3.3 Waste and Contaminated Lands

Waste and contaminated lands are discussed in this section. Waste is broadly defined as unwanted materials left over from manufacturing processes or refuse from places of human or animal habitation. Several waste categories and types are included within this broad definition. In general, waste can be categorized as either hazardous or non-hazardous. Hazardous wastes are the by-products of society that can pose substantial or potential hazards to human health or the environment when improperly managed. These wastes may appear on special EPA lists and they possess at least one of the four following characteristics: ignitability, corrosivity, reactivity, or toxicity. Hazardous waste includes specific types of waste, such as toxic waste and radioactive waste. All other waste is considered to be non-hazardous (EPA, OEI, May 2002).

Several specific kinds of waste consist of mixed hazardous and non-hazardous content. For instance, municipal solid waste (e.g., garbage) is largely non-hazardous but does typically contain some household hazardous waste items such as solvents or batteries. Other materials and waste types that can have mixed hazardous/non-hazardous content include animal waste, by-products of oil and gas production, materials from leaking underground storage tanks, and waste from coal combustion.

Contaminated lands are lands that have been contaminated with hazardous materials and require remediation. Contaminated lands are not the same as lands used for waste management. In many instances, lands used for waste management are not contaminated. Similarly, often no waste is present on contaminated lands. Contaminated lands can pose a direct risk if they expose people, animals, or plants to harmful materials or cause the contamination of air, soil, sediment, surface water, or ground water.

Despite numerous waste-related data collection efforts at the state and national levels, nationally consistent and comprehensive data on the status, pressures, and effects of waste and contaminated lands are limited. Various parties are responsible for tracking types and amounts of waste and contaminated sites. National-level data on waste and contaminated land tend to be collected to satisfy the requirements of specific federal regulations. For example, EPA's Resource Conservation and Recovery Act Information System (RCRAInfo) contains data on RCRA hazardous waste and EPA's Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) contains some data on contaminated sites, including Superfund sites.

Few national data sets exist for the waste types that are not federally regulated, such as non-hazardous industrial waste. Although a significant amount of waste information and some site contamination information is collected and tracked at the local or state government levels, these data are seldom aggregated nationally. Also, most of the available data describe waste in terms of weight, rather than volume. The weight data alone do not address the extent of the waste situation in the U.S. Similarly, national information about contaminated lands tends to focus on number of sites and types of contamination, rather than the extent of land contaminated. Finally, there is a lack of national data that track the effects of waste and contaminated land on human health and ecological condition.

While major improvements have been made in managing the nation's waste and cleaning up contaminated sites, more work remains. National, state, tribal, and local waste programs and policies aim to prevent pollution by reducing the generation of wastes at their source and by emphasizing prevention over management and disposal. Preventing pollution before it is generated and poses harm is often less costly than cleanup and remediation. Source reduction and recycling programs often can increase resource and energy efficiencies, reduce pressures on the environment, and extend the life span of disposal facilities.

The following questions and discussion of indicators provide an overview of what is known about waste generation and management and about contaminated lands in the U.S. Trends and conditions on a national basis are described to the extent that data are available. The five questions considered in this section are:

- How much and what types of waste are generated and managed?
- What is the extent of land used for waste management?
- What is the extent of contaminated land?
- What human health effects are associated with waste management and contaminated lands?
- What ecological effects are associated with waste management and contaminated lands?

EPA is the primary source of data for this section, providing municipal solid waste data on generation, management, recovery, and disposal; data on RCRA hazardous waste and corrective action sites from the RCRAInfo database; and data on the number and location of contaminated sites that are on the Superfund National Priorities List (NPL) from CERCLIS. The U.S. Department of Energy's (DOE) Central Internet Database provides information on the types and quantities of radioactive waste generated and in storage.

3.3.1 How much and what types of waste are generated and managed?

Indicators

Quantity of municipal solid waste (MSW) generated and managed
Quantity of RCRA hazardous waste generated and managed
Quantity of radioactive waste generated and in inventory

There are numerous types of waste, but only three types are tracked with any consistency on a national basis. The three that are described as indicators on the following pages include municipal solid waste (MSW), hazardous waste (as defined by RCRA), and radioactive waste. The other types of waste range from materials generated during mining and agricultural activities to wastes from manufacturing and construction. Current national data are not available on these other types of waste. Exhibit 3-22 summarizes the types of waste.

