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Using Existing Hazardous Waste Databases: Limitations and Future Needs

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ABSTRACT

The Illinois Hazardous Waste Research and Information Center (HWRIC) has sponsored some 22 research studies to catalog and develop a database on waste generation and management in Illinois. This paper discusses why the present database is not adequate to answer many questions presently being asked concerning the success of industrial pollution prevention projects and the risks that waste streams pose to the environment. The data limitations are in the types of information required of industry, the lack of scientific data on the effects of wastes, and in the quality of data reported.

INTRODUCTION

In 1984 the state of Illinois established the Hazardous Waste Research and Information Center (HWRIC), within the Department of Energy and Natural Resources (ENR), with the goal of making it a focal point for the state's non-regulatory hazardous waste activities. We were mandated to combine research and education. Duties include information collection, analysis, and dissemination and direct technical assistance to industry, agriculture, and communities. We are engaged in a multi-disciplinary approach to reducing the generation of hazardous wastes in Illinois.

Hazardous waste research requires current information on the locations, quantities, properties, and components of hazardous materials. HWRIC maintains data on hazardous waste/toxic substances on a PRIME 9650 mini computer with geographic information system software. Data included on our computer come from regulatory sources, and from various research projects conducted under contract to the Center. By the end of 1990, HWRIC had obtained 17 different types of hazardous waste-related data files from about 7 sources and projects as shown in Table I.

Hazardous waste data compiled by regulatory agencies have major limitations. Unfortunately, often large amounts of money are spent trying to answer questions that available data were not designed to answer. Attempting to use the existing data for measuring pollution prevention achievements has proved to be especially troublesome. This paper discusses the limitations of the present regulatory database when it is used to measure pollution prevention or determine the degree of hazard of waste streams.

THE RCRA HAZARDOUS WASTE DATABASE FOR ILLINOIS

HWRIC has sponsored some 22 research studies to help us catalog data and develop a database on waste generation and management in Illinois. The types of studies undertaken included database design and development, analysis of trends in the rates and types of wastes generated, environmental risks, geographic and spatial relationships, and policy options. Data limitations have also become apparent through these studies. This section will examine some of the data limitations that we have identified. We will begin by describing some of the major studies and then we will note major discrepancies.

Data collected to fulfill the requirements of the Resource Conservation and Recovery Act (RCRA) have been the major source of information about hazardous waste. One of our earliest studies on RCRA hazardous waste generation was by Raghavan (1). The main objectives of this study were to identify RCRA and RCRA-exempt waste streams generated in Illinois, assemble detailed information on physical and chemical characteristics of each waste, identify and describe the industrial processes that generate these wastes, develop waste generation factors, and assess the relative hazards of different wastes. Based on 1982 and 1983 Generator Annual Reports, Raghavan identified the industrial groups in Illinois with the highest volume of RCRA hazardous waste as primary steel manufacturing (Standard Industrial Classification (SIC) Code 3312), paint manufacturing (SIC 2851), miscellaneous organic chemicals manufacturing (SIC 2869), explosives (SIC 2894), and plastics and synthetic resins manufacturing (SIC 2821). Problems encountered in analyzing the annual reports included inconsistencies, major anomalies between the different data sources, and the very general characterization of many waste streams which precluded a determination of their relative hazard.

In a study of hazardous waste generation in Illinois in 1984, Hulse and Levine (2) found that 37.4% of the waste was from industrial inorganic chemicals (SIC 2819); 15.3% from refuse systems (SIC 4953); 13.0% from pesticides and agriculture chemicals (SIC 2879); and 9.5% from petroleum refining (SIC 2911). They calculated that 79% (1.7 million metric tons) of the waste generated in the state was managed on site. Major data limitations were also found in this study. For example, only 14 percent of the non-water waste by volume had health effects data and approximations of the constituents, and concentrations had to be assumed for characteristic wastes (e.g. RCRA D, F and K series wastes).

The most recent study of hazardous waste generation and management in Illinois is a study by Warren, Powell, and Ellestad (3). They analyzed the 1986 data for Illinois from two major surveys done for USEPA: the National Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities (TSDR); and the National Survey of Hazardous Waste Generators (Generator Survey). Even though the data from these surveys were collected for the calendar year 1986, they represent the most current and complete data available on the generation and management of hazardous waste in all 50 states. They found that the largest quantities of hazardous waste generated in Illinois were from blast furnaces and steel mills (SIC 3312, 8.3 million tons), small arms ammunition (SIC 3482, 5.5 million tons), hardware, nec. (SIC 3429, 2.5 million tons), construction machinery (SIC 3531, 1.97 million tons), and plating and polishing (SIC 3471, 1.95 million tons). Of the hazardous waste generated in Illinois, 96.5% was managed on site at the facility where it was generated (3).

