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Economic Analysis of Air Pollution Regulations: Off-Site Waste and Recovery Operations

Final Report

Prepared for

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This report contains portions of the economic impact analysis report that are related to the industry profile.

SECTION 2
DEMAND FOR OWR SERVICES

Waste is generated during the course of nearly all of life's activities. For example, producing goods and services almost always involves the simultaneous production of waste materials. During the process of manufacturing goods or providing services, the material inputs that are not embodied in the products become waste. Environmental regulations require that these wastes, once generated, be treated and disposed of in an environmentally sound manner.

2.1 DEMAND FOR WASTE SERVICES

The demand for waste services is a derived demand since waste is a by-product of manufacturing or other production activities. For example, the higher the demand for plastic wrap, the greater the quantity of plastic wrap produced, and, in turn, the greater the quantity of by-products of plastic wrap manufacturing that must be treated and disposed.

Producers generating waste have three choices when they determine how to treat and dispose of the waste properly. First, they may invest in capital equipment and hire labor to manage the waste on site, that is, at the same site where it is generated. For large volumes of waste, this is often the least expensive way to manage the waste because producers can avoid the cost of transporting it. Managing waste on site also enables producers to manage their ultimate liability under environmental laws.

Another choice is for producers to treat waste on site initially and then to send it off site for ultimate treatment and disposal; this method is known as on site/off site. Finally,

producers may choose to send some or all of the waste they generate directly to another site, a method that is called off-site. The producers of waste who choose either the on site/off-site or the off-site method create the demand for OWR facilities.

2.1.1 Types of OWR Services Affected by this Regulation

The regulation addresses all facilities accepting waste from off site for management, except the following types of facilities:

- municipal landfills,
- incinerators,
- site remediation, and
- POTWs.

Therefore, OWR facilities affected by this regulation include hazardous waste management facilities, oil re-refining facilities, off-site wastewater treatment facilities, industrial landfills, and so on. Because of data limitations, this analysis estimated impacts on only two of those categories: hazardous waste management facilities and off-site wastewater treatment facilities.

2.1.2 Data Sources

Most of the data used for this analysis came from three sources:

- the TSDR Survey,[4]
- the GENSUR Survey,[5] and
- the CWT Survey.[6]

EPA's Office of Solid Waste and Emergency Response conducted the GENSUR and TSDR Surveys in 1987 and 1988. Their goal was to collect 1986 data from a sample of hazardous waste generators and all hazardous waste treatment, recycling, or disposal facilities regulated by the Resource Conservation and Recovery Act (RCRA). Together the surveys provide a detailed portrait of the types of facilities generating and managing wastes in 1986, the types of waste generated, and ways in which those wastes were managed. The TSDR Survey is a census of all RCRA-regulated facilities that treated, disposed, or recycled hazardous waste in 1986 and a 50 percent sample of all facilities that stored hazardous waste in RCRA-permitted units in 1986, but did not treat, dispose, or

recycle on site. This survey provides information about the types of waste management operations a facility has on site; the quantities of waste managed in each operation; and the source of those wastes (generated on site, generated off site by facilities under the same ownership, or generated off site by facilities not under the same ownership). The GENSUR provides, among other things, a detailed characterization of the hazardous wastes generated in 1986 and where and how they were treated, disposed, or recycled.

EPA's Office of Water conducted the CWT Survey in 1991 and 1992 to collect 1989 data about facilities that accept waste from off site for treatment and that discharge water either directly or indirectly to surface water. These data were collected to support the development of an effluent guideline for that industry. Approximately 83 percent of the facilities covered by the CWT Survey were also contacted for the TSDR and GENSUR Surveys.

2.1.3 Industries Demanding OWR Services

Data from GENSUR can be used to characterize the generators of hazardous waste by industry and to profile the types of waste generated. This extensive survey database gives the most detailed information on the generation of waste available. The survey was designed to collect information on the generation of wastes defined as hazardous under Subtitle C of RCRA. Thus, this pattern of generation by industry may not correspond to the generation pattern for the customers of OWR facilities because their customers include generators of nonhazardous wastes. Some overall patterns, however, may be instructive.

Each RCRA regulated facility's Standard Industrial Classification (SIC) code was identified from its response to Question 17 of the TSDR Survey. Non-RCRA-regulated facilities primary SIC code was identified from their responses to Question N.2 of the CWT Survey. For a complete list of 4-digit SIC codes provided to TSDR Survey respondents see Appendix A. Table 2-1 shows SIC codes and the quantities of waste those industries generate and ultimately send off site for treatment, recovery,

and/or disposal. This is the portion of total waste generated in 1986 that was managed off site. Two types of treatment locations are specified: Off Site Only and On Site/Off Site. As explained earlier, wastes that, once generated, are sent directly to an off-site management facility are called Off Site Only. Wastes generated and treated initially on site, then sent off site for additional treatment or disposal, are called On Site/Off Site. Most of the first page of the table shows wastes shipped off site without prior treatment, while the remaining rows at the bottom and the second page show wastes shipped off site after initial on-site treatment.

Clearly, many manufacturing industries send waste off site for management and/or recovery as shown in Table 2-1. The most frequently appearing SIC codes are those in the 2800s (chemicals manufacturing) and the 3300s (primary metals manufacturing). Industrial organic chemicals (2869) ships the greatest quantity of waste off site, followed by plastics and resins (2821), inorganic pigments (2816), and semiconductor manufacturing (3674). The SIC code with the most generators is plating and polishing (3471). Other industries with many generators include electronic components (3679) and semiconductors (3674). Wastes shown in Table 2-1

TABLE 2-1. 1986 WASTE GENERATION BY SIC CODE, BY TREATMENT LOCATION

Treatment location	SIC code	Quantity generated (10^3 Mg)	Quantity sent off site (10^3 Mg)	Number of generators
Off site only	2816	3,816.7	3,816.7	1
	2821	308.1	308.1	2
	3851	288.4	288.4	1
	2813	249.3	55.8	1
	3484	176.9	176.9	5
	2869	101.6	101.2	8
	2911	31.6	31.2	16
	2833	20.1	20.1	2
	2879	16.0	16.0	2
	3644	15.7	15.7	1
	4931	14.0	14.0	9
	3317	9.8	9.8	4
	4953	8.8	8.8	22
	3714	7.5	2.9	6
	3721	5.8	5.8	6
	3471	4.9	4.9	29
	3600	4.7	4.5	14
	5983	3.2	3.2	7
	2819	3.1	3.1	5
	3661	2.3	2.3	7
	2899	2.2	2.2	14
	3441	2.2	2.2	9
	4463	2.0	2.0	1
	3312	1.9	1.9	6
	3452	1.8	1.8	15
	3679	1.3	1.3	14
	3585	1.2	1.2	2
	3728	1.1	1.1	49
	3479	1.0	1.0	5
	1311	1.0	1.0	4
	5171	1.0	1.0	21
All other SICs, off site only		52.4	52.0	
Off site total, only		5,157.7	4,958.7	
On site, then off site	2869	14,637.0	10,674.1	165
	2821	9,028.9	9,000.8	71
	3674	7,985.1	2,843.3	151
	3361	4,514.2	3.9	5
	3714	3,264.9	816.5	123
	2611	2,899.1	2,899.1	8

(continued)

TABLE 2-1. 1986 WASTE GENERATION BY SIC CODE, BY TREATMENT LOCATION (continued)