Exhibit 3-22: Types of Waste

Type	Description
Municipal Solid Waste (Indicator)	Municipal solid waste (MSW) is the waste discarded by households, hotels/motels, and commercial, institutional, and industrial sources. MSW typically consists of everyday items such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. It does not include wastewater. In 2000, 232 million tons of MSW were generated. (EPA, OSWER, June 2002)
RCRA Hazardous Waste (Indicator)	The term "RCRA hazardous waste" applies to certain types of hazardous wastes that appear on EPA's regulatory listing (RCRA) or that exhibit the specific characteristics of ignitability, corrosiveness, reactivity, or toxicity. More than 40 million tons of RCRA hazardous waste were generated in 1999. (EPA, OSWER, June 2001)
Radioactive Waste (Indicator)	Radioactive waste is the garbage, refuse, sludge, and other discarded material, including solid, liquid, semi-solid, or contained gaseous material that must be managed for its radioactive content (DOE Order 435.1 Issued July 1999). The technical names for the types of waste that are considered "radioactive waste" for this report are high-level waste, spent nuclear fuel, transuranic waste, low-level waste, mixed low-level waste, and contaminated media. Data on the amounts of these waste types are provided in the radioactive waste discussion. (See Appendix D for definitions of these terms).
Extraction Wastes	Extraction activities such as mining and mineral processing are large contributors to the total amount of waste generated and land contaminated in the U.S. EPA estimates that 5 billion tons of mining wastes were generated in 1988 (EPA, OSWER, October 1988).
Industrial Non-Hazardous Waste	Industrial non-hazardous waste is process waste associated with electric power generation and manufacturing of materials such as pulp and paper, iron and steel, glass, and concrete. This waste usually is not classified as either municipal solid waste or RCRA hazardous waste by federal or state laws. State, tribal, and some local governments have regulatory programs to manage industrial waste. EPA estimated that 7.6 billion tons of industrial non-hazardous wastes were generated in 1988. (EPA, OSWER, October 1988)
Household Hazardous Waste	Most household products that contain corrosive, toxic, ignitable, or reactive ingredients are considered household hazardous waste. Examples include most paints, stains, varnishes, solvents, and household pesticides. Special disposal of these materials is necessary to protect human health and the environment, but some amount of this type of waste is improperly disposed of by pouring the waste down the drain, on the ground, in storm sewers, or by discarding the waste with other household waste as part of municipal solid waste. EPA estimates that Americans generate 1.6 million tons of household hazardous waste per year, with the average home accumulating up to 100 pounds annually. (EPA, OSWER, October 2002)
Agricultural Waste	Agricultural solid waste is waste generated by rearing animals and producing and harvesting crops or trees. Animal waste, a large component of agricultural waste, includes waste from livestock, dairy, milk, and other animal-related agricultural and farming practices. Some of this waste is generated at sites called Confined Animal Feeding Operations (CAFOs). The waste associated with CAFOs results from congregating animals, feed, manure, dead animals, and production operations on a small land area. Animal waste and wastewater can enter water bodies from spills or breaks of waste storage structures (due to accidents or excessive rain) and non-agricultural application of manure to crop land (EPA, OW, November 2001; EPA, OW, June 2002). National estimates are not available.
Construction and Demolition Debris	Construction and demolition debris is waste generated during construction, renovation, and demolition projects. This type of waste generally consists of materials such as wood, concrete, steel, brick, and gypsum. (The MSW data in this report do not include construction and demolition debris, even though sometimes construction and demolition debris are considered MSW.) National estimates are not available.
Medical Waste	Medical waste is any solid waste generated during the diagnosis, treatment, or immunization of human beings or animals, in research, production, or testing. National estimates are not available.
Oil and Gas Waste	Oil and gas production wastes are the drilling fluids, produced waters, and other wastes associated with the exploration, development, and production of crude oil or natural gas that are conditionally exempted from regulation as hazardous wastes. National estimates are not available.
Sludge	Sludge is the solid, semisolid, or liquid waste generated from municipal, commercial, or industrial wastewater. National estimates are not available.

Indicator: Quantity of municipal solid waste (MSW) generated and managed - Category 2

As noted in Exhibit 3-22, municipal solid waste (MSW) is the waste discarded by households and by commercial, institutional, and industrial operations. This type of waste is familiar to most Americans because they are specifically responsible for its generation. MSW typically consists of everyday items such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. It does not include wastewater.

What the Data Show

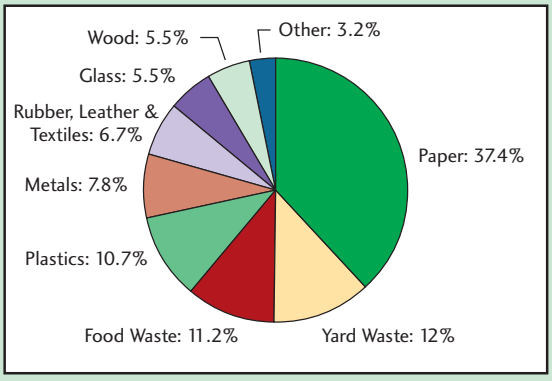
In 2000, Americans generated 232 million tons of MSW (Exhibit 3-23). This total amount, which does not take into account MSW that was ultimately recycled or composted, equated to approximately 4.5 pounds of waste per person per day. Paper and paperboard products accounted for the largest component of MSW generated (37 percent), and yard trimmings constituted the second-largest material component (12 percent). Glass, metals, plastics, wood, and food scraps each constituted 5 to 11 percent of the total. Rubber, leather, and textiles combined made up about seven percent of MSW, while other miscellaneous wastes made up approximately 3 percent (EPA, OSWER, June 2002).

The total amount of MSW generated increased nearly 160 percent between 1960 and 2000 (Exhibit 3-24). For comparison purposes, during that same time frame, the U.S. population increased by 56 percent, gross national product increased nearly 300 percent, and per capita generation of waste rose more than 70 percent (DOC, BEA, 2002; EPA, OSWER, June 2002). The amount of MSW generated per capita generally stabilized between 1990 and 2000, increasing less than one percent.

The data on the total amount of MSW generated do not factor in source reduction and waste prevention or materials recovery (recycling and composting), which are also important contributors to the overall municipal waste picture. Source reduction and waste prevention include the design, manufacture, purchase, or reuse of materials to reduce their amount or toxicity or lengthen their life before they enter the MSW system. Between 1992 and 2000, source reduction in the U.S. prevented more than 55 million tons of MSW from entering the waste stream (EPA, OSWER, June 2002) (Exhibit 3-25).

Exhibit 3-23: Total municipal solid waste generated, 2000

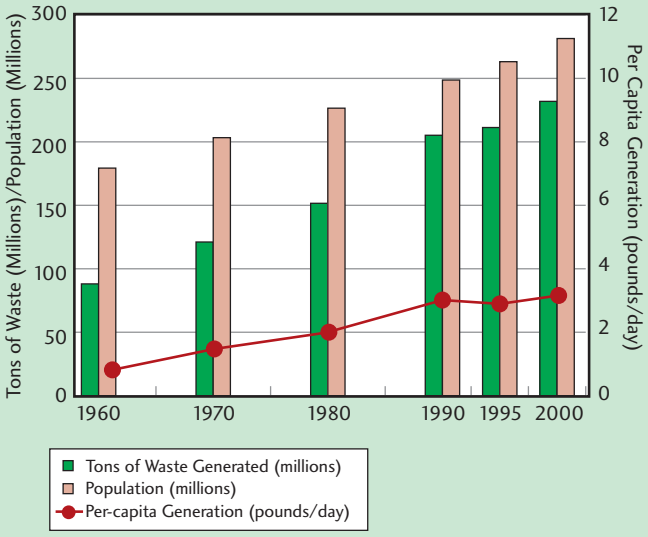
Total (before recycling and composting) = 232 million tons



Source: EPA, Office of Solid Waste and Emergency Response. *Municipal Solid Waste in the United States: 2000 Facts and Figures.* June 2002.