Data from the above three studies reveal a number of discrepancies, including identification of which industries are the largest generators. A comparison of some of the findings from these studies is shown in Table II. It appears from these studies that each year the industry groups that were the largest generators of hazardous waste changed dramatically. Some reasons for differences in the results of these studies are that reporting requirements changed significantly between 1982 and 1986 and the 1986 Generator Survey actually included some wastes that are "hazardous" but are normally exempt from RCRA (e.g., PCBs, asbestos, dioxin/furans, and hazardous waste that was managed in units and processes exempt from RCRA permitting requirements) (3). It is generally felt that data collected before 1986 are not reliable, since early attempts at data collection suffered from more ambiguous questions and inaccurate responses than later surveys. Unfortunately it takes a long time for the regulatory agencies to process and verify data, and to make them available to others.

APPLICATION OF THE DATABASE

It was our intention in developing various data files on hazardous waste activities in Illinois, that it would serve as a significant research tool. We have concluded that most researchers would not be familiar enough with the limitations of the data, as outlined in this paper, to effectively make use of them. Thus, we will probably be the primary user of this very complex, multifaceted and less than accurate database. We have been able to use contractors to analyze portions of the database or to add new data to our files. However, limitations in the data in terms of the questions asked of generators and the accuracy of the data that were reported have limited the usefulness of any analyses. Two examples of contractor studies utilizing the hazardous waste database are given below.

During 1985, Temple, Barker and Sloane, Inc. (TBS) developed for the USEPA a planning model that assessed the costs and risks of hazardous waste generation and handling. They applied this Waste Planning Model to Illinois to provide a framework for analyzing the effects of hazardous waste management in the state (2). They utilized data from the 1984 annual report filed by RCRA generators and TSDFs to develop a database of hazardous waste generation, handling, and flows (both within the state and between Illinois and other states). At the time, this was the most current and reliable data available.

Data required for the model included:

- quantity of waste generated and handled by waste type
- characterization of waste stream constituents
- exposure routes plus contaminant fate and transport
- cluster and environmental characterizations
- exposed population estimates
- health effects
- management costs
- transportation risks and costs

Clusters with a radius of 19 kilometers, based on the location of generators and TSDFs, were created throughout the state. Facilities were clustered to take into account coincident human exposures to releases from multiple nearby facilities (2). Figure 1 shows the distribution, by cluster, of the amount of waste handled on-site. Figure 1 shows that waste generation is strongly clustered. A few 100,000+ ton per year areas dominate the picture for Illinois. The model is designed to be a planning and policy testing tool. It provides a framework to assess changes in costs and risks under various scenarios on an aggregate basis. One interesting conclusion from the study was that spills, leaks and transfer operations associated with wastes in storage represent the dominant cancer risk associated with waste generation and management in the state.

Limitations on use of the model are numerous including the quality of data provided by generators, and the limited data available on waste handling practices, toxic effects of many wastes, environmental fate data, and exposure. Also, this study dealt only with RCRA hazardous

Table 1. Elements of the Illinois Hazardous Waste Research and Information Center (HWRIC) Database Files