Treatment location	SIC code	Quantity generated (10^3 Mg)	Quantity sent off site (10^3 Mg)	Number of generators
On site, then off site (cont.)	2819	2,368.2	1,009.4	40
	3312	2,306.8	644.4	78
	2865	2,290.4	1,811.4	31
	2911	2,170.7	891.0	132
	3429	2,056.5	62.1	51
	3585	1,880.1	19.3	32
	2800	1,574.6	63.3	41
	3700	1,364.5	1,364.5	1
	9511	1,323.4	1,323.4	13
	3711	1,102.6	736.0	66
	3471	942.2	116.8	352
	4953	843.5	797.2	49
	3573	828.4	34.5	63
	3321	758.2	23.4	11
	3679	757.0	747.8	256
	3479	631.2	571.8	133
	2899	607.9	293.2	93
	3815	583.3	0.9	5
	3291	575.0	3.9	16
	2842	571.0	571.0	13
	3721	517.1	525.4	59
	2834	475.2	475.1	53
	3691	376.6	19.6	27
	3079	371.0	13.9	156
	3341	345.2	342.0	43
	3713	332.1	2.3	3
	2879	283.4	29.9	46
	3548	179.8	0.1	1
	3678	170.3	170.3	34
	3531	170.2	1.5	8
	3639	169.3	169.3	4
	7391	159.1	10.6	125
	3316	156.6	155.6	13
	3452	150.4	134.6	40
	7535	142.7	1.9	1
	3497	138.6	138.6	2
	3592	122.9	15.1	6
	3552	122.0	0.4	15
	3351	120.2	4.3	22
	3825	105.0	102.9	10
	3317	98.4	52.0	36
	2542	96.1	0.0	2
All other SIC codes, on then off		2,209.9	2,020.0	
On then off total		76,000.7	41,163.0	
Total waste in 1986		590,935.1	46,121.8	

may be doublecounted; that is, the quantities generated at a facility are listed on a waste-specific basis. At some facilities, wastes generated by the treatment of other wastes are listed separately, so the summed waste quantities for the facility may exceed the total quantity of raw waste generated. Thus, the total quantity of waste generated by a particular SIC code may be overstated.

These quantities do not correspond exactly to the quantity of waste management demanded by generators from OWR facilities in 1986. Some of the wastes in Table 2-1 sent off site were sent for management at facilities not covered by this NESHAP. Also, some of the wastes treated in off-site waste operations covered by this NESHAP are not hazardous under RCRA and thus would not appear in Table 2-1. But the overall patterns of generation by SIC code shown in Table 2-1 are expected to be similar to the patterns of waste generation for wastes being managed at OWR facilities.

Of 678 million Mg of EPA-regulated hazardous waste generated in 1986, only 46 million Mg were sent off site. Thus, the vast majority of the volume of RCRA hazardous waste generated in 1986 was treated and disposed on site and is outside the scope of this analysis. Relying on on-site treatment is typical of waste management patterns: to avoid transportation costs, the largest volume wastes are treated on site. Waste that is sent off site for management tends to be relatively low in volume although it may be highly toxic.

2.2 TRENDS IN THE DEMAND FOR OWR SERVICES

The data described above reflect demand for hazardous waste management services in 1986. They demonstrate that the demanders of OWR services are diverse, including most manufacturing and many service sectors. This pattern is probably true for all waste as well and is probably still true today. The overall quantity of OWR services demanded and the pattern of off-site waste management, however, have probably changed since 1986.

The late 1980s were a period of transition for the waste management industry, particularly the RCRA hazardous waste industry. Several regulatory and policy changes combined to change the framework for waste generation and management.

2.2.1 The Land Disposal Restrictions (LDR)

First, regulations authorized by the Hazardous and Solid Waste Amendments to RCRA and promulgated by EPA since 1986 prohibit the land disposal of hazardous waste unless hazardous chemicals and characteristics have been removed, reduced, or stabilized to the greatest extent possible or unless EPA determines on a site-specific basis that there will be no migration of hazardous constituents from the land disposal unit. Beginning in July 1987, wastes banned from land disposal in California were subject to these national restrictions (LDR). By August 1988, the most hazardous 33 percent of RCRA hazardous wastes were banned; beginning in June 1990, the "second third" of RCRA hazardous wastes were banned. In May 1991, the final third were banned from land disposal. Thus, the LDR (or "land ban") has changed the pattern of hazardous waste management, increasing the amount of treatment prior to disposal. In addition, smaller quantities of some types of waste will be land-disposed (waste that must be thermally treated, for example), while greater quantities of other wastes will be land-disposed (such as wastewater treatment sludges, which must now be mixed with stabilizing agents). The average per-unit costs of waste management have increased.

2.2.2 The Toxicity Characteristic Leachate Procedure (TCLP) Test

In addition to the LDR, the introduction of the TCLP test to determine if a waste is toxic under RCRA changed the classification of many wastes from nonhazardous to hazardous. Since September 1990, facilities have been required to use this test rather than the extraction procedure (EP) leaching test to determine whether wastes are hazardous. The most notable distinction between the tests is that the EP test estimates the leaching of metals only while the TCLP also estimates the leaching

of organic compounds. Many organic chemicals will ultimately be added to the characteristic list of RCRA hazardous wastes as a result of this rule change. Facilities managing these wastes must now have a RCRA permit. Thus, the TCLP increases the demand for RCRA-permitted OWR services relative to other, non-RCRA-permitted types of waste management because these wastes can no longer be treated by a POTW or disposed in a municipal landfill without prior treatment.

2.2.3 Pollution Prevention

Another recent policy change is EPA's and state agencies' greatly increased emphasis on pollution prevention. Generators are encouraged to modify their processes, improve their housekeeping, increase their reuse and recycling of production by-products, and generally reduce the amount of waste they release to the environment. Many facilities have found cost-effective ways to modify their operations and decrease the quantity of waste they generate for a given level of production of their primary good or service. This trend has, other things equal, reduced the demand for OWR services.

To assess the overall trend in the demand for OWR services, EPA would need a time-series database giving several years' data about the quantity of waste sent off site for management each year. Unfortunately, no database corresponds exactly to the data needed. No national data source provides time-series information about the quantity of RCRA-regulated waste sent off site for management. Because of the lack of detailed national time-series data on hazardous waste generation and management, quantifying the overall trend in demand for OWR services over the past five years is impossible. If the increasingly stringent regulation of pollution releases to the environment has dominated, the quantity of waste that must be managed by specialists (OWR facilities) for a given level of production may have increased. If, on the other hand, the emphasis on pollution prevention has dominated, a given level of production may have resulted in a smaller quantity of

waste being generated, and the demand for OWR services may have declined.

2.2.4 Evidence from the Toxics Release Inventory (TRI)

The TRI does provide a time series of data on releases of materials, but the materials are chemicals of concern rather than RCRA-regulated wastes. Many of the TRI chemicals, if discarded, are RCRA-regulated hazardous wastes. Thus, the TRI database does provide information from which inferences may be drawn about the quantities of waste being generated.

A recent study done for EPA's Office of Pollution Prevention and Toxics assesses the changes in reported TRI releases and transfers between 1989 and 1990.[7] This study collected data from a sample of TRI-reporting facilities to attempt to quantify the changes in releases and transfers reported in TRI between 1989 and 1990, and to assess the contribution of "real" changes in releases as opposed to "paper" changes in releases. Real changes in releases represent actual changes in the physical quantities of a chemical sent off site. Paper changes, on the other hand, represent changes in reported quantities of chemicals released that are not actual changes in physical releases but occur because of changes in measurement or data errors.