Exhibit 3-24: Municipal solid waste generation rates, 1960-2000

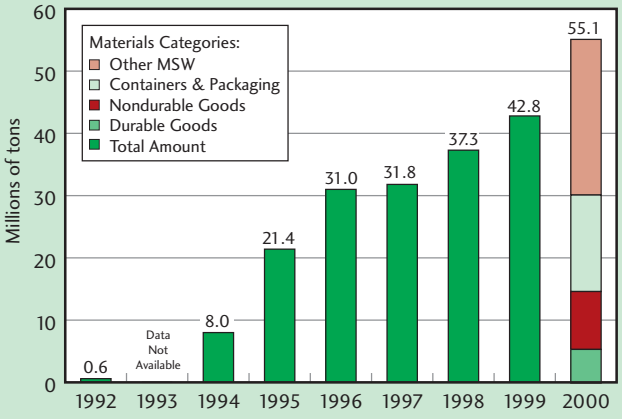
(before recycling and composting)



Source: EPA, Office of Solid Waste and Emergency Response. *Municipal Solid Waste in the United States: 2000 Facts and Figures.* June 2002.

Indicator: Quantity of municipal solid waste (MSW) generated and managed - Category 2 (continued)

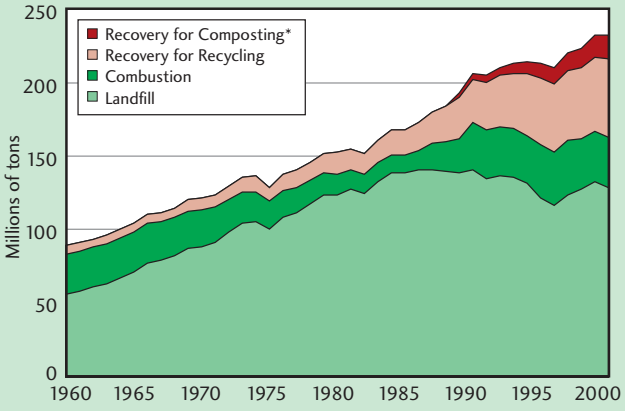
Exhibit 3-25: Source reduction of municipal solid waste, 1992-2000



Source: EPA. Office of Solid Waste and Emergency Response. *Municipal Solid Waste in the United States: 2000 Facts and Figures*. June 2002.

Exhibit 3-26: Municipal solid waste management, 1960-2000

(2000 total = 232 million tons)



* Composting of yard trimmings and food wastes. Does not include mixed MSW composting or backyard composting.

Source: EPA, Office of Solid Waste and Emergency Response. *Municipal Solid Waste in the United States: 2000 Facts and Figures*. June 2002.

Materials recovery (recycling and composting) has also reduced the total amount of MSW being discarded. In 2000, approximately 30 percent (70 million tons) of the MSW generated was recovered and thereby diverted from landfills and incinerators. Between 1960 and 2000, the total amount of MSW recovered has significantly increased from 5.6 million tons to 69.9 million tons, more than a 1,100 percent increase. During this time period, the amount recovered on a per capita basis increased from 0.17 pounds per person per day to 1.35 pounds per person per day—an 8-fold increase (EPA, OSWER, June 2002). The percentage of MSW disposed of in landfills has dropped from 83.2 percent of the amount generated in 1986 to 55.3 percent of the amount generated in 2000 (Exhibit 3-26). Combustion (incineration) is also used to reduce waste volume prior to disposal in a land-based waste management facility. Approximately 33.7 million tons (14.5 percent) of MSW were combusted in 2000. Of this amount, approximately 2.3 million tons were combusted with energy recovery—also known as waste-to-energy combustion (EPA, OSWER, June 2002).

Indicator Gaps and Limitations

Limitations for this indicator include the following:

- The MSW data do not include construction and demolition debris, municipal waste water treatment sludge, automobile bodies, combustion ash, and non-hazardous industrial wastes that may go to a municipal waste landfill. The data (including the generation, recycling, and recovery data) are generated using the materials flow method, which does not include these materials, even though some of these materials (namely construction and demolition debris) are typically counted as MSW.
- Residues associated with other items in MSW (usually containers) are not accounted for in the data.
- The percentage of total waste that MSW represents is unknown.
- The indicator does not necessarily measure the effects of changes in consumer or disposal trends.

Data Source

The data source for this indicator is Municipal Solid Waste Data, EPA, Office of Solid Waste and Emergency Response, 1990-2000. (See Appendix B, page B-22, for more information.)

Indicator: Quantity of RCRA hazardous waste generated and managed - Category 2

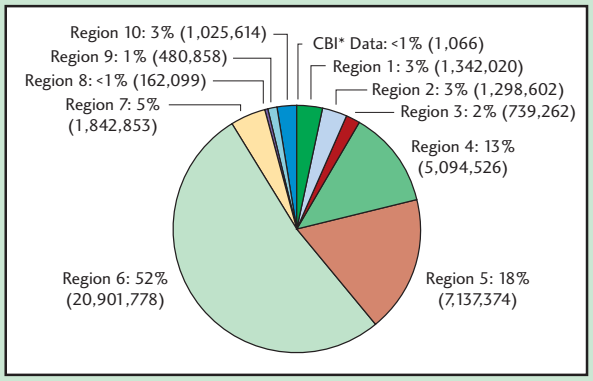
Businesses that generate a substantial amount of RCRA hazardous waste as part of their regular activities are called "large quantity generators" or LQGs. ("Substantial" is defined as more than 2,200 pounds per month.) National data on "small quantity generators" (SQGs) and "conditionally-exempt small quantity generators" (CESQGs) are not available. Estimates indicate, however, that the amount of RCRA hazardous waste that SQGs and CESQGs generate is relatively small (EPA, OSWER, June 2000).