Data/Source	Years Included	Description
Special Waste Disposal Applications/Illinois EPA	1984-1987	Submitted by waste treatment storage and disposal (TSD) facilities for permit to receive special wastes; includes information on quantities, types and characteristics
Comprehensive Inventory of Special Waste Handlers/Illinois EPA	1984-1987	State-regulated generators, transporters and TSD facilities
Manifest History/Illinois EPA	1982-1987	Record of chain-of-custody of special wastes from source to disposal; identifies handlers, quantities, and types of waste
Annual Hazardous Waste Reports/ Illinois EPA	1982-1987	Reports of RCRA-hazardous waste sources, amounts, handling and disposal
Water Quality Standards/Illinois EPA	1984,1987	Criteria for assessing drinking water quality and standards for general use
Water Quality Analysis/Illinois EPA	1984-1986	Water quality data from groundwater and surface water monitoring at RCRA sites
Permit Conditions/Illinois EPA	1984,1987	Site information and reporting requirements for disposal sites required to monitor local groundwater quality
Resource Conservation and Recovery Act (RCRA)/USEPA	1984,1986	Hazardous waste generator and TSD facility information; includes waste type, handling, and transportation data
Comprehensive/USEPA	1984,1986 and 1988	Information on uncontrolled hazardous waste sites that may qualify for "Superfund" cleanup
Toxic Release Inventory/USEPA	1989	Compilation of chemical releases to air, land and water
Surface Impoundment Assessment/USEPA	1984	1978 inventory of industrial, municipal, agricultural, mining, and oil and gas ponds
National Survey of Hazardous Waste Generators/Collected by Research Triangle Institute (RTI) for the USEPA	1986	Survey data from Illinois' hazardous waste generators; includes types, quantities, and disposal methods of waste produced

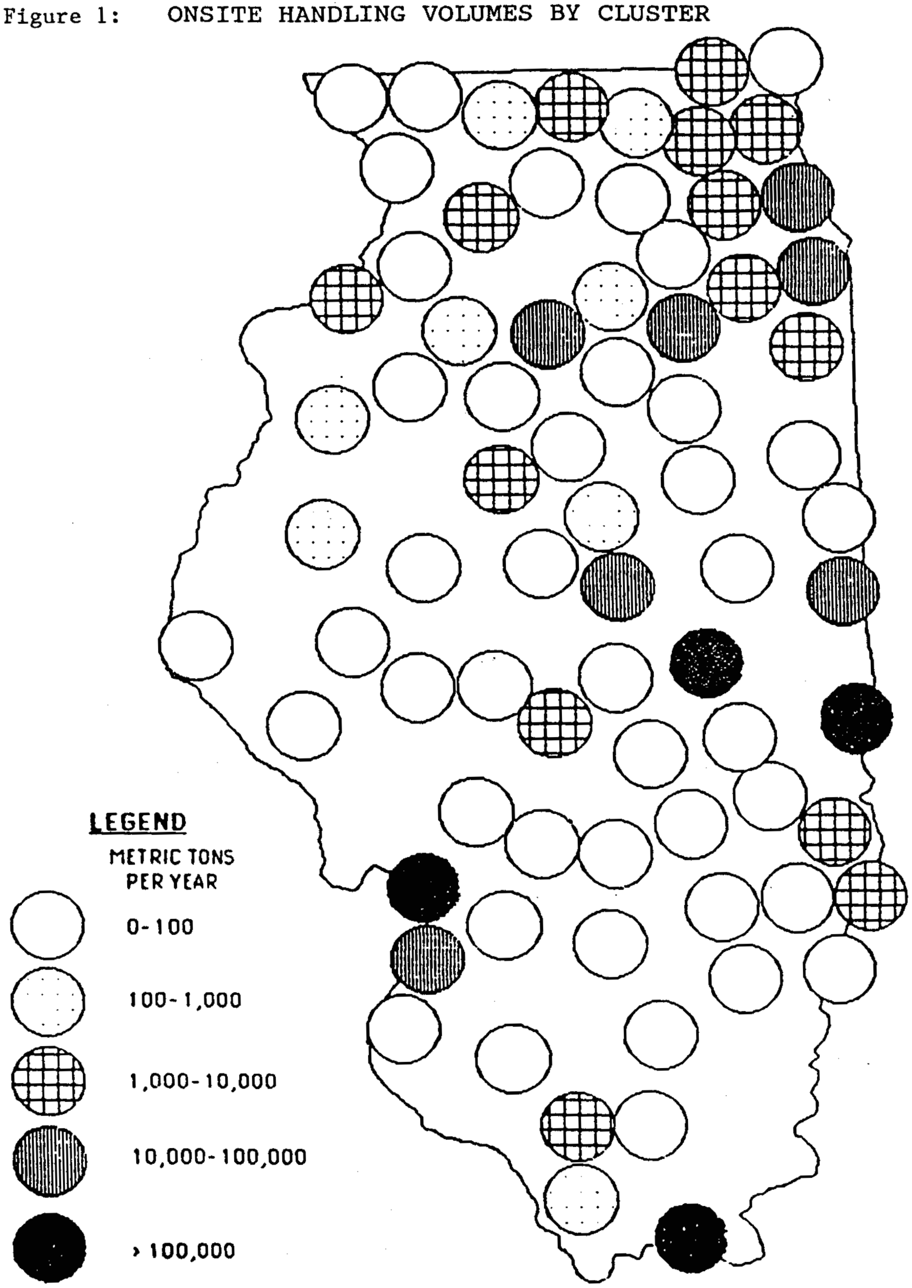
National Survey of Hazardous Waste	1986	Survey data from Illinois' hazardous waste TSDR facilities;