A sample of facilities was drawn from the population of facilities in two-digit SIC codes between 20 and 39 that reported releases in the TRI in both 1989 and 1990. Based on survey results, the target population reported a 15.4 percent decrease in TRI releases and transfers between 1989 and 1990. Of the 15 percent, approximately half (6.9 percentage points) is attributed to source reduction. The rest is attributed to measurement changes, changes in production, and other factors. Based on these results, it appears likely that, overall, the demand for OWR services may be declining.

2.2.5 Other Evidence of Trends in Demand for OWR Services

Anecdotal evidence abounds that indicates a declining demand for OWR services, especially for hazardous waste OWR services. Numerous case studies have been performed documenting pollution

prevention activities and the resulting decreases in quantities of waste being generated. For example, Motorola, in conjunction with two U.S. Department of Energy laboratories, developed a no-clean soldering process for circuit board production that eliminates all solvent cleaning, eliminates the use of chlorofluorocarbons (CFCs), speeds up production, decreases energy use, reduces production costs, and produces reliable hardware.[8] Additionally, in a recent assessment of pollution prevention in the chemicals industry for INFORM, Dorfman, Muir, and Miller cite dozens of examples of companies making changes to production processes, inputs, or products to reduce their waste generation. DuPont, for example, reduced solvent waste at their Deepwater, New Jersey, Chambers Works plant by approximately 40 million pounds per year. Most of their pollution prevention activities involve in-process recycling. The company estimates that these activities save DuPont $3.75 million each year. Dow Chemical's Pittsburg, California, plant modified its inputs and production processes and reduced its waste generation by approximately 12 million pounds per year.[9]

A recent article in the Wall Street Journal stated that, contrary to concerns in the late 1980s, hazardous waste disposal capacity seems abundant:

> Existing dumps have about 50 years of capacity left. . . . Licensed hazardous waste incinerators ran at 74 percent of capacity in 1990. . . . Hazardous waste disposal capacity went from a feared shortage to an actual glut in part because companies . . ., facing rising disposal costs and potential cleanup liability, overhauled production methods to reduce waste volume.[10]

For all of the reasons cited above, it is probable that the pattern and total volume of OWR demanded in 1991 are very different from that reported in the TSDR/GENSUR database. No data sources reflect OWR demand in 1991; the data used in this analysis, although out of date, are the best available.

2.3 DEMAND FOR MANAGEMENT OF SPECIFIC TYPES OF WASTE

Generators of wastes demand the management of the wastes they generate by OWR facilities. For example, a generator may produce wastewater contaminated with metals, sludges or solids, or spent solvents as a result of the production of other goods or services. The generator demands the management of a particular type of waste. Over 400 specific RCRA waste codes describe hazardous wastes of particular types. In addition, many other wastes are not hazardous under RCRA. For simplicity, this analysis grouped the wastes into six general types, or waste forms. Table 2-2 defines these waste forms.

TABLE 2-2. WASTE FORMS FOR WHICH OWR SERVICES ARE DEMANDED

Waste form	Waste description code	Definition
1	B37-B56	Inorganic solids
	A10	Incinerator ash
	A11	Solidified treatment residuals
2	B20-B35	Inorganic sludges
3	B77-B78	Biological treatment or sewage sludge
	B19	Lime sludge without metals
	A05	Wastewater or aqueous mixture
4	B58-B70	Organic liquids
	A01	Spent solvents
	A02	Other organic liquid
5	B28	Degreasing sludge with metals
	B36	Soil contaminated with organics
	B71-B90	Organic sludges and solids
	A03	Still bottoms
	A04	Other organic sludge
	A06	Contaminated soil or cleanup residue
6	B57	Inorganic gases
	B91	Organic gases
	A07	Other F or K waste[a] exactly as described
	A08	Concentrated off-spec or discarded product
	A09	Empty containers
	A12	Other treatment residue
	A13	Other untreated wastes

[a] Wastes whose RCRA codes begin with F or K.

TABLE 2-3. TREATMENT PROCESSES AT OWR FACILITIES

Management process number	Process description
1	Incineration
2	Reuse as fuel
3	Fuel blending
4	Solidification stablization
5	Solvent recovery
6	Metals recovery
7	Wastewater treatment
8	Landfill disposal
9	Underground injection
10	Other waste management process

Appendix B provides more detailed information about the specific wastes included in each waste form.

Within each waste form, some of the specific wastes may be suitable for management using one waste management process while other wastes are suitable for management using other processes. This analysis assumed that the process used to manage a particular waste is a function of its characteristics. Waste of Form 1 that is incinerated is assumed to be different from waste of Form 1 that is landfilled or that undergoes wastewater treatment. Thus, the specific waste types for which OWR services are demanded are described by the combination of the waste form and the treatment process. Table 2-3 lists the types of OWR management processes included in the analysis.

Waste type (i_j) = waste of Form i managed in process j

$$i = 1,\ldots, 6$$
$$j = 1,\ldots, 10$$

Because ten waste management processes and six waste forms are being analyzed, the analysis groups waste into a total of 60

individual waste types for which waste management services are demanded.

Only commercially treated wastes constitute a demand in the market for OWR services although noncommercial off-site waste management activities are also subject to this regulation. The regulation does not affect the wastes that are generated and treated on site.

2.4 CHARACTERISTICS OF DEMAND AS REFLECTED BY THE MARKET MODEL

As explained above, waste management is an input into the production of other goods and services, whose production simultaneously creates waste. The demand for the OWR input is

$$Q_j^D = Y_{ij} \cdot P_j^E \quad , \qquad (2\text{-}1)$$

derived from the demand for the other goods and services. In the market model, the demand for OWR services is given by

where Y is a constant parameter and E is the elasticity of market demand of waste management operations.

The price elasticity of demand (which is referred to as the elasticity of demand from here on) measures the responsiveness of demand for a service to changes in its price. It is defined as the percentage change in the quantity demanded of a service divided by the percentage change in its price.

Economic theory states that the elasticity of the derived demand for an input is a function of the following:

- demand elasticity for the final good it will be used to produce,
- the cost share of the input in total production cost,
- the elasticity of substitution between this input and other inputs in production, and
- the elasticity of supply of other inputs.[11,12,13]

As explained in Appendix C, the magnitude of the elasticity of demand for OWR services depends on the cost share of OWR services in the production of the generators' primary goods and services. Other analyses done on the OWR industry show that the cost share for waste management is usually very small, frequently hundredths of a percent of total production costs. Accordingly, the elasticity of demand for waste management is expected to be small. A uniform -0.1 elasticity of demand is assumed for each of the types of OWR services.

SECTION 3
SUPPLY OF OWR SERVICES

OWR services are waste management services performed at facilities that accept waste from off site (i.e., generated at other facilities). While some waste is generated at these facilities as a result of the treatment of other waste (and, in some cases, as the result of manufacturing), much of the waste treated there is generated elsewhere and transported to the OWR facility for treatment and/or disposal. Producers of OWR services include both RCRA-regulated hazardous waste management facilities and non-RCRA-regulated off-site waste management facilities.

The EPA believes that organic HAP air emissions from the hazardous waste management activities at RCRA-regulated waste management facilities provide the best estimate available for organic HAP emissions from OWR facilities.[14] Another type of facility believed to emit organic HAPs in fairly large quantities is off-site wastewater treatment facilities that are not RCRA-regulated. Because these two types of facilities are believed to be the major OWR emitters of organic HAPs, the economic impact analysis treats these facility types in the greatest detail. Other types of OWR activities (such as industrial landfills or oil re-refiners) are discussed qualitatively.

