, cadmium, chromium, iron, oxide	20,375	72 percent
42	Trucking and warehousing	24,964	58,991	79	Toluene, xylenes, methanol, methyl ethyl ketone, acetone,	18,668	75 percent
38	Instruments and related products	18,478	38,312	132	Methanol, acetone, silica, ethyl acetate, methylene chloride	13,204	71 percent
50	Wholesale trade, durable goods	14,759	53,276	61	Naphtha, tetrachloroethylene, alkyl benzenes, xylenes, toluene	12,844	87 percent
29	Petroleum and coal products	14,271	80,940,236	156	P-cresol, alkylbenzenes, xylenes, benzene, toluene	8,357	59 percent
Total		1,978,587	207,836,884		---		---
% NHWCS Total		**96 percent**	**96 percent**		---		---

Results of constituent prevalence analysis for hazardous PBTs reflect similar patterns. Again, most of the dominant generating industries produce large numbers of constituents, but just a few primary constituents account for most of the hazardous PBT quantity. Exhibit 6-6 illustrates the distribution by industry sector of the total 93 hazardous PBTs highly reported in the NHWCS. The chemicals industry and electric, gas, and sanitary services industry report the highest numbers of constituents, with 66 and

61, respectively. Environmental quality and housing (SIC 95) and the wholesale goods (SIC 50) industry sectors report the lowest number of hazardous PBT constituents, with 9 and 13 constituents, respectively.

Exhibit 6-6
GENERATION OF HAZARDOUS PBTS, BY INDUSTRY SECTOR

SIC Code	Industry Sector	Quantity of Hazardous PBTs (tons)	Number of Hazardous PBTs	Top 5 Hazardous PBTs	Quantity of Hazardous PBTs	Quantity of Top 5 as Percent of Industry Total
	Unspecified	178,777	34	Lead, antimony, zinc, chromium, arsenic	178,527	100 percent
33	Primary metal industries	21,698	20	lead, zinc, cadmium, chromium, arsenic	20,117	93 percent
28	Constituents and allied products	21,246	66	2,4-Toluene diisocyanate, zinc, benzene, hexachlorobutadiene, pentachloroethane	11,833	56 percent
95	Environmental Quality and Housing	5,584	9	Mercury, lead, chromium, barium, silver	5,583	100 percent
36	Electronic and other electric equipment	5,438	17	Lead, zinc, chromium, barium, nickel	5,437	100 percent
49	Electric, gas, and sanitary services	2,222	61	Benzene, barium, nitrobenzene, lead, cadmium	1,754	79 percent
29	Petroleum and coal products	2,141	35	Benzene, dicyclopentadiene, lead, chromium, barium	2,073	97 percent
34	Fabricated metal products	1,407	17	Zinc, nickel, lead, chromium, barium, copper	1,401	100 percent
50	Wholesale trade, durable goods	510	13	Lead, cadmium, 1,2,4,5-tetrachlorobenzene, benzene, nitrobenzene	510	100 percent
38	Instruments and related products	492	45	Copper, zinc, lead, barium, silver	462	94 percent
Total Quantity		239,515				
Percent of Total Hazardous Quantity in NHWCS		**100 percent**				

The importance, however, of a very small number of constituents in determining total hazardous PBT quantity is even more pronounced than in determining overall constituent quantity. As Exhibit 6-6 also illustrates, over 90 percent of the hazardous PBT quantity is accounted for by the top five constituents in each sector, with the exception of the chemical industry and the electric, gas and sanitary services industry. The top five constituents for the chemical sector represent 56 percent of the hazardous PBT quantity, but the top ten constituents increase the contribution to 77 percent to the total hazardous PBT quantity.

Among hazardous PBTs, heavy metals dominate constituent prevalence. As shown in Exhibit 6-6, lead is generated by nine out of the ten industry sectors, once again primarily due to lead acid battery waste. Second to lead, barium and zinc are among the most prevalent constituents for the top ten industry sectors. Within the unspecified category, all five of the high quantity constituents are metals. Of the few organics included in the high-quantity hazardous PBTs, benzene is the most prevalent.

In summary, data on constituent prevalence in the NHWCS suggest that focusing on a small number of constituents within key industries could produce a relatively comprehensive picture of environmental impacts and potential opportunities for improvement.

MANAGEMENT METHODS BY INDUSTRY

Another interesting consideration is the link between generating industries and the waste management practices they typically employ. A closer look at management methods used by the primary industry sectors in NHWCS can provide important insights into trends in waste treatment, disposal, and recovery. By identifying the most common management methods used within dominant industries, EPA should be able to better target waste management policies for certain industries, wastes and constituents. This is especially important for hazardous PBTs, given the health and environmental risks involved in the treatment and disposal of toxic waste.