What the Data Show

In 1999, EPA estimated that more than 20,000 LQGs collectively generated 40 million tons of RCRA hazardous waste (EPA, OSWER, June 2001). The number reflects between 95 and 99 percent of the total amount of RCRA hazardous waste generated. The exact total amount of RCRA hazardous waste generated by LQGs, SQGs, and CESQGs combined is not known, but the contributions of SQGs and CESQGs are estimated to be between 0.4 million tons and 2.1 million tons (or 1 to 5 percent) of the total amount of RCRA hazardous waste (EPA, OSWER, June 2000).

LQGs within EPA Region 6 (see Exhibit 1-12 for Regional delineation) generated more than half of all RCRA hazardous waste in 1999 (Exhibit 3-27). Less than 9 percent of the LQGs nationwide are located in Region 6, but 15 of the 22 largest national generators (by quantity generated) are there. Of the large Region 6 generators, 13 manufacture chemicals, petrochemicals, minerals, and metal; and two manage chemical wastes. Generation in Regions 4 and 5 accounted for 18 percent and 13 percent of the national total, respectively, and all other Regions combined accounted for the remaining 17 percent (EPA, OSWER, June 2001).

Exhibit 3-27: Amount of Resource Conservation and Recovery Act (RCRA) hazardous waste generated in EPA regions, 1999
(Tons)



* Confidential Business Information not shown in pie chart

Source: EPA, Office of Solid Waste and Emergency Response. *The National Biennial RCRA Hazardous Waste Report. June* 2001.

Assessing trends in hazardous waste is difficult because the data collected over the last several years have changed. For example, the exclusion of wastewater from the 1999 totals makes a comparison of the 1999 data with previous data (which included wastewater) misleading. What is known, however, is that the amount of a specific set of toxic chemicals (Waste Minimization Priority Chemicals, or WMPC) found in hazardous waste is declining. (See the discussion of WMPC in the "Chemicals in the Landscape" section of this chapter.)

RCRA hazardous waste management is conducted at RCRA treatment, storage, and disposal facilities (TSDs) (see indicator in the following pages on Land Used for Waste Management). In 1999, TSDs managed 26.3 million tons of hazardous waste through treatment, storage, or disposal.

The (non-wastewater) management methods used in 1999 were as follows:

- Land disposal (69 percent): Includes deepwell/underground injection (16.0 million tons), landfill (1.4 million tons), surface impoundment (0.7 million tons), and land treatment/application/farming (30 thousand tons). Prior to land disposal, hazardous waste is treated to reduce toxicity and to prevent exposure of people and the environment to harmful constituents.
- Thermal treatment (11 percent): Includes energy recovery (1.5 million tons) and incineration (1.5 million tons).
- Recovery operations (10 percent): Includes fuel blending (1.1 million tons), metals recovery for reuse (0.72 million tons), solvents recovery (368 thousand tons), and other recovery (152 thousand tons).
- Other (11 percent): Includes other disposal (1.4 million tons), stabilization (1.3 million tons), sludge treatment (48 thousand tons) (EPA, OSWER, June 2001).

Indicator: Quantity of RCRA hazardous waste generated and managed - Category 2 (continued)

Indicator Gaps and Limitations

While RCRAInfo is a reliable source of data about much of the hazardous waste generated throughout the U.S., it does not provide information about all hazardous waste generated nationally. RCRAInfo includes data on amounts and types of hazardous waste generated nationally by large quantity generators only. Data about amounts and types of hazardous waste generated by RCRA SQGs and CESQGs are not collected. Similarly, data on waste that does not fit the RCRA definition of "hazardous" are not available. Some states regulate and collect data on wastes they designate as "hazardous" that are not tracked by EPA, but these data are not aggregated nationally.

Data Source

The data source for this indicator is 1999 RCRAInfo data, from EPA, Office of Solid Waste and Emergency Response. (See Appendix B, page B-22, for more information.)

Indicator: Quantity of radioactive waste generated and in inventory - Category 2

The manufacture and production of nuclear materials and weapons requires activities that can generate large amounts of radioactive waste. Over the past few decades, the production of nuclear weapons has largely been suspended. The largest quantities of radioactive waste generated today (when measured by volume) result from the cleanup of contaminated sites.

What the Data Show

A significant amount of the radioactive waste in existence today will remain radioactive for many years—in some cases thousands of years. When measured by volume, the radioactive waste that is still being generated reflects only a small percentage (<10 percent) of the total amount of waste that is either in storage (inventory) or disposed of already. When measured by radioactivity, the amount of radioactive waste in inventory far exceeds the radioactivity of newly-generated radioactive waste (U.S. DOE, April 2001). Exhibit 3-28 provides summary data on the total amount of radioactive waste generated and in inventory (storage) at the end of fiscal year (FY) 2000.

Over time, the amount of radioactive waste generated has fluctuated primarily due to the progress of site cleanup operations. Trend data on generation rates over the past several years are not available. According to the DOE, however, the amount of waste generated between late 1997 and late 2000 remained fairly constant, while the amount in inventory increased in proportion to the amount generated (DOE, 2002). Although some radioactive waste is still being disposed of (e.g., small amounts of transuranic waste are being disposed of at the Waste Isolation Pilot Plant in New Mexico), most of the highly radioactive waste types remain in storage until they can be placed in safe long-term disposal facilities.

The amount of radioactive waste being generated and stored is expected to drop over the next few decades as cleanup operations are completed and waste currently in storage is disposed of. Depending on the radioactive decay rate, the disposed-of waste will remain radioactive for time periods ranging from days to thousands of years.