OWR facilities differ widely from one another in terms of their size, the types of waste management services they offer, and their profitability. They differ in terms of their ownership type and the financial health of the companies owning them. This section profiles the suppliers of OWR services.

3.1 DESCRIPTION OF SUPPLIERS

As described in Section 2, the regulation affects all facilities that accept waste from off site for management, with a few exceptions. OWR facilities thus include hazardous waste management facilities, off-site wastewater treatment facilities, oil re-refining facilities, industrial landfills, and so on. The impact analysis focuses on RCRA-regulated hazardous waste management facilities and non-RCRA-regulated off-site wastewater treatment facilities because the Agency believes that these two subsets represent the most significant sources of organic HAP air emissions and because the data on these two subsets are the most complete. Using the TSDR and GENSUR Surveys, EPA collected the data that form the basis for characterizing RCRA-regulated facilities that manage hazardous wastes from off site. This analysis also used data from the CWT Survey.

Of the 87 facilities identified by the CWT Survey, 72 also are covered by the TSDR/GENSUR database. Only 15 of the CWT facilities were not also RCRA-regulated in 1986. For the 72 for which data are contained in both data sources, TSDR and GENSUR data were used to characterize their waste management operations because those data are more detailed. For the 15 CWT-only facilities, data from the CWT Survey were used.

3.1.1 Data Limitations

The data used to characterize the supply of OWR services in 1991 combine data collected in 1986 and data collected in 1989. The 1989 data have been checked to ensure that they are still reasonably accurate. The 1986 data, on the other hand, may be very out of date. In particular, the LDR, or "land ban," discussed in Section 2, have significantly transformed the pattern of management for organic waste forms. Wastes that were legally managed in land-based operations in 1986 must now be managed in a different way. Some waste management operations are no longer used to manage hazardous wastes, such as surface impoundments, waste piles, and land treatment. In an attempt to make the data

correspond to current practices, wastes that were reported in the TSDR/GENSUR as going to those OWR operations were reassigned to landfills. Other discrepancies, such as assigning organics to land-based management operations still in use but not legal for organics, have not been corrected because no data exist to indicate the relative quantities of those wastes now managed in other practices.

The TSDR/GENSUR database, although out of date, still represents the most recent and detailed characterization of hazardous waste management practices. For this reason, it forms the basis for characterizing waste management patterns in the absence of the regulations. However, recognizing its shortcomings is important, so they will be noted as relevant throughout this document.

3.2 TYPES OF OWR SERVICES

To be subject to the regulation, facilities must accept waste from off site. Generally, they also treat at least some waste that is generated on site. They offer waste generators the service of managing their wastes that, for the purposes of this analysis, fall into one of six general waste forms:

- inorganic solids,
- inorganic sludges,
- aqueous liquids or sludges,
- organic liquids,
- organic sludges or solids, and
- other wastes.

These waste forms were further divided based on treatability, as discussed in Section 2. Thus, for each of the six waste forms, as many as 10 waste types reflect how the waste is treated.

Each OWR facility may manage those wastes in one of the following waste management processes (not all general waste types are managed in all processes):

- incineration,
- reuse as fuel,
- fuel blending,

- solidification and stabilization,
- solvent recycling,
- metals recovery,
- wastewater treatment,
- landfill disposal,
- underground injection, and
- other waste management.

For purposes of this analysis, the Agency assumed that each waste form and management operation constitute a unique waste management service that is marketed. This assumption reflects the belief that the wastes within each broad waste form are in fact quite variable and that different waste management operations would be appropriate for different wastes within the broad category. Therefore, for example, the Agency believes that organic liquid waste treated in incineration is really a different waste than organic liquid waste treated in wastewater treatment. Because there are six waste forms, each of which may be managed in each of 10 processes, the model estimates market effects in each of 60 markets.

TABLE 3-1. WASTE TYPE DEFINITIONS

Waste type	Definition waste form	Waste management process
Q1_1	Inorganic solids	Incineration
Q1_2	Inorganic solids	Reuse as fuel
Q1_3	Inorganic solids	Fuel blending
Q1_4	Inorganic solids	Solidification/stabilization
Q1_5	Inorganic solids	Solvent recovery
Q1_6	Inorganic solids	Metals recovery
Q1_7	Inorganic solids	Wastewater treatment
Q1_8	Inorganic solids	Landfill disposal
Q1_9	Inorganic solids	Underground injection
Q1_10	Inorganic solids	Other waste management process
Q2_1	Inorganic sludges	Incineration
Q2_2	Inorganic sludges	Reuse as fuel
Q2_3	Inorganic sludges	Fuel blending
Q2_4	Inorganic sludges	Solidification/stabilization
Q2_5	Inorganic sludges	Solvent recovery
Q2_6	Inorganic sludges	Metals recovery
Q2_7	Inorganic sludges	Wastewater treatment
Q2_8	Inorganic sludges	Landfill disposal
Q2_9	Inorganic sludges	Underground injection
Q2_10	Inorganic sludges	Other waste management process
Q3_1	Aqueous liquids or sludges	Incineration
Q3_2	Aqueous liquids or sludges	Reuse as fuel
Q3_3	Aqueous liquids or sludges	Fuel blending
Q3_4	Aqueous liquids or sludges	Solidification/stabilization
Q3_5	Aqueous liquids or sludges	Solvent recovery
Q3_6	Aqueous liquids or sludges	Metals recovery
Q3_7	Aqueous liquids or sludges	Wastewater treatment
Q3_8	Aqueous liquids or sludges	Landfill disposal
Q3_9	Aqueous liquids or sludges	Underground injection
Q3_10	Aqueous liquids	Other waste management process

(continued)

TABLE 3-1. WASTE TYPE DEFINITIONS (continued)

Waste type	Definition waste form	Waste management process
Q4_1	Organic liquids	Incineration
Q4_2	Organic liquids	Reuse as fuel
Q4_3	Organic liquids	Fuel blending
Q4_4	Organic liquids	Solidification/stabilization
Q4_5	Organic liquids	Solvent recovery
Q4_6	Organic liquids	Metals recovery
Q4_7	Organic liquids	Wastewater treatment
Q4_8	Organic liquids	Landfill disposal
Q4_9	Organic liquids	Underground injection
Q4_10	Organic liquids	Other waste management process
Q5_1	Organic sludges or solids	Incineration
Q5_2	Organic sludges or solids	Reuse as fuel
Q5_3	Organic sludges or solids	Fuel blending
Q5_4	Organic sludges or solids	Solidification/stabilization
Q5_5	Organic sludges or solids	Solvent recovery
Q5_6	Organic sludges or solids	Metals recovery
Q5_7	Organic sludges or solids	Wastewater treatment
Q5_8	Organic sludges or solids	Landfill disposal
Q5_9	Organic sludges or solids	Underground injection
Q5_10	Organic sludges or solids	Other waste management process
Q6_1	Other wastes	Incineration
Q6_2	Other wastes	Reuse as fuel
Q6_3	Other wastes	Fuel blending
Q6_4	Other wastes	Solidification/stabilization
Q6_5	Other wastes	Solvent recovery
Q6_6	Other wastes	Metals recovery
Q6_7	Other wastes	Wastewater treatment
Q6_8	Other wastes	Landfill disposal
Q6_9	Other wastes	Underground injection
Q6_10	Other wastes	Other waste management process

Table 3-1 shows the waste type definitions; each market analyzed represents supply and demand for management of one waste type.