Surface Impoundment Assessment/USEPA	1984	1978 inventory of industrial, municipal, agricultural, mining, and oil and gas ponds
National Survey of Hazardous Waste Generators/Collected by Research Triangle Institute (RTI) for the USEPA	1986	Survey data from Illinois' hazardous waste generators; includes types, quantities, and disposal methods of waste produced
National Survey of Hazardous Waste TSDR Facilities/RTI	1986	Survey data from Illinois' hazardous waste TSDR facilities; includes types, quantities and disposal methods
Chicago Sanitary Sewer Discharges/ Chicago Metropolitan Sanitary Sewer District	1984	List of facilities that discharge waste into Chicago's sanitary sewer system; includes location and activity information
Dun's Market Identifiers/ Dun and Bradstreet		Illinois businesses listed with Dun and Bradstreet; includes address and activity
Inventory of Land-based Disposal Sites/ HWRIC and State Geological Survey	1988	Historical inventory (1900 - present) of Illinois landfills and other land disposal facilities with emphasis on location, status and type of materials
Spills on Major Illinois Waterways/ HWRIC and State Water Survey	1990	Historical inventory of spills on Mississippi, Illinois and Chicago rivers and Illinois shoreline of Lake Michigan

Table II. Comparison of Results of Hazardous Waste Generation Studies for Illinois

	Study		
	Raghavan, 1985	Hulse and Levine, 1987	Warren, Powell and Ellestad, 1991
Years of Data	1982-1983	1984	1986
% of Waste Managed On-Site	Not determined	79%	96.5%
Standard Industrial Classification (SIC) Code of Largest Generators	3312	2819	3312
	2851	4953	3482
	2869	2879	3429
	2894	2911	3531
	2821	3341	3471

Figure 1: ONSITE HANDLING VOLUMES BY CLUSTER



waste, and would not have covered other waste or chemical releases not regulated under RCRA. Still, it provides a tool to begin comparing risks under various management strategies and allows one to begin to examine the tradeoffs associated with these strategies.

The second study we are highlighting was conducted by Research Triangle Institute (RTI). They conducted two major surveys for the USEPA:

- 1987 National Survey of Hazardous Waste Generators (Generator Survey);

- National Survey of Hazardous Waste Treatment, Storage, Disposal, and Recycling Facilities (TSDR Survey).

For the State of Illinois they provided analyses of the generation, management, and waste minimization conducted by facilities using data (from 1986) collected in these two surveys. The Generator Survey identified 864 large quantity generators in the state, of which 134 managed waste in units requiring a RCRA permit, and 730 managed waste only in units exempt from RCRA permitting requirements or shipped offsite to a management facility. The TSDR Survey identified 134 TSDR facilities of which 19 were commercial facilities operating in 1986. The total quantity of hazardous waste generated in Illinois in 1986 was estimated to be 28.49 million tons.

The Illinois EPA (4) indicated that in 1986 there were 1574 regulated generators who shipped off-site, 26 regulated generators who handled all waste on-site, and 276 regulated TSDFs. The total amount of hazardous waste generated in 1986 was reported to be about 2.1 million tons. These numbers differ significantly from the RTI data. Part of the differences in the number of generators occurred because the Illinois EPA included some small quantity generators in their list of regulated generators. In terms of volume of waste generated, the RTI surveys included waste from facilities with units exempt from RCRA permitting requirements and also some wastes like asbestos and PCBs that are not normally reported under RCRA. Other differences may have been due to the wording of questions for the two reports. All of these points contribute to the confusion in interpretation of the hazardous waste database, and are one of the primary reasons why there is such variability in estimates of even somewhat simple statistics such as the number of generators in a state or the total amount of hazardous waste generated in a year.

RTI (3) made an important conclusion when they stated that the hazardous waste universe is continually changing. They found that in the one-year period between the Screening Survey and the TSDR Survey, 50% of the TSDR facilities had changed their status or type of waste management practice.