Indicator Gaps and Limitations

The radioactive waste data in this report do not account for all radioactive materials in the U.S. The term "radioactive waste" applies to any garbage, refuse, sludge, and other discarded material that must be managed for its radioactive content (DOE Order 435.1, issued July 1999). Other radioactive materials are used for defense, energy production, and other purposes, but these materials are not considered "waste." Further, DOE is not responsible for some additional radioactive waste (quantity unknown). Data on these wastes are not included in this report.

Data Source

The data source for this indicator is radioactive waste data, from U.S. Department of Energy's Central Internet Database, 2000. (See Appendix B, page B-23, for more information.)

Indicator: Quantity of radioactive waste generated and in inventory - Category 2 (continued)

Exhibit 3-28: Total amount of radioactive waste* generated in fiscal year 2000 as reported by Department of Energy

Waste Type	Generated	Inventory (Storage)	Units
Vitrified High-Level Waste	n/a	1,201	Canisters
High-Level Waste	14,166	353,501	Volume (cubic meters)
Low-Level Waste	38,911	101,256	
Mixed Low-Level Waste	10,834	44,588	
Ex-Situ Contaminated Media	559,249	63,570	
Transuranic Waste	1,621	111,226	
Spent Nuclear Fuel	0.85	2,467	Mass (metric tons of heavy metal)

Source: U.S. Department of Energy, Office of Environmental Management, Central Internet Database. 2002. (January 2003; *http://cid.em.doe.gov*).

* For the purposes of this report, all of the materials in this table are considered radioactive waste.

3.3.2 What is the extent of land used for waste management?

Indicators

Number and location of municipal solid waste (MSW) landfills

Number and location of RCRA hazardous waste management facilities

Most types of waste are disposed of in land-based waste management units such as MSW landfills and surface impoundments. Prior to the 1970s, waste disposed of on the land was typically dumped in open pits, and waste was seldom treated to reduce its toxicity prior to disposal (EPA, OSWER, June 2002). Early land disposal units that still pose threats to human health and the environment are considered to be contaminated lands subject to federal or state cleanup efforts and are discussed in the next section. Today, most of the hazardous and MSW land disposal units are subject to federal or state requirements for landfill, surface impoundment, or pile design and management. National data for these disposal units is described in the indicators following.

Many other sites are used for waste management in addition to the MSW landfills and RCRA hazardous waste facilities just mentioned. Although comprehensive data sets are not available to assess the number of additional sites used for waste management, various EPA estimates show that there were approximately 18,000 non-hazardous industrial waste surface impoundments in 2000, more than 2,700 non-hazardous industrial waste landfills in 1985, and more than 5,300 non-hazardous industrial waste piles in 1985 (EPA, OSWER, March 2001). These numbers do not include other waste management sites, such as those used to collect and manage (but not dispose of) waste (e.g., recycling centers, household hazardous waste collection centers), waste transfer stations, sites that store discarded automobile and industrial equipment, and non-regulated landfills.

The two indicators identified for this question address the number and location of MSW landfills and RCRA facilities.

Indicator: Number and location of municipal solid waste (MSW) landfills - Category 2

Municipal solid waste landfills are the most commonly known places of waste disposal. Yet this does not mean that there are good data to track them. The data presented in support of this indicator are estimates compiled by a national journal. No federal agency specifically compiles information nationally on these landfills.

What the Data Show

In 2000, approximately 128 million tons (55 percent) of the nation's 232 million tons of MSW were disposed of in the nation's 2,216 municipal waste landfills (EPA, OSWER, June 2002). Between 1989 and 2000, the number of municipal landfills in the U.S. decreased substantially (down from 8,000). Over the same period, the capacity of all landfills remained fairly constant because newer landfills typically have larger capacities. In 2000, these landfills were geographically distributed as follows: 154 (8 percent) in the Northeast, 699 (35 percent) in the Southeast, 459 (23 percent) in the Midwest, and 655 (33 percent) in the West (Goldstein, 2000).

Indicator Gaps and Limitations

MSW data are voluntarily submitted to BioCycle Journal and are not reviewed for quality or consistency. The data exclude landfills in Alaska and Hawaii and do not indicate the capacity or volume of landfills, or in general, a means to estimate extent of lands used for MSW management. For example, the fact that there are fewer landfills does not mean that less land is used for managing wastes because newer landfills are typically larger than their predecessors. The information is also limited by the fact that other lands are also used for waste management, such as for recycling facilities and waste transfer stations, but are not included in the indicator data. The data also do not reflect upon the status or effectiveness of landfill management or the extent to which contamination of nearby lands does or does not occur.

Data Source

The data source for this indicator is *BioCycle Journal* municipal landfill data 1990-2000. (See Appendix B, page B-23, for more information.)

Indicator: Number and location of RCRA hazardous waste management facilities - Category 2

The RCRA Treatment, Storage, and Disposal (TSD) facilities used to manage the more than 26 million tons of annually generated hazardous waste are tracked closely by EPA. The data, however, are tracked and reported in terms of number of facilities and volumes of waste managed, not the acres of land used for management.

What the Data Show

Nearly 70 percent of the RCRA hazardous waste (not including wastewater) generated in 1999 was disposed of at one of the nation's 1,575 RCRA TSDs. Of the 1,575 facilities, 1,049 were storage-only facilities. The remaining facilities perform one or more of the following management methods, which include recovery operations (the percentages reflect the percentage of total facilities that conduct each management method): metals recovery (16.8 percent), solvents recovery (21.1 percent), other recovery (8.8 percent), incineration (28.4 percent), energy recovery (18.9 percent), fuel blending (19.8 percent), sludge treatment (3.0 percent), stabilization (16.0 percent), land treatment/application/farming (1.3 percent), landfill (11.4 percent), surface impoundment (0.4 percent), deepwell/underground injection (8.8 percent), or other disposal methods (7.4 percent).