3.3 COMMERCIAL STATUS

OWR facilities accept waste from off site for treatment, storage, and disposal or for recycling; that is, they manage waste that was generated at other facilities. An OWR facility may or may not be owned by the same company that generates the waste. OWR facilities fall into one of three commercial status categories:

- commercial--facilities that accept waste from off-site generators not under the same ownership as their facility;
- noncommercial--facilities that accept waste only from off-site generators under the same ownership as their facility; and
- mixed commercial and noncommercial--facilities that treat waste generated by other facilities under the same ownership as their facility and also accept waste from off-site generators not owned by the same company.

Commercial waste treatment facilities are specialists in waste treatment; it is their business. They generally do not have manufacturing or other activities on site. They offer one or more waste management services on a commercial basis and accept waste from customers that are not part of the same company. They compete with other commercial or mixed commercial and noncommercial OWR facilities offering the same services. Only waste that is managed commercially passes through the market for OWR services.

Noncommercial waste treatment facilities are typically located at manufacturing sites. The noncommercial waste treatment operations at these sites manage waste generated on site and also manage waste generated at other sites owned by the same company. Because of the potentially large liabilities associated with hazardous waste, companies sometimes choose to manage their waste

internally rather than employ commercial waste management services. To take advantage of economies of scale in waste management operations, they may choose to centralize their waste management operations. For such facilities, managing waste generated by off-site facilities under the same ownership is frequently regarded as a "cost of doing business," similar to centralized accounting or legal services provided for the entire company by a company division. The facilities may receive revenues directly for the treatment services (usually at a lower price than would be charged by a commercial treater), or they may be reimbursed for expenses. Changes in the quantities of waste managed noncommercially do not affect the market for OWR services.

Finally, some facilities offer both commercial and noncommercial services. Generally, these facilities have excess treatment capacity and choose to use it to manage waste generated by facilities not under the same ownership. These facilities are referred to as mixed commercial and noncommercial OWR facilities.

In addition to managing wastes generated off site on a commercial, noncommercial, or mixed commercial and noncommercial basis, most OWR facilities manage waste generated on site. Some treatment processes generate residuals, which are new wastes that are usually smaller in volume and/or less toxic than the original waste, but which must still be managed as hazardous wastes. Such residuals include stabilized sludges from wastewater treatment, still bottoms from solvent recovery, and scrubber water from incineration. Also, many OWR facilities are also manufacturing sites, and the manufacturing activities generate waste that must be managed.

The TSDR Survey includes information about the commercial status of facilities. In each treatment process questionnaire, facilities were asked for the quantity of waste managed in each process that is generated on site and treated on site, the quantity that is received from another off-site facility under the same ownership and treated on site, and the quantity received from an off-site facility not under the same ownership and treated on

site. Table 3-2 shows the number of facilities managing each type of waste commercially and the number of facilities managing each type noncommercially on an off-site basis, as well as the number of facilities generating each waste type on site and managing it on site. Waste type Qi_j represents waste of form i managed in process j, as defined in Table 3-1.
OWR services offered on a commercial basis are shown in the first column. This column represents the numbers of facilities active in each OWR market at baseline. The second column shows the number of facilities offering OWR services on a noncommercial basis. The third column shows the number of wastes generated on site and treated on site. Finally, the total column shows the number of facilities managing each waste form in each process, regardless of the source of the waste. Note that the individual columns do not sum to the total because one facility may manage the same waste form in the same process on a commercial, noncommercial, and on-site
basis. Summing across the columns would triple-count that facility.

3.4 QUANTITIES OF WASTE MANAGED BY OWR FACILITIES

Table 3-3 provides quantities of each waste type managed in 1986.

TABLE 3-2. NUMBER OF FACILITIES TREATING WASTE, BY PROCESS AND COMMERCIAL STATUS[a]

Waste type	Commercial	Noncommercial	On site	Total
Q1_1	22	25	25	35
Q1_2	9	18	10	26
Q1_3	7	4	8	11
Q1_4	23	8	13	24
Q1_5	14	7	8	20
Q1_6	26	10	14	30
Q1_7	27	28	31	50
Q1_8	46	40	40	68
Q1_9	2	1	1	2
Q1_10	25	22	33	44
Q2_1	12	13	14	21
Q2_2	9	18	10	26
Q2_3	7	0	3	7
Q2_4	19	6	11	20
Q2_5	4	2	1	6
Q2_6	14	5	8	18
Q2_7	37	32	31	60
Q2_8	37	33	31	55
Q2_9	1	0	1	1
Q2_10	18	18	29	37
Q3_1	19	21	22	32
Q3_2	13	20	12	31
Q3_3	29	5	13	32
Q3_4	26	9	14	27
Q3_5	29	11	10	37
Q3_6	19	10	13	26
Q3_7	78	67	65	113
Q3_8	37	34	33	56
Q3_9	9	6	7	10
Q3_10	31	25	37	52

(continued)

TABLE 3-2. NUMBER OF FACILITIES TREATING WASTE, BY PROCESS AND COMMERCIAL STATUS[a] (continued)

Waste type	Commercial	Noncommercial	On site	Total
Q4_1	25	32	32	45
Q4_2	36	23	16	56
Q4_3	66	14	33	71
Q4_4	23	7	15	24
Q4_5	98	33	27	117
Q4_6	10	5	6	13
Q4_7	38	32	32	61
Q4_8	34	32	29	51
Q4_9	8	6	5	9
Q4_10	32	27	39	56
Q5_1	22	26	26	37
Q5_2	24	21	13	42
Q5_3	43	11	21	47
Q5_4	28	7	16	29
Q5_5	60	15	16	67
Q5_6	10	5	6	13
Q5_7	23	27	30	44
Q5_8	38	39	34	60
Q5_9	4	4	3	6
Q5_10	24	25	36	48
Q6_1	18	20	22	32
Q6_2	15	23	15	36
Q6_3	14	6	13	19
Q6_4	25	6	15	26
Q6_5	24	12	12	33
Q6_6	20	6	10	24
Q6_7	52	41	44	83
Q6_8	43	35	33	63
Q6_9	5	5	5	7
Q6_10	129	146	272	341

[a] As noted in Section 3.2, the majority of the data used to construct this table come from the TSDR/GENSUR database and reflect waste management patterns in 1986. Regulatory and other changes since 1986 have resulted insignificant changes in both the quantities and patterns of hazardous waste management. Thus, the patterns reflected in Tables 3-2 and 3-3 may no longer be accurate. They do reflect the best and most current data available to the Agency.