POLLUTION PREVENTION DATA REQUIREMENTS

The RTI study of the Illinois data was undertaken primarily to better understand the waste minimization practices of industry in the state. The survey used the term "hazardous waste minimization", which was defined by USEPA as actions taken to reduce (or minimize), through source reduction and recycling, the volume or toxicity of hazardous waste that is generated. Results of this survey showed Illinois generators ranked 19th among all the states in terms of the number of different waste minimization practices that they reported implementing.

Better housekeeping and operating practices where the most commonly indicated waste minimization practices for the various waste streams. Other common strategies used included equipment or technology modification, process or procedure modification, and offsite recycling or recovery for reuse. The most often reported impediments to hazardous waste minimization were economic feasibility, technical limitations, concern about a decline in product quality, and lack of technical information.

About 92% of the facilities reported that they had a waste minimization plan and 86% said they were implementing waste minimization. However, little information was available regarding the specificity of any hazardous waste audits that had been performed or facility plans that had been developed (3). RTI concluded that, even with information from these extensive national surveys, data currently available on hazardous waste minimization in Illinois are not sufficient for evaluating hazardous waste minimization progress.

In a recent study of industrial waste data in Illinois, Thomas et al. (5) also found that the data currently available on waste reduction are not sufficient to evaluate the progress industry is making to reduce wastes. Current data sources focus on regulating the quantity of waste released or the treatment methods used for each separate environmental medium. The reporting requirements are for the transfer of wastes off site or release to the environment. In contrast, waste reduction focuses on reductions in the generation of all industrial wastes prior to treatment or transfer. These data are generally not being collected by regulatory agencies and, in fact, are usually not measured at industrial facilities.

Title III of the Superfund Amendments and Reauthorization Act (SARA) requires facilities to report releases of specific toxic chemicals. The Toxic Release Inventory (TRI) under SARA does cover releases to all environmental media, but it only includes about 300 chemicals. The amount of chemicals reported each year can be compared with the amount reported in previous years. However, it is not appropriate to use this as an estimate of the amount of pollution prevention that occurred. While reductions in releases of these chemicals may reflect pollution prevention activities, they may also result from treatment or changes in production. The confusion between release reduction (reducing emissions or waste removed from a facility) and pollution prevention (the reduction of waste through source reduction or in-process recycling) is persistent. EPA's Industrial Toxics Project (recently termed the 33/50 project) and the Amoco Yorktown refinery project (6), billed as pollution prevention projects, are both essentially release reduction projects, although in both projects the preferred reduction methods are pollution prevention. In other words, under the 33/50 project the data that will be used to evaluate progress are releases to the environment. Reductions of those releases can be achieved by many means including treatment, reduced production, or true source reduction.

Baker, Dunford and Warren (7) looked at various measures of waste reduction that could be undertaken by industry. They discussed four alternative measures of waste reduction progress:

actual:	the quantity generated in the current reporting year less the quantity generated in the previous year,
adjusted quantity change:	a measure of waste reduction progress that accounts for changes in the level of production, service, or other business activity for the processes that generate waste,
throughput ratio:	the ratio of the quantity of a chemical in waste before treatment to the quantity of throughput for that chemical. The quantity of throughput is the total quantity of a chemical used onsite, including productive use (i.e., in product) and non-productive uses (waste).
changes in level of hazard:	reducing the level of hazard of a waste stream (i.e., switching from an organic solvent to a water-based solvent).

Each of these measures of waste reduction would require different types of data. Baker, Dunford and Warren (7) discussed a number of problems with making these measurements and collecting the data. They concluded that measures should be multimedia, and cover a number of years. No single measure of waste reduction progress is accurate or appropriate for all facilities and all waste.

Pojasek and Cali (8) stated that industry's primary goal in developing a pollution prevention program should be to control losses from the manufacturing process. The data needed by industry to measure pollution prevention include the following:

- Material purchases and use by unit operation
- Material throughput for each unit operation
- Generation of losses from each unit operation

- Loss classification by medium
- Scrap and defective product generation
- Recycled material
- Production outputs.

The present regulatory system looks at waste released from a facility, not necessarily waste generated. As Pojasek and Cali (8) point out, often several waste streams (losses) are blended or mixed into one regulated discharge. Each of these waste flows must be attributed to the unit or process contributing waste to the combined flows before a measure of pollution prevention success can be undertaken.