TSD facilities in five states accounted for approximately 65 percent of the national management total. From another perspective, over 80 percent of the TSD facilities are located in EPA Regions 4 (19.6 percent), Region 5 (16.9 percent), and Region 6 (43.7 percent) (EPA, OSWER, June 2001).

Indicator Gaps and Limitations

Some hazardous waste management information that is collected by states is not included in the provided totals because it is not compiled nationally. Further, data on actual extent of land used for waste management are not collected, reported, or aggregated. Basic data on the number of sites or facilities used for waste management do not answer the extent question.

Data Source

The data source for this indicator is 1999 RCRAInfo data from EPA Office of Solid Waste and Emergency Response. (See Appendix B, page B-23, for more information.)

3.3.3 What is the extent of contaminated lands?

Indicators

Number and location of superfund national priorities list (NPL) sites
Number and location of RCRA corrective action sites

Contaminated lands range from sites where underground storage tanks have failed to areas where accidental spills have occurred to legacy sites where poor site management resulted in the contamination of soil, sediment, and ground water. Sites are still being discovered and national data do not currently exist to describe the full extent of contaminated lands. Additionally, sites are continually being cleaned up by a variety of programs, although these sites are not always immediately removed from the tracking lists maintained by the cleanup programs (e.g., Superfund NPL).

Two indicators are described. One addresses Superfund (NPL) sites and the other RCRA Corrective Action sites. They represent the limited data available for a national view of contaminated lands. Both indicators are based on data collected to track cleanup efforts and list numbers of sites, but neither specifically delineate the extent or total area of land contamination. Besides these two indicators that track specific programs, there are several other types of contaminated lands for which national data are limited or are not available. In some cases, states collect and maintain accurate data inventories, but these state-specific data sets are not compiled nationally. Exhibit 3-29 summarizes the types of lands that are or might be considered contaminated.

Exhibit 3-29: Types of contaminated lands

Type	Description
Superfund National Priorities List Sites (Indicator)	Congress established the Superfund Program in 1980 to clean up abandoned hazardous waste sites throughout the U.S. The most seriously contaminated sites are on the NPL. As of October 2002, there were 1,498 sites on the NPL (EPA, SERP, October 2002).
RCRA Corrective Action Sites (Indicator)	EPA and authorized states have identified 1,714 hazardous waste management facilities that are the most seriously contaminated and may pose significant threats to humans or the environment (EPA, OSWER, October, 2002). Some RCRA Corrective Action sites are also identified by the Superfund Program as NPL sites.
Leaking Underground Storage Tanks	EPA regulates many categories of underground storage tanks (USTs), often containing petroleum or hazardous substances. These exist at many sites, such as gas stations, convenience stores, and bus depots. USTs that have failed due to faulty materials, installation, operating procedures, or maintenance systems are categorized as leaking underground storage tanks (LUSTs). LUSTs can contaminate soil, ground water, and sometimes drinking water. Vapors from UST releases can lead to explosions and other hazardous situations if those vapors migrate to a confined area such as a basement. LUSTs are the most common source of ground water contamination (EPA, OW, 2000), and petroleum is the most common ground water contaminant (EPA, OW, 1996). According to EPA's corrective action reports, in 1996 there were 1,064,478 active tanks located at approximately 400,000 facilities. In 2002, there were 697,966 active tanks (a 34 percent decrease) and 1,525,402 closed tanks (a 42 percent increase). As of the fall of 2002, 427, 307 UST releases (LUSTs) were confirmed. (EPA, OSWER, December 2002).
Accidental Spill Sites	Each year, thousands of oil and chemical spills occur on land and in water. Oil and gas materials that have spilled include drilling fluids, produced waters, and other wastes associated with the exploration, development, and production of crude oil or natural gas. Accurate national spill data are not available.

Exhibit 3-29: Types of contaminated lands (continued)

Type	Description
Land Contaminated with Radioactive and Other Hazardous Materials	Approximately 0.54 million acres of land spanning 129 sites in over 30 states are contaminated with radioactive and other hazardous materials as a result of activities associated with nuclear weapons production and research. Although DOE is the landlord at most of these sites, other parties, including other federal agencies, private parties, and one public university, also have legal responsibilities over these lands (DOE, January 2001).
Brownfields	Brownfields are real property, the expansion, redevelopment or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant (Small Business Liability Relief and Brownfields Revitalization Act, 2002). Brownfields are often found in and around economically depressed neighborhoods. As brownfields are cleaned and redeveloped, surrounding communities benefit from a reduction of health and environmental risks, more functional space, and improved economic conditions. A complete inventory of brownfields does not exist. According to the General Accounting Office (1987), there are approximately 450,000 brownfields nationwide (General Accounting Office, 1987). The EPA's national brownfield tracking system includes a large volume of data on brownfields across the nation, but does not track all of them. EPA's Brownfield Assessment Pilot Program includes data collected from over 400 pilot communities (EPA, OSWER, May 2002).
Some Military Bases	Some (exact number or percentage unknown) military bases are contaminated as a result of military activities. A national assessment of land contaminated at military bases has not been conducted; however, under the Base Realignment and Closure (BRAC) laws, closed military bases undergo site investigation processes to determine extent of possible contamination and the need for site cleanup. Currently, 204 military installations that have been closed or realigned are undergoing environmental cleanup. These installations collectively occupy over 400,000 acres, though not all of this land is contaminated. Thirty-six of these installations are on the Superfund NPL list, and, of these, 32 are being cleaned up under the Fast Track program to make them available for other uses as quickly as possible (DOD, 2001).
Poorly Designed or Poorly Managed Waste Management Sites	Prior to the 1970s, untreated waste was typically placed in open pits or directly onto the land. Some of these early waste management sites are still contaminated. In other cases, improper management of facilities (that were typically used for other purposes such as manufacturing) resulted in site contamination. Federal and state cleanup efforts are now addressing those early land disposal units and poorly-managed sites that are still contaminated.
Illegal Dumping Sites	Also known as "open dumping" or "midnight dumping," illegal dumping of such materials as construction waste, abandoned automobiles, appliances, household waste, and medical waste raises concerns for safety, property values, and quality of life. While a majority of illegally dumped waste is not hazardous, some of it is, creating contaminated lands.
Abandoned Mine Lands	Abandoned mine lands are sites that have historically been mined and have not been properly cleaned up. These abandoned or inactive mine sites may include disturbances or features ranging from exploration holes and trenches to full-blown, large-scale mine openings, pits, waste dumps, and processing facilities. The Department of the Interior's (DOI) Bureau of Land Management (BLM) is presently aware of approximately 10,200 abandoned hardrock mines located within the roughly 264 million acres under its jurisdiction. Various government and private organizations have made estimates over the years about the total number of abandoned and inactive mines in the U.S., including estimates for the percent land management agencies, and state and privately-owned lands. Those estimates range from about 80,000 to hundreds of thousands of small to medium-sized sites. The BLM is attempting to identify, prioritize, and take appropriate actions on those historic mine sites that pose safety risks to the public or present serious threats to the environment (DOI, BLM, 2003).