TABLE 3-3. QUANTITIES OF WASTE MANAGED AT OWR FACILITIES, BY PROCESS AND COMMERCIAL STATUS[a]

Waste type	Commercial (Mg)	Noncommercial (Mg)	On site (Mg)	Total (Mg)
Q1_1	6,659	13,585	1,681,956	1,702,201
Q1_2	107	389	12,053	12,548
Q1_3	392	0	43	435
Q1_4	38,992	338	62,970	102,299
Q1_5	3,841	9	653	4,503
Q1_6	234,918	39,344	139,394	413,656
Q1_7	9,247	6,561	181,503	197,311
Q1_8	1,004,531	76,658	8,672,851	9,754,040
Q1_9	74	1	11	86
Q1_10	5,497	1,702	350,824	358,023
Q2_1	853	138	906,634	907,626
Q2_2	8,351	461	12,075	20,888
Q2_3	16,797	0	607	17,405
Q2_4	87,618	1,367	147,409	236,395
Q2_5	4,720	132	93	4,946
Q2_6	9,894	263	120,470	130,628
Q2_7	101,757	23,172	2,175,835	2,300,764
Q2_8	688,666	45,257	8,707,414	9,441,337
Q2_9	2,382	0	1,852	4,235
Q2_10	84,814	170	126,357	211,341
Q3_1	15,417	6,626	1,427,131	1,449,173
Q3_2	22,600	107,836	62,586	193,023
Q3_3	15,364	30	8,333	23,727
Q3_4	78,025	278	68,594	146,897
Q3_5	13,444	26,065	2,870	42,379
Q3_6	52,135	2,080	134,605	188,820
Q3_7	2,945,628	29,274,964	49,328,691	81,549,282
Q3_8	454,460	69,621	679,314	1,203,395
Q3_9	234,539	131,783	1,528,316	1,894,638
Q3_10	181,833	36,837	4,766,706	4,985,375
Q4_1	124,216	38,090	2,384,496	2,546,802
Q4_2	196,986	5,942	313,408	516,335
Q4_3	1,427,190	3,239	43,731	1,474,160
Q4_4	20,738	64	146,941	167,743
Q4_5	1,353,433	104,770	177,765	1,635,969
Q4_6	4,647	49	20,194	24,889
Q4_7	139,811	9,046	5,413,749	5,562,606
Q4_8	125,291	9,142	634,048	768,480
Q4_9	11,685	2,404	4,158	18,248
Q4_10	40,902	762	129,344	171,008

(continued)

TABLE 3-3. QUANTITIES OF WASTE MANAGED AT OWR FACILITIES, BY PROCESS AND COMMERCIAL STATUS[a] (continued)

Waste type	Commercial (Mg)	Noncommercial (Mg)	On Site (Mg)	Total (Mg)
Q5_1	35,207	11,714	1,622,216	1,669,137
Q5_2	97,654	1,155	1,395,629	1,494,438
Q5_3	1,198,104	3,696	10,660	1,212,460
Q5_4	139,339	601	162,745	302,685
Q5_5	1,136,392	4,439	3,186	1,144,017
Q5_6	6,719	323	23,610	30,652
Q5_7	64,459	2,490	2,417,021	2,483,969
Q5_8	503,721	144,653	3,683,509	4,331,883
Q5_9	7,968	26,076	283,650	317,694
Q5_10	19,841	270	6,686,798	6,706,908
Q6_1	11,283	7,764	2,954,280	2,973,327
Q6_2	7,392	1,661	67,411	76,463
Q6_3	3,720	577	10,395	14,692
Q6_4	69,718	55	69,125	138,898
Q6_5	7,465	757	142,157	150,379
Q6_6	126,200	1,235	96,970	224,406
Q6_7	2,869,826	1,689,773	55,343,005	59,902,603
Q6_8	2,308,437	333,521	37,620,514	40,262,472
Q6_9	4,580	8,940	596,015	609,535
Q6_10	612,957	73,619	36,745,122	37,431,698
Total[b]	18,999,436	32,352,494	240,510,002	291,861,932

[a] As noted in Section 3.2, the majority of the data used to construct this table come from the TSDR/GENSUR database and reflect waste management patterns in 1986. Regulatory and other changes since 1986 have resulted in significant changes in both the quantities and patterns of hazardous waste management. Thus, the patterns reflected in Tables 3-2 and 3-3 may no longer be accurate. They do reflect the best and most current data available to the Agency.

[b] The totals of these columns do not correspond to the totals shown in Table 2-1 because some of the wastes in 2-1 are not treated at OWR facilities.

Several overall observations should be made about this table. First, the table shows the total quantities of each waste type managed in 1986 at OWR facilities that will be affected by the regulation. Of that quantity, the wastes shown in the first two columns originate off site and are thus subject to the regulation. A share of the waste shown in the third column, derived from the treatment of off-site waste, is also covered by this regulation. Only the treatment of commercial waste, shown in the first column, is traded in the market. The first column thus represents the quantity supplied in each waste management market. Of specified waste types (not counting "other") aqueous waste managed in wastewater treatment is the highest volume category, both for commercial waste management and overall. This is reasonable because aqueous waste is usually relatively dilute and correspondingly high in volume. The second largest quantity of waste managed commercially in 1986 is organic liquids managed in fuel blending.

Historically, more waste is generated and managed on site than is sent off site for management. Because the waste management facilities subject to this regulation are only those that accept waste from off site, this pattern is not true for some of the waste types they manage. For many of the waste types shown in Table 3-3, the largest share of the waste managed at OWR facilities comes from off-site facilities not under the same ownership; that is, it is managed commercially.

3.5 LOCATION OF OWR FACILITIES

OWR facilities are located in 46 states and Puerto Rico. The states with the highest concentration of waste management facilities are California, Ohio, Texas, and Michigan. Table 3-4

TABLE 3-4. LOCATION OF OWR FACILITIES, BY STATE

State	Number	Percent
AK	3	0.41
AL	11	1.52
AR	7	0.97
AZ	10	1.38
CA	74	10.21
CO	2	0.28
CT	22	3.03
DE	2	0.28
FL	13	1.79
GA	13	1.79
HI	3	0.41
IA	8	1.10
ID	2	0.28
IL	33	4.55
IN	26	3.59
KS	6	0.83
KY	16	2.21
LA	17	2.34
MA	10	1.38
MD	9	1.24
MI	31	4.28
MN	14	1.93
MO	17	2.34
MS	6	0.83
MT	2	0.28
NC	17	2.34
ND	1	0.14
NE	1	0.14
NH	1	0.14
NJ	32	4.41
NV	2	0.28
NY	36	4.97
OH	57	7.86
OK	13	1.79
OR	4	0.55
PA	33	4.55
PR	8	1.10
RI	6	0.83
SC	18	2.48
TN	10	1.38
TX	54	7.45
UT	8	1.10
VA	17	2.34
VT	2	0.28
WA	16	2.21
WI	20	2.76
WV	12	1.66
Total	725	100.00

shows the number of facilities located in each state.

Since OWR facilities offer different services, facilities located near one another may not be in the same markets. Likewise, an OWR facility may compete with facilities located a long distance away, if the services offered are similar. Section 4 examines the structure of the markets in which OWR facilities interact.

3.6 FACILITY SIZE

Facility size can be defined in terms of total quantity of waste treated (throughput), number of employees, or total revenues and costs. OWR facilities vary widely in size, no matter which measure is used. This section examines facility size using each definition in turn.

3.6.1 Facility Throughput

Table 3-5 shows the number of OWR facilities in various size categories, defined by facility throughput. OWR facilities responding to the TSDR Survey were asked to list the total quantity of waste managed on site for three "where-was-it-generated" categories:

- waste that was managed on site and was also generated on site,
- waste that was managed on site but was generated off site at a facility under the same ownership as the OWR facility, and
- waste that was managed on site but was generated off site at a facility not under the same ownership as the OWR facility.