A key insight here is that the management methods among the top ten industry sectors are relatively consistent, with a small number of principal methods accounting for a majority of the management. Moreover, there is significant overlap between methods used to manage all hazardous constituents and those used to manage the more toxic subset of hazardous PBTs. For most industries, the top three management methods consistently account for the vast majority of constituent quantity managed. As shown in Exhibit 6-7, for total constituent quantity, these three methods account for over 70 percent of constituent quantity for all industry sectors, and over 90 percent of constituent quantity for seven industry sectors. Similarly, three management methods account for over 80 percent of all industry sectors for hazardous PBTs.

Energy recovery accounts for a significant percentage of constituent management for the ten industry sectors. As Exhibit 6-7 illustrates, at least 15 percent of the total constituent quantity in four industry sectors is managed by energy recovery. Energy recovery is slightly less common for hazardous PBT toxics; three of the ten industry sectors report that energy recovery is a top management method. Not surprisingly, due to the predominance of metals among hazardous PBTs found in NHWCS, metals recovery methods are more common for managing PBT quantity than for other constituent quantities. Fuel blending is less common among hazardous PBTs, as the heat content of most of these wastes is insignificant.

In spite of regulatory initiatives such as the Land Disposal Restrictions, management methods that deposit waste on land or into the ground still account for a substantial percentage of waste managed in many industry sectors. As Exhibit 6-7 shows, while land disposal methods are used to manage less total constituent quantity than recycling methods, landfills, surface impoundments, and deepwell/underground injection nonetheless remain among the most prevalent methods of management in many industry sectors. Primary metals (SIC 28) and petroleum refining (SIC 29) are the principle industry sectors that use landfills — for these two industries, 35 percent and 26 percent of constituent quantities, respectively, is disposed in landfills. Similarly, deepwell/underground injection is used to manage 30 percent of the total constituent quantity for the chemicals industry.

Land disposal methods, are less common for hazardous PBTs. Only four industry sectors generating hazardous PBTs list landfills among their top three management methods. Of these four sectors, primary metals remains the principle industry using landfills, with 26 percent of its constituent quantity sent to landfills. The remaining three industries manage no more than 13 percent of their waste through landfills. In short, a much smaller percentage of the hazardous PBT quantity is directly deposited into the ground.

A third method of management commonly used by the top ten industry sectors is combustion. Incineration is the primary management method for the instruments and related products industry sector (SIC 38), accounting for 65 percent of the constituent quantity. Although many constituent generators assert that they have a corporate preference for incinerating waste, only 15 percent of the hazardous constituent quantity in the chemicals industry is managed as such. The chemical industry actually combusts a larger proportion of their hazardous PBT quantities (75 percent). Electric, gas and sanitary services combust 78 percent of the total hazardous PBT quantities.

Finally, stabilization is a method commonly used by many of the top industry sectors.[3] For total constituent quantities, stabilization is a principal method of management for four industry sectors. These industries, on average, stabilize 22 percent of their constituent quantity. Stabilization is even more common for management of hazardous PBTs, as it is listed among the top three methods for seven of the industry sectors. Despite the prevalence of this method, though, stabilization usually accounts for a low proportion of the PBT quantity managed. An exception to this is the instruments and related products industry, for which 78 percent of hazardous PBT quantities is stabilized.

[3] Although the NHWCS asked respondents to report all management methods used for each waste stream (i.e., the entire treatment train), most facilities report only one management method per waste stream. As a result, it is difficult to assess whether wastes are managed by multiple methods, and to what extent constituent quantities may be double counted across management methods.