Indicator: Number and location of Superfund National Priorities List (NPL) sites - Category 2

Congress established the Superfund Program in 1980 to clean up abandoned hazardous waste sites throughout the U.S. The Superfund Program tracks and investigates thousands of potentially contaminated sites to determine whether they are indeed contaminated and require cleanup. Some sites are not contaminated, whereas others are seriously contaminated and require either extensive, long-term cleanup action and/or immediate action to protect human health and the environment. The most seriously contaminated sites are proposed for placement on the NPL. "Proposed" NPL sites that meet the qualifications for cleanup under the Superfund Program become "final" NPL sites. Sites are considered for deletion from the NPL when all cleanup goals are met and there is no longer reason for federal action.

What the Data Show

As of October 1, 2002, there were 1,498 sites that were either final (1,233) or deleted (265). Of the 1,498 sites, 846 have completed all necessary cleanup construction. A construction complete site is a former toxic waste site where physical construction of all cleanup actions are complete, all immediate threats have been addressed, and all long-term threats are under control. An additional 62 sites were proposed in 2002 (Exhibit 3-30). The total number of NPL sites (including proposed) grew from 1,236 in 1990 to 1,560 in 2002. During this time period, the number of sites that have been cleaned up and have been transferred from "final" to "deleted" status have increased nearly 10-fold, from 29 in 1990 to 265 in 2002. In 2002, over 56 percent of the final and deleted sites were construction complete, compared to only four percent of the sites in 1990 (EPA, SERP, February 2003).

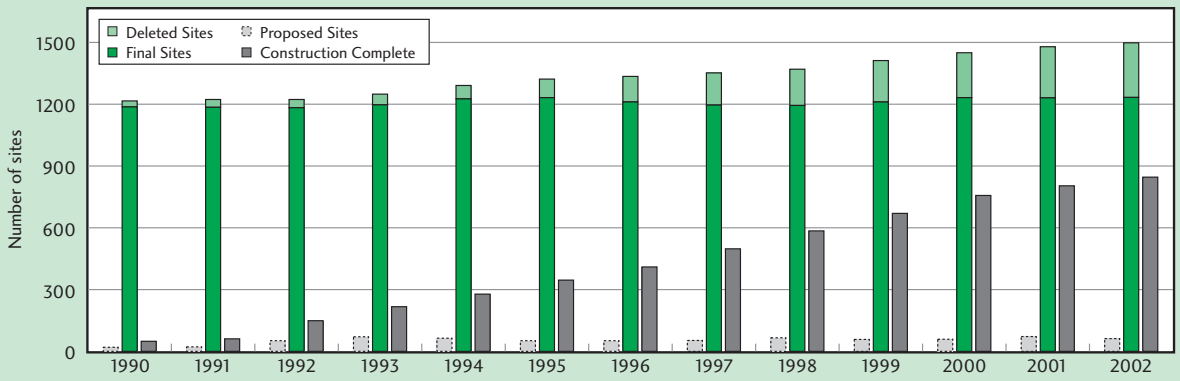
Indicator Gaps and Limitations

The NPL sites are tracked in CERCLIS. This database contains information on hazardous waste sites across the nation and U.S. territories including location, status, contaminants, and actions taken from 1983 to the present. The number of NPL sites provides a general indicator of contaminated lands, but these numbers do not translate directly to the extent of contaminated land. The NPL data cannot easily be used to clarify how many lands are contaminated because the NPL sites are divided into administrative groups (i.e., proposed, final, and deleted) that do not clearly describe whether the sites are currently contaminated. Additionally, there are many contaminated sites in CERCLIS that are not listed on the NPL, some contaminated sites are not in CERCLIS (e.g., are known only by local and state programs), and not all of the sites in CERCLIS are contaminated.

Data Source

The data source for this indicator is Comprehensive Environmental Response Compensation, and Liability Information System (CERCLIS) data, EPA Superfund Emergency Response Program, 1983-2002. (See Appendix B, page B-24, for more information.)

Exhibit 3-30. Superfund National Priorities List (NPL) site totals by status and



Note: "Construction Complete" sites include most "Deleted" sites and some "Final" sites.

Source: EPA, Office of Solid Waste and Emergency Response. National Priorities List Site Totals by Status and Milestone. March 26, 2003. (April 3, 2003; *http://www.epa.gov/superfund/sites/query/queryhtm/npltotal.htm*) and Number of NPL Site Actions and Milestones by Fiscal Year. March 26, 2003. (April 3, 2003; *http://www.epa.gov/superfund/sites/query/queryhtm/nplfy/htm*).