Facilities included in the analysis include 710 with data from the TSDR Survey and 15 with data from the CWT Survey. Of these 725 facilities, 721 reported positive quantities treated or recovered on site. These 721 facilities reported total quantities managed on site ranged from a fraction of a metric ton to 89.4 million Mg. As shown in Table 3-5a, only 39 facilities reported managing more than 1 million Mg of hazardous waste in

TABLE 3-5. FACILITY SIZE BY THROUGHPUT

3-5a. Total Quantity of Waste Managed

	Number	Percent
0 Mg or missing response	4	0.6
500 Mg or less	174	24.0
501 to 1,000 Mg	54	7.4
1,001 to 50,000 Mg	332	45.8
50,001 to 1,000,000 Mg	122	16.8
Over 1,000,000 Mg	39	5.4
Total	725	100.0

3-5b. Quantity of Waste Generated on Site and Managed on Site[a]

	Number	Percent
0 Mg or missing response	213	29.4
1 to 100 Mg	123	17.0
101 to 500 Mg	66	9.1
501 to 10,000 Mg	141	19.4
10,000 to 100,000 Mg	93	12.8
Over 100,000 Mg	89	12.3
Total	725	100.0

3-5c. Quantity of Noncommercial Waste Managed at OWR Facilities

	Number	Percent
0 Mg or missing response	351	48.5
1 to 10 Mg	92	12.7
11 to 100 Mg	85	11.7
101 to 500 Mg	59	8.1
501 to 1,000 Mg	19	2.6
Over 1,000 Mg	119	16.4
Total	725	100.0

3-5d. Quantity of Commercial Waste Managed at OWR Facilities

	Number	Percent
0 Mg or missing response	275	37.9
1 to 100 Mg	57	7.9
101 to 500 Mg	73	10.1
501 to 5,000 Mg	129	17.8
5,001 to 10,000 Mg	43	5.9
Over 10,000 Mg	148	20.4
Total	725	100.0

[a] Includes waste generated by manufacturing and waste management.

1986; 178 facilities reported managing less than 500 Mg on site in 1986. Only 54 facilities managed between 501 and 1,000 Mg, while 332 managed between 1,001 and 50,000 Mg.

Of the 725 facilities in the database, 512 report managing some positive quantity of waste that was also generated on site. The quantities of waste generated range from fractions of a Mg to 88.9 million Mg (see Table 3-5a). As described above, many facilities that manage waste from off site also manufacture products at the same site and generate waste in their manufacturing processes. Not all facilities reporting on-site generation are manufacturing sites, however. As noted earlier, most waste treatment processes generate waste in the course of treating it. For example, incineration generates ash; wastewater treatment generates sludge; solvent recovery generates still bottoms. Thus, almost all waste management facilities are also waste generators. Table 3-5b shows the number of facilities managing waste generated on site.

Accepting waste from off-site qualifies facilities for coverage under the regulation. There are two categories of off-site waste:

- off-site waste generated by other facilities under the same ownership as the OWR facility (waste accepted on a noncommercial basis) and
- off-site waste generated by a facility not under the same ownership as the OWR facility (waste accepted on a commercial basis).

Table 3-5c shows numbers of facilities treating various quantities of off-site noncommercial waste, while Table 3-5d shows numbers of facilities treating various quantities of off-site commercial waste. Only 384 facilities report managing positive quantities of off-site waste on a noncommercial basis while 450 facilities manage positive quantities of off-site waste commercially. Overall, facilities tend to manage larger quantities of waste on a commercial basis than on a noncommercial basis.

Quantities of noncommercial waste range from fractions of a Mg to 18.7 million Mg. Many facilities accept only small

quantities of off-site noncommercial waste; 236 of the 374 accept less than 500 Mg, and only 119 facilities manage more than 1,000 Mg of noncommercial off-site waste.

Quantities of commercial waste managed range from a fraction of a Mg to 4.2 million Mg; 148 facilities manage more than 10,000 Mg.

3.6.2 Number of Employees

OWR facilities were asked in the TSDR, GENSUR, and CWT Surveys to list the number of employees they had in several employment categories: waste management, production, administrative, and total. Table 3-6 gives employment information for OWR facilities. For the 551 facilities providing employment data, employment at OWR facilities ranged from one employee to 45,000 employees. Nearly 50 percent of facilities had fewer than 100 employees. Most commercial waste management facilities with no nonwaste-based manufacturing on site have relatively few employees. The facilities with large numbers of employees include manufacturing facilities in the chemicals and refining industries and a Naval base. Frequently, their waste management operations are fairly small. Table 3-6a shows the pattern of total employment at OWR facilities.

TABLE 3-6. EMPLOYMENT AT OWR FACILITIES

3-6a. Total Employment

	Number	Percent
25 or fewer	137	25.2
26 to 100	122	22.4
101 to 500	103	18.9
501 to 1,000	44	8.1
1,001 to 5,000	81	14.9
Over 5,000	57	10.5
Total	544	100.0

3-6b. Waste Management Employment

	Number	Percent
5 or fewer	181	34.0
6 to 10	120	22.5
11 to 20	97	18.2
21 to 100	112	21.0
Over 100	23	4.3
Total	533	100.0

3-6c. Other Employment

	Number	Percent
10 or fewer	113	21.2
11 to 25	61	11.5
26 to 100	88	16.5
101 to 1,000	133	25.2
1,001 to 5,000	81	15.1
Over 5,000	56	10.5
Total	532	100.0

As Table 3-6b indicates, waste management employment is much less than total employment for some facilities. Employment in this category ranges from one to 2,000; 50 percent of facilities have fewer than ten employees and 75 percent have 20 or fewer employees in waste management operations. Other (nonwaste-management) employment varies widely, ranging from zero to 44,991, as Table 3-6c demonstrates. Many OWR facilities specialize in waste management and have relatively few employees in the "other" category. Thus, more than 30 percent of facilities have 25 or fewer nonwaste-management employees, and 50 percent have fewer than 120. At the other end of the spectrum are large manufacturing or federal facilities, for whom waste management is a small share of the total employment. Thus, more than 25 percent of facilities have more than 1,000 "other" employees, and 5 percent have more than 22,000.

In addition to being a measure of facility size, facility-level employment is of interest to the Agency because, if production falls at a facility as a result of a regulation, some of its employees may become unemployed. As residents of the community, these people who are now unemployed would consume fewer goods and services, thereby affecting the economic health of the entire community. Unemployment results in real costs are discussed in Section 6.4.

3.6.3 Facility Revenues

Facility size may also be defined in terms of facility revenues. Facility revenues were estimated for all OWR

facilities with commercial operations by multiplying the quantity of waste managed commercially in each process times the price per Mg for managing waste in that process, and summing across all the commercial processes at the facility. Obviously, facilities may obtain revenues from other sources (manufacturing operations, noncommercial OWR operations), but the Agency has no data on those revenues. Of 725 OWR facilities, 275 have no commercial operations on site and therefore no commercial revenues. For the remaining 450 facilities, estimated OWR commercial revenues range from less than $100 to more than $3 billion. Table 3-7 shows facility revenues from commercial OWR operations.

As shown in Table 3-7, more than 22 percent of OWR facilities have commercial revenues less than $250,000. Approximately 40 percent of facilities have commercial revenues less than $1 million. Approximately 24 percent have revenues between $5 million and $20 million. Only 14 percent have revenues exceeding $20 million.

Revenues are also important in defining company size. Section 4.2 discusses company revenues.

TABLE 3-7. FACILITY COMMERCIAL OWR REVENUES[a]

	Number of facilities	Percent
Less than $250,000	103	22.9
$250,000 to $1 million	88	19.6
$1 million to $5 million	89	19.8
$5 million to $20 million	107	23.8
Over $20 million	63	14.0
Total	450	100.0

[a] 275 OWR facilities have no commercial OWR revenues.