Exhibit 6-7

MOST PREVALENT MANAGEMENT METHODS BY INDUSTRY SECTOR

SIC Code	Industry Sector	Constituent Quantity (tons)	Top 3 Management Methods	Constituent Quantity of Top 3 Methods (tons)	Percent of Total Constituent Quantity of Industry Sector
28	Constituents and allied products	1,342,678	Deepwell/Underground Injection	398,912	30 percent
			Stabilization	320,911	24 percent
			Incineration	206,173	15 percent
--	Unspecified	275,897	Metals Recovery	193,560	70 percent
			Fuel Blending	61,538	22 percent
			Landfill	9,468	3 percent
73	Business services, not elsewhere classified	106,760	Fuel Blending	72,806	68 percent
			Energy Recovery	15,253	14 percent
			*no method given	10,338	10 percent
49	Electric, gas, and sanitary services	84,458	Fuel Blending	29,164	35 percent
			Energy Recovery	25,245	30 percent
			Stabilization	8,061	10 percent
32	Stone, clay, and glass products	68,196	Energy Recovery	58,869	86 percent
			Landfill	4,095	6 percent
			* no method given	2,743	4 percent
33	Primary metals	28,126	Landfill	9,715	35 percent
			Metals Recovery	8,250	29 percent
			Stabilization	8,215	29 percent
42	Trucking and warehousing	24,964	Energy Recovery	21,177	85 percent
			Fuel Blending	3,167	13 percent
			Landfill	620	2 percent
38	Instruments and related products	18,478	Incineration	12,013	65 percent
			Stabilization	4,043	22 percent
			Landfill	1,308	7 percent
50	Wholesale trade, durable goods	14,759	Solvents Recovery	10,917	74 percent
			Fuel Blending	3,333	23 percent
			Metals Recovery	506	3 percent
29	Petroleum and coal products	14,271	Fuel Blending	5,287	26 percent
			Landfill	3,726	26 percent
			Energy Recovery	3,187	22 percent

Exhibit 6-8

MOST PREVALENT MANAGEMENT METHODS FOR HAZARDOUS PBTS BY INDUSTRY SECTOR

SIC Code	Industry Sector	Quantity of Hazardous PBTs (tons)	Top Management Methods	PBT Quantity Managed per Method (tons)	Percent of Industry Hazardous PBT Quantity
--	Unspecified	178,777	Metals Recovery	177,159	99 percent
			Stabilization	1,488	1 percent
			Fuel Blending	77	<1 percent
33	Primary metals	21,698	Metals Recovery	8,195	38 percent
			Stabilization	7,686	35 percent
			Landfill	5,726	26 percent
28	Constituents and allied products	21,246	Incineration	11,058	52 percent
			Energy Recovery	4,855	23 percent
			Surface Impoundment	2,579	12 percent
95	Environmental quality and housing	5,584	Other Treatment	5,583	100 percent
			Stabilization	0	<1 percent
36	Electronic and other electric equipment	5,438	Metals Recovery	4,418	81 percent
			Stabilization	900	17 percent
			Sludge Treatment	94	2 percent
49	Electric, gas, and sanitary services	2,222	Energy Recovery	1,439	65 percent
			Incineration	290	13 percent
			Landfill	281	13 percent
29	Petroleum and coal products	2,141	Energy Recovery	815	38 percent
			Other Treatment	464	22 percent
			Aqueous Organic Treatment	462	22 percent
34	Fabricated metal products	1,407	Aqueous Inorganic Treatment	1,026	73 percent
			Stabilization	249	18 percent
			Landfill	83	6 percent
38	Instruments and related products	492	Stabilization	382	78 percent
			Other Treatment	85	17 percent
			Incineration	25	5 percent
50	Wholesale trade, durable goods	510	Metals Recovery	506	99 percent
			Fuel Blending	2	<1 percent
			Stabilization	1	<1 percent

The *National Hazardous Waste Constituent Survey* (NHWCS) provides the Agency with detailed data about the constituent composition of approximately half of the RCRA waste quantity reported in 1993. NHWCS data represent an improvement over existing hazardous waste generation data from the Generator Survey because: (1) they are more recent and therefore more likely to reflect current trends in waste and constituent generation and management, and (2) they provide more precise estimates of the concentrations of RCRA constituents within individual waste streams, thereby allowing more accurate estimates of constituent quantities.

To conduct detailed analyses of NHWCS, we focused primarily on constituent composition data, with the intent of discerning major patterns and trends in individual constituent generation, generation by major industry sectors, and constituent management practices that are not evident from examining BRS waste data alone. In addition, we focus many of our analyses on a subset of RCRA constituents that the Agency has designated as high priority for waste minimization efforts because of their unique tendency to persist and to bioaccumulate in ecosystems, as well as their overall toxicity. Below we highlight the major findings from these analyses.

MAJOR FINDINGS

Survey Coverage

By using a sampling protocol based on 'major' waste streams that account for 90 percent of hazardous waste in each of six major waste categories, NHWCS covers a majority of total hazardous waste in the universe reported in 1993; it also provides comparably comprehensive coverage within each waste subcategory with the exception of characteristic waste (only 19 percent).[1] Because the rate of response to the Survey was relatively high (70 percent, or 156 facilities), it also describes the constituent composition of approximately half of the reported waste in the 1993 universe. Hence the Survey data can be used to describe many characteristics of waste streams and constituents at the point that they are managed on-site by large generators or by TDRs.