Wilkinson (9) stated that as businesses and industries try to adjust their successful waste reduction programs of the 1980s to meet the more demanding corporate goals and public expectations of the 1990s, they need more detailed knowledge of their waste in order to achieve greater source reduction. He stated that, in fact, industry often does not really have an adequate characterization of its wastes, and if they do not know what the wastes are or where they come from, they also do not know the costs of generating and managing their wastes. As the identity and source of each waste stream is established, one can enumerate the costs of activities related to that waste. The costs cover a wide range of activities including transportation, disposal, disposal taxes, equipment rental, treatment, special containers, permitting, and service charges (9).

Waste Advantage, Inc. (10) has shown that lost raw materials constitute the greatest cost an industry incurs as a result of generating waste. In an example they give on waste paint, the purchase cost of wasted raw materials made up 84% of the total cost of the waste generated. Waste prevention to them means efficiently using raw materials to make products instead of waste. After visiting over 300 facilities, they reached the startling conclusion that it is technically and economically feasible to prevent the generation of an average of 68% of the industrial waste currently generated, and simultaneously maintain or improve product quality.

Many government entities are trying to use the present regulatory database to measure pollution prevention, despite the fact that these reporting requirements were not designed for this purpose and the kind of data needed to correctly measure pollution prevention is not being collected. Similarly, industry is, in general, not collecting the kind of data needed to accurately assess the costs of waste production. And few industries have the throughput data for chemicals used in each process.

The state of New Jersey has been collecting throughput data from industry for the last few years. Since 1990, facilities which "manufactured and/or processed and/or otherwise used" over 10,000 lbs. of a SARA Title III, Section 313 substance were asked to report the quantities of these chemicals produced, brought, or consumed on site; quantities shipped off-site; quantities recycled, reprocessed or reused on site; and quantities destroyed through on-site treatment (Instructions for the Completion of the Release and Source Reduction Report (DEQ-114) for 1990 Pursuant to the New Jersey Worker and Community Right to Know Act, March 15, 1991). The State's analyses of these throughput data may indicate how effective these data are for measuring pollution prevention.

MEASURING THE DEGREE OF HAZARD OF WASTE STREAMS

Almost all definitions of pollution prevention include reductions in the volume and toxicity of waste streams. However, few individuals have successfully quantified reductions in toxicity. As pointed out previously, a significant problem is that the chemical constituents of waste streams are often not known. Even when the composition is known, in many cases we lack data on toxicity, environmental fate, or carcinogenic activity that is needed to assess overall reductions in "hazard". In addition, there is no accepted method to assess the toxicity of a mixture of

Table III. Toxicity Conversion Factors

Conversion Factors For The Equivalent Oral Toxicities (B_i):		
Toxicity Measure	Units	B_i
Oral - LD_{50}	mg/kg	1.00
Carcinogen/mutagen - LD_{50}	mg/kg	1.00
Aquatic - 48 or 96 hr LC_{50}	ppm	5.00
Inhalation - LC_{50}	mg/l	25.00
Dermal - LD_{50}	mg/kg	0.25

chemicals except to conduct a suite of biological assays on the entire waste stream. This is expensive and would have to be repeated each time the waste composition changes. The issue of waste stream variability is another problem beyond the scope of this paper.

In 1984 the Illinois legislature mandated that the Department of Energy and Natural Resources "complete a study of the benefits and feasibility of establishing a system of classifying and regulating special waste according to their degree-of-hazard." The term "special waste" includes all federally regulated hazardous wastes, as well as industrial process wastes and pollution control wastes as defined by the state of Illinois (non-RCRA industrial wastes). This Degree-of-Hazard system was developed as a scientifically sound and consistent way to deregulate the tracking of manifested non-RCRA special wastes that pose low or negligible hazard. In Illinois, non-RCRA special waste must be disposed of in a landfill permitted to receive special waste. The cost of disposing of special waste is higher than if it can be deregulated and disposed of as a municipal waste. It was also expected that more stringent regulations might be needed for non-RCRA special wastes that pose a higher degree of hazard.

The study that lead to the development of Illinois' degree-of-hazard system was by Reddy (11). It based a degree-of-hazard evaluation on five characteristics of a waste stream: weighted-accumulative toxicity of constituents (as modified by environmental fate), disease potential (infectious waste), fire (ignitability), leaching agents (pH), and biological hazard (biodegradability). In follow-on studies, Plewa et al. (12,13) computerized the system and made some modifications. The current system was adopted into regulations by the Illinois Pollution Control Board in 1990 (35 Illinois Administrative Code, 808).