3.7 COMPANY FINANCIAL PROFILE

OWR facilities, which include a site of land with plant and equipment, combine inputs (materials, energy, and labor) to produce outputs (waste treatment services, clean solvents, and residuals). Companies that own the OWR facilities are legal business entities that have the capacity to conduct business transactions and make business decisions that affect the facility. The terms facility, establishment, and plant are synonymous in this analysis and refer to the physical location where waste treatment and disposal services are performed. Likewise, the terms company and firm are synonymous and refer to the legal business entity that owns one or more facilities. Section 3.7.1 of this report describes the data sources used to compile the company financial profile. Following the description of data sources, the population of potentially affected companies is described using three characteristics:

- company size expressed in annual receipts,
- degree of vertical and/or horizontal integration, and
- cost of capital and capital structure.

Each of these characteristics influences how a regulatory action affects firms and how the company-level analysis is approached.

3.7.1 Data Sources

Of the 725 OWR facilities initially identified as affected by the proposed regulation, 61 are owned by government entities and are therefore excluded from the company-level impacts analysis. The Agency identified 406 companies as owners of the remaining 664 OWR facilities. Analysis of the financial impacts of the regulation on these 406 companies using the techniques adopted for this analysis involves comparing these companies' baseline financial statements with Agency projections of their financial statements after the regulation is in place. Income statements and balance sheets are the two basic financial statements kept by firms. The former reports the results of a firm's operation during a period of time--usually 1 year. The latter is a

statement of the financial condition of the firm at a point in time--usually December 31, or the last day of the firm's fiscal year. These sources of data were not available from reliable published sources for all firms included in this analysis.* Data collection efforts for each of the 406 potentially affected companies identified for this analysis correspond to one of the following four approaches:

- Obtain complete (or nearly complete) financial statements from reliable published sources.
- Identify the company's SIC code and obtain a point estimate for the company's level of sales or assets from published sources. Assign a financial health indicator (above average, average, or below average) to each company and construct the company's financial statements using published financial ratios for an "above average," "average," or "below average" company in the corresponding industry (SIC code).
- Identify the company's SIC code and assume that the company's only source of revenue is commercial sales of OWR services at the market prices used for the facility-level analysis. Assign a financial health indicator (above average, average, or below average) to each company and construct the company's financial statements using published financial ratios for an "above average," "average," or "below average" company in the corresponding industry (SIC code).
- Exclude from the company-level impacts analysis because of insufficient knowledge of company finances.

Table 3-8 presents the sources of company-level financial information used in this analysis, the number of firms and associated facilities for which each source was used, and the types of data available from each.

*For a more detailed description of how financial statements were constructed for companies with limited financial information available from published sources, please turn to Appendix D.

Two of the sources identified in Table 3-8, Moody's Industrial Manual[15] and Dun's Market Identifiers,[16] contain complete financial statements for 102 firms. However, two of these firms are excluded from this analysis because they are foreign based and have different accounting practices from U.S. firms. Data gathered through the CWT Survey are sufficient to construct nearly complete financial statements for another 58 firms. Consequently, complete (or nearly complete) financial data are available for only 158 of the potentially affected companies.

Financial statements were constructed using the approach described in Appendix D for another 133 firms using total revenues and/or total assets data available from Ward's Business Directory of U.S. Private and Public Companies[17] and Business America Online.[18]

Company-level data are unavailable for the remaining 113 facilities. However, rough estimates of facility-level revenues for commercial facilities are available from the estimates of baseline quantities and prices described in Section 4.* The remaining 113 facilities include 97 commercial facilities and 16 noncommercial facilities. Financial statements were constructed for the firms that own the 97 commercial facilities using the estimated facility-level revenues and the approach described above. Implicit in the methodology is the assumption that these firms own only one facility and that firm-level revenues equal facility-level waste management revenues. The 16 noncommercial facilities and the firms that own them are not included in the company-level analysis because data on revenues at either the company- or facility-level are unavailable.

The 388 companies evaluated in this analysis include the following:

- 158 for which financial statements were available from published sources,

*The revenue estimates used for these 97 firms were obtained by multiplying estimated waste quantities from the 1986 TSDR/GENSUR-databases times the corresponding average prices for each waste from Table 4-3.

- 133 for which company-level revenues or total assets are used in combination with D&B data to construct financial statements, and
- 97 for which facility-level revenues are used in combination with D&B data to construct financial statements.

The baseline financial profile that follows is based on these 388 companies.

3.7.2 Company Size Distribution

The first characteristic by which companies are described is company size expressed in annual receipts. Firm size is likely to be a factor in the distribution of the regulatory action's financial impacts. Grouping the firms by size facilitates the analysis of small business impacts. Furthermore, reporting the distribution of impacts by size category helps ensure that sensitive, proprietary data are not revealed for an individual firm.

The financial impacts of a regulatory policy depend not only on the size distribution of potentially affected firms but also on the size distribution of the potentially affected facilities owned by these firms. For example, a firm with six uncontrolled facilities with average annual receipts of $1 million per facility may face approximately six times the control capital requirements of a firm with one uncontrolled facility whose receipts total $6 million per year. Alternatively, two firms with the same number of facilities facing approximately the same control capital costs may be affected very differently financially if one firm is significantly larger than the other.

TABLE 3-8. DATA SOURCES

Data source	Firms	Facilities	Type of data
Dun and Bradstreet Dun's Market Identifiers (1993)	2	2	Complete financial statements
Moody's Industrial Manual (1992)	100	240	Complete financial statements
Waste Treatment Industry Questionnaire (EPA, 1989)	58	144	Nearly complete financial statements
Ward's Business Directory of U.S. Private and Public Companies (1993)	86	114	Annual sales or total assets
Business America Online (1993-94)	47	51	Annual sales range, number of employees
Other commercial operations	97	97	Facility level revenues
Other noncommercial operations	16	16	No financial data
Subtotal	406	664	—
Government-owned facilities	—	61	—
Total	406	725	—

Other sources:
Dun & Bradstreet. Industry Norms and Key Business Ratios. New York, Dun & Bradstreet. 1992-1993.
EPA National Computation Center. National Survey of Hazardous Waste Treatment,

TABLE 3-9. SIZE DISTRIBUTION OF POTENTIALLY AFFECTED COMPANIES[19-25]

Company size in annual receipts (10^6)	Number of companies	Total annual receipts (10^6)	Average annual receipts per company (10^6)[a]
<6	110	207	1.9
6 to 60	93	1,882	20.2
60 to 1,000	80	26,319	329.0
Over 1,000	105	1,236,640	11,777.5
Total	388	1,265,049	3,260.4

[a] Computed by dividing total annual receipts by the number of companies.

Potentially affected firms range in size from $100,000 to over $116 billion in annual receipts. Table 3-9 shows the size distribution of potentially affected companies by annual receipts. Firms in the largest receipts category account for approximately 98 percent of receipts for all potentially affected firms. Figure 3-1 shows the size distribution of potentially affected companies in percentage terms. Ninety percent of the (smallest) firms account for only about 20 percent of total annual receipts. Conversely 10 percent of the (largest) firms account for about 80 percent of total annual receipts.

Firms may differ in size for one or both of the following reasons:

- Potentially affected facilities vary widely by receipts. All else being equal, firms with large facilities are larger than firms with small facilities.
- Firms vary in the number of facilities they own. All else being equal, firms with more facilities are larger than those with fewer facilities.