[1] While coverage of characteristic waste is low in percentage terms, the coverage may indeed be adequate if the characteristic waste not captured by the Survey is fairly homogeneous in nature (e.g., primarily ignitable).

Because NHWCS focuses on the largest waste streams in the RCRA universe, however, it provides incomplete coverage of small-and medium-quantity waste streams that make up the vast majority of waste streams in the hazardous waste universe. As many of these streams are typically generated by small- and medium-sized facilities, the NHWCS sample does not represent the full diversity of the RCRA waste universe — there are numerous industries and individual facilities not represented at all in NHWCS. Also, because smaller waste streams are under-represented, the Survey probably does not fully reflect occurrences of certain RCRA constituents, nor does it provide a comprehensive assessment of overall prevalence of RCRA constituents.

Distribution of NHWCS Waste and Constituents

Similar to the hazardous waste universe overall, the distribution of waste and constituent quantities in NHWCS is highly skewed. Not only do a small number of facilities and very large waste streams account for most of the waste quantity in NHWCS, they also dominate overall constituent quantities. Of the 2.1 million tons of hazardous constituent quantity reported in NHWCS, over 60 percent is contributed by a few very large waste streams containing more than 10,000 tons of constituent quantity each. Quantities of hazardous PBT constituents are distributed differently — a larger number of waste streams contain 10 tons or less of hazardous PBT constituent quantity.

NHWCS Constituents

According to the NHWCS data, there are over 12,000 occurrences of over 724 unique constituents reported by respondent facilities. The distribution of these constituent occurrences among facilities suggests that most facilities generate or manage a relatively complex set of constituents. The median NHWCS waste stream contains about 12 constituents, while 90 percent of facilities generate or manage fewer than 60 (and more than 10) constituents.

Highly prevalent constituents reported in NHWCS include metals (lead, chromium, cadmium, barium, and arsenic) as well organics and inorganics (toluene, xylenes, benzene, acetone, methyl ethyl ketone, methylene chloride, ethyl benzene, methanol, methyl isobutyl ketone, and ethyl acetate). These fifteen constituents dominate overall occurrences. Each occurs at least 200 times, and each also occurs in at least 20 percent of the Survey's waste streams. Together, these fifteen constituents account for about 30 percent of all NHWCS occurrences.

There is little overlap, however, between highly prevalent constituents and constituents that account for a significant proportion of overall constituent quantity. Toluene, xylenes, and methyl ethyl ketone are both high-quantity also highly prevalent constituents, but none of the remaining high-quantity constituents — sulfate, sulfuric acid, lead, methanol, kjeldahl nitrogen, acetone, chloride, ammonia — overlap with the fifteen most prevalent constituents.

Concentrations of constituents that are highly prevalent and high-quantity also differ — among the highly prevalent constituents, concentrations of organics and inorganics are generally higher than those reported for metals. Median concentrations of toluene, xylenes, acetone, methyl ethyl ketone, and methylene chloride are between 10,000 and 100,00 parts per million (ppm). Metals exhibit median concentrations an order of magnitude lower, or about 1 to 200 ppm. Among high-quantity constituents, median concentrations are both higher overall than those for highly prevalent constituents and also span much broader ranges between 10th percentile and 90th percentile concentrations. Median concentrations are between 10,000 and 100,000 ppm for all high-quantity constituents except sulfate (between 1,000 and 10,000 ppm), lead (between 100 and 1,000 ppm), and ammonia (between 100 and 1,000 ppm).

Of the 267 hazardous PBT constituents that present the greatest hazard to the human health and the environment, 93 are reported at least once in the NHWCS. Metals and semi-metals make up more than three-quarters of the fifteen most prevalent hazardous PBTs — the only non-metals on this list are benzene, carbon tetrachloride, and nitrobenzene. In terms of hazardous PBT constituent quantity, a single PBT constituent — lead — contributes the vast majority of overall hazardous PBT quantity with 191,439 tons. A few very large lead-bearing waste streams account for most of this quantity. None of the other high-quantity PBT constituents, which include eight metals and six organics, account for more than 10,000 tons individually. Together, these fifteen hazardous PBTs account for almost all of the total PBT constituent quantity.

Concentrations of hazardous PBTs are considerably lower than those of highly prevalent and high-quantity NHWCS constituents. Of highly prevalent hazardous PBTs, most report median concentrations between 0.10 ppm and 100 ppm; only lead and barium report between 100 ppm and 1,000 ppm. Reported median concentrations of large-quantity PBTs are generally low, between 0.10 and 1,000 ppm. One notable exception is 2,4 toluene diisocyanate (50,000 ppm).

Waste and Constituent Management

Most of the waste streams for which management information is reported are managed off-site (72 percent), but these waste streams tend to be smaller in size (median of 42 tons) than those managed on-site and account for less than 40 percent of constituent quantity. The majority of overall NHWCS constituent quantity (1.2 of 2.1 million tons) is managed on-site by large generating facilities. Interestingly, most of the quantity of hazardous PBTs (87 percent) is managed off-site, but most of this is lead destined for recycling facilities.

Some interesting differences exist among EPA regions in terms of total constituent quantities managed within each region. EPA Regions 5 and 6 manage over three-quarters of total NHWCS constituent quantities, which is consistent with the high percentage of generators and TDRs located in these regions, particularly in Texas and Louisiana. However, for hazardous PBTs, Regions 5 and 2 manage the largest constituent quantities, (132,673 tons and 61,529 tons, respectively), while Region 6 is third (17,648 tons). Without lead-bearing waste streams, however, constituent quantities managed in Regions 5 and 2 would be considerably smaller.

In terms of individual management methods in NHWCS, large generators and TDRs report that they use five primary methods to manage almost three-quarters of constituent quantities. Underground injection, energy recovery, fuel blending, incineration, and metals recovery are each used to manage over 200,000 tons of constituent quantity. Incineration is common for organics and other solvents, while recycling is most viable for metals that appear highly concentrated. Land disposal methods, in particular, deepwell/underground injection, are common for managing large quantities of inorganic constituents.

NHWCS provides constituent concentration data for as-generated waste and treatment residuals that allow inferences about the effectiveness of treatment. Although the concentrations for many high-quantity and highly prevalent constituents span broad ranges, median concentrations in treatment residuals are significantly lower than these in as-generated waste of organics. Concentrations of metals in treatment residuals are generally only one order of magnitude than those in as-generated waste, but also are lower in concentrations at the point of generation.

Management methods reported for hazardous PBTs differ significantly from those reported for non-PBT constituents. Metals recovery is used to manage 80 percent (190,000 tons) of these constituents. In addition, stabilization and landfilling are used to manage higher percentages of hazardous PBT constituent quantities than non-PBT quantities, typically metals that exhibit concentrations that are too low to recycle cost-effectively.

<u>**Industry Analysis**</u>

A few key industry sectors dominate generation of NHWCS constituents. Facilities in the chemicals and allied products industry (SIC 28) generate more than ten times the constituent quantity of any other specified industry sector. Together, the top ten industry sectors account for almost 100 percent of total NHWCS constituent quantity, with a relatively small number of facilities driving the totals within most of these industry sectors. Additionally, the top five constituents make up 90 percent of constituent quantities for nine of these ten industries. Considering hazardous PBTs, the primary and fabricated metals industries (SIC 33 & 34) combine for 10 percent, while the chemicals industry is much less influential as a percentage of the hazardous PBT total (9 percent).

POSSIBLE FUTURE APPLICATIONS OF NHWCS

In addition to the results presented in this analysis, EPA may benefit from additional analyses of NHWCS that explore subsets of the data relevant to specific rulemakings or regulatory initiatives under development. For example, since the constituents used in this analysis include some that are not regulated as hazardous under RCRA (e.g., kjeldahl nitrogen), screening out these constituents may affect the relative picture of overall constituent prevalence and constituent quantities. Analyses that focus solely on NHWCS constituents regulated as hazardous may allow the Agency to further refine lists of hazardous 'constituents of concern,' similar to the Draft Prioritized List, for developing risk-based approaches to regulating constituents.

Analysis of the extent to which constituents co-occur with one another would provide EPA with additional insights about "constituents of concern" in addition to those provided by the analysis of constituent prevalence provided here. If highly prevalent NHWCS constituents frequently occur in the presence of one another, EPA may address these constituents more effectively as groups of constituents. Conversely, it is also interesting to know if constituents are used in isolation, as this may simplify approaches to waste minimization.

In addition to constituent data, NHWCS contains a variety of other information that describes physical attributes of waste streams, such as flash point, pH, and biological oxygen demand. These data in the NHWCS may be used in conjunction with constituent composition data to enhance future analyses addressing specific rulemakings. For example, waste stream and constituent data may be used to evaluate the physical form of waste streams (e.g., wastewaters or non-wastewaters) that may be eligible for exemptions from Subtitle C requirements under HWIR. This information may in turn be useful to refine conditional management options more tailored to eligible wastestreams.