The Degree-of-Hazard evaluation scheme involves calculation of the equivalent toxic concentration of each component in a waste stream (C_{eq}) as follows:

$$C_{eq} = A\sum_{i}(C_i/B_iT_i) \qquad (1)$$

where C_i is the concentration of component i as a percent of the waste by weight, T_i is a measure of the toxicity of component i and A is a constant equal to 300 used to allow entry of percent values for C_i, and to adjust the results so that a reference material, 100% copper sulfate, with an oral toxicity of 300 mg/kg, achieves an equivalent toxicity of 100.

B_i is a conversion factor used to convert toxicities (T_i) to equivalent oral toxicities. B_i is determined from Table III. For carcinogens and mutagens, a TD_{50} oral rat will be used if available. Otherwise carcinogens are assigned a T_i of 0.1 mg/kg; and mutagens are assigned a

Table IV. Comparative Degree-of-Hazard Evaluation of RCRA and Non-RCRA Special Wastes in Illinois

	RCRA Wastes		Non-RCRA Wastes	
Total Number Evaluated	202		135	
Type of Evaluation	Toxicity Hazard Only	Full Degree-of-Hazard	Toxicity Hazard Only	Full Degree-of-Hazard
% High	56.4	15.3	32.6	24.4
% Moderate	3.0	2.5	8.1	8.1
% Unknown	40.6	82.2	59.3	67.4
% No evaluation	0	0	2.0	2.4

T_i of 0.6 mg/kg. Toxicities are converted to equivalent oral toxicities as specified in Table III. The equivalent toxicity given in this Table have the same toxicological response as referenced in the RCRA listing criteria (Title 40 CFR, Chapter 1, section 261.33).

Oral rat toxicity values are preferred followed by inhalation rat, dermal rabbit, aquatic toxicity, and other mammalian toxicity values. If there is more than one value for the toxicity from the best available source, the lowest (most toxic equivalent oral toxicity value) is used. If a carcinogen or mutagen is assigned a value for T_i in the absence of a TD_{50}, B_i is assigned a value of 1.

The relative toxic amount, M, of the entire waste stream mixture is calculated as follows:

$$M = S\ C_{eq}$$

where S is the maximum size (kilograms) of a waste stream produced in a month.

The result of these calculations will be an estimate of the relative toxic amount (M) for each

Table V. Percentage of Applications With Data Deficiencies Found in 1986 Illinois Special waste Permit Applications

Data Component	RCRA Wastes	Non-RCRA Wastes
pH	67.5	17.9
Flash Point	16	0
Oral Toxicity	36	61
Inhalation Toxicity	82	95
Dermal toxicity	100	99
Aquatic Toxicity	38	55
No toxicity data	18	39

Table VI: Degree-of-Hazard Analysis of Gray Iron Foundry Molding Sands

Sand #1			Sand #2		
Component Name	Concentration (%)	Equivalent Toxicity	Component Name	Concentration (%)	Equivalent Toxicity
Chromium	0.000002	0.00006	Nickel	0.00171	0.0513
Barium peroxide	0.000012	0.000003	Phenol	0.001544	0.00772
Arsenic pentoxide	0.000002	0.00000008	Cadmium	0.00008	0.0024
Lead monoxide	0.000005	0.000000001	Chloroform	0.000039	0.00117
Cadmium	0.000000	0.000000000	Barium peroxide	0.00028	0.000067
Selenium dioxide	0.000002	0.000000000	Fluorine	0.09	0.000058
			Chromium oxide	0.00017	0.000006
			Lead monoxide	0.000074	0.0000009643
			Xylenes, total	0.000002	0.0000000888
			Arsenic pentoxide	0.000002	0.000000075
			Methylene chloride	0.00003	0.00000005389
			Toluene	0.000044	0.0000000528
			2-butanone	0.00022	0.00000004074
			Acetone	0.00042	0.0000000252
			Silver dioxide	0.000035	0.00000000372
			Mercury oxide	0.000000000	0.000000000
			Selenium dioxide	0.000003	0.000000000
			Silica	99.9049	0.000000000
Total Equivalent Toxicity		0.000063	Total Equivalent Toxicity		0.0068
Overall Hazard Ranking		Negligible	Overall Hazard Ranking		High

waste evaluated that takes into account the comparative toxicity and amount of each component. For each waste, the number calculated for M can range from 0 to greater than 10,000. The relative toxic amount is converted to categories of negligible, low, moderate, or high hazard.