Indicator | Number and location of RCRA corrective action sites - Category 2

Congress established the RCRA Corrective Action Program in 1984 because many hazardous waste management facilities were contaminated from current or past solid and hazardous waste management activities and required cleanup to protect humans and the environment. As with the Superfund Program, some sites subject to RCRA corrective action may be investigated and found to require little or no cleanup, while others may be found to have extensive soil, ground water, and/or sediment contamination.

What the Data Show

EPA estimates that approximately 3,700 hazardous waste management facilities may be subject to cleanup under the RCRA corrective action program (EPA, OSWER, October 2002). To date, EPA and authorized states have identified approximately 1,700 hazardous waste management facilities that are the most seriously contaminated and may pose significant threats to human health or the environment (EPA, OSWER, October 2002). These sites typically have both soil and ground water contamination and many also have contaminated sediments. Some RCRA corrective action sites are also identified by the Superfund Program as NPL sites.

Indicator Gaps and Limitations

RCRAInfo contains information about hazardous waste generators and management facilities in the U.S. and its territories. RCRAInfo includes data on site location, status, contaminants and contaminant sources, and actions taken. RCRAInfo provides reliable data about the number and location of RCRA corrective action sites and about cleanup priorities; however, information on cleanup status at sites is less reliable, particularly for lower priority sites. Cleanup status data for the 1,700 high priority sites is current—particularly with respect to ongoing exposures of humans to contamination and migration of contaminated ground water, the two site conditions that the RCRA corrective action program has chosen to track most closely. Also, there are overlaps between the list of high priority RCRA corrective action sites and NPL sites. Due to these overlaps, number-of-site comparisons between programs and simple counts of contaminated sites can be misleading.

Data Source

The data source for this indicator is EPA Office of Solid Waste and Emergency Response, RCRA Info Data, 1997-1999. (See Appendix B, page B-24, for more information.)

3.3.4 What human health effects are associated with waste management and contaminated lands?

While some types of waste (e.g., most food scraps) are not typically toxic to humans, other types (e.g., mercury) pose dangers to human health and must be managed accordingly. The number of substances that exist that can or do affect human health is unknown; however, the TRI program requires reporting of more than 650 chemicals and chemical categories that are known to be toxic to humans.

The EPA Superfund Emergency Response Program and the Agency for Toxic Substances and Disease Registry (ATSDR) have created useful lists of common contaminant sources and their potential health effects. Every 2 years, the ATSDR and EPA prepare a list, in order of priority, of hazardous substances that are most commonly found at the NPL sites and pose the most significant threat to human health due to their known or suspected toxicity and potential for human exposure (EPA, SERP, September 2002; ATSDR, 2001). Arsenic, lead, and mercury are the highest ranking substances on the list. All three of these substances are toxic to the kidneys, and lead and arsenic can cause decreased mental ability, weakness, abdominal cramps, and anemia (EPA, SERP, September 2002). Additional discussion of these substances is available in Chapter 4, Human Health.

EPA also maintains a separate list of common contaminants and their potential health effects. The list includes commercial solvents, household items, dry cleaning agents, and chemicals. With chronic exposure, commercial solvents such as benzene, can suppress bone marrow function and cause blood changes. Dry cleaning agents and degreasers contain trichloroethane and trichloroethylene, which can cause fatigue, depression of the central nervous system, kidney changes (e.g., swelling, anemia), and liver changes (e.g., enlargement). Chemicals used in commercial and industrial manufacturing processes such as arsenic, beryllium, cadmium, chromium, lead, and mercury, are toxic to kidneys. Long-term exposure to lead can cause permanent kidney and brain damage. Cadmium can cause kidney and

lung disease. Arsenic, beryllium, cadmium, and chromium have been implicated as human carcinogens (EPA, SERP, September 2002).

Contaminants can come into contact with humans through three exposure pathways: inhalation, ingestion, and direct contact. Exposure routes can vary for each substance. Chemicals can contaminate ground water due to leaking tanks, runoff, and leaching through soil or sediment. In addition, the cleanup of sites contaminated with radioactive materials has involved the remediation of approximately 1.7 trillion gallons of ground water—an amount equal to four times the U.S. daily water consumption (DOE, 2000).

Information on waste generation amounts alone does not lead to a complete understanding of the effects of waste on people and the environment. The specific risks and burdens differ substantially from waste type to waste type. For example, one pound of grass clippings is not "equal" in terms of potential risk in exposure to one pound of dioxin. Exposure to waste is likely to vary as a function of management practices: treatment, storage, transfer, and disposal actions. Waste that is efficiently and safely treated and disposed of is likely to have relatively little effect on human health. No specific indicators have been identified at this time. Additional discussion of the human health effects associated with waste management and contaminated lands is found in Chapter 4, Human Health.

3.3.5 What ecological effects are associated with waste management and contaminated lands?

Hazardous substances can have negative effects on the environment by degrading or destroying wildlife and vegetation in contaminated areas, causing major reproductive complications in wildlife, or otherwise limiting the ability of an ecosystem to survive. Certain hazardous substances also have the potential to explode or cause a fire, threatening both wildlife and human populations (EPA, SERP, September 2002).

Waste from extraction activities can contaminate water, soil, and air; affect human health; and damage vegetation, wildlife, and other biota. Toxic residues left from mining operations can be transported into nearby areas, affecting resident wildlife populations. This type of damage is often the result of unlined land-based units that have minimal release controls. These units include surface impoundments containing mill tailings and/or process wastewater, heap-leaching solution ponds, dusts, piles of slags, refractory bricks, sludge, waste rock/overburden, and spent ore. Spills and leaks from lined management units, valves, and pipes also are known to occur.

Contaminated lands can pose a threat depending on several factors such as site characteristics and potential exposure of sensitive populations. The negative effects of land contamination on ecosystems and wildlife occur after contaminants have been released on land (soil/sediment) or into the air or water. Often, land contamination leads to water or air contamination by means of gravity, wind, or rainfall. No specific indicator was identified at this time.