Data from Illinois special waste applications were used to evaluate 1,952 RCRA wastes and 3,060 non-RCRA special wastes. The results of this evaluation are shown in Table IV. However, over 70% of the waste stream applications (including RCRA hazardous waste) were ranked as "unknown" hazard, primarily because of the following data deficiencies: (1) missing information that was required on the special waste application form, (2) data that were necessary for the degree-of-hazard evaluation but not requested on the special waste application form, and (3) data on specific components of a waste stream that were necessary for the toxicity hazard category but were not available in the published scientific literature. Vague names for wastes (such as oil, salts, ash or resin) were a particular problem, and trade names were often used rather than names of specific chemical components.

The primary determinant of the degree of hazard is toxicity. In addition to considering environmental fate of the chemicals in question, Plewa, et al. (13) also incorporated in the system the carcinogen potency database developed under National Institute of Health sponsorship. As is true of data needed to measure pollution prevention, the data needed to conduct a degree-of-hazard analysis are being collected only partially under our present regulatory reporting requirements. Data deficiencies found in the projects by Plewa are illustrated in Table V. To conduct a degree-of-hazard analysis requires knowledge of the volume and the percentage composition of the primary chemical constituents in the waste stream. Having this information allows one to determine, for example, which chemical constituents are causing the waste stream to fall into the high hazard category. A strategy can then be developed, such as waste segregation or process change, for reducing those chemicals in the waste and the degree-of-hazard for the entire waste stream can then be reevaluated.

During the past year the American Foundryman's Society (AFS) has been using the degree-of-hazard system to determine which non-RCRA special wastes from foundries might be deregulated in Illinois (14). The quantities and compositions of three main classes of foundry wastes were determined by survey and laboratory records. Data were obtained on 71 waste analyses selected randomly from AFS files. Laboratory testing revealed wide variations in physical and chemical properties between representative samples from each class and within each class of waste. The results of the degree-of-hazard analysis of two of the wastes are shown in Table VI. One received an overall ranking of "high" while the other was ranked as "negligible" hazard even though these are from the same type of process.

The information required for EP toxicity or TCLP analysis, which are used by the USEPA to determine if a waste is hazardous, includes eight heavy metals in elemental form plus several other organic compounds. Toxicity testing is usually done with compounds and not on the elemental form of inorganic chemicals. For this project, AFS chemists had to deduce the most likely chemical forms of each inorganic constituent.

CONCLUSION

The present regulatory database has given us information on chemical releases and waste removed for disposal or discharged from an industrial facility, however, the data have serious limitations. Some of the specific data limitations identified in this paper include

- Merging or comparing data from different sources is difficult due to the different sampling procedures and wording used in hazardous waste data collection. Definitions of what constitutes a hazardous waste that vary over time also make data comparisons difficult.

- Our ability to measure progress in pollution prevention or assessing the degree of hazard of waste streams is limited because the data available were not designed to answer these questions and because the data are of questionable quality.

To improve our ability to use the data to measure the success of pollution prevention strategies or to accurately define the potential hazard of waste streams, we need to know for each process in an industrial facility more about the throughput of various chemicals and materials, and the specific origins of waste being generated. We also need to know more about the chemical constituents of each waste stream. For many chemicals, and particularly combinations of chemicals, we still know little about the toxicity and potential carcinogenic effects of the chemical or waste.

It is important for government officials and researchers to realize that much of the data collected from industry is to satisfy very specific regulatory concerns. Unfortunately, it is all too common for people to analyze the data to answer questions that go well beyond the intent of the initial data collection. In addition, quality control on the data which are reported by industry are not good, and the measurement of releases often differs significantly from one facility to another or even within a facility.

As we come to understand waste databases better and ask more sophisticated questions, industrial reporting requirements will need to be modified to obtain the data needed. This will probably mean dropping many questions which have not proved useful and adding a number of new ones. The great interest shown nationally in the TRI data indicates the value that asking a new set of questions can have. To effectively measure the success of pollution prevention will also require a change in the data that are collected. It may be necessary, for example, to allow each company to define the best way to measure their pollution prevention progress.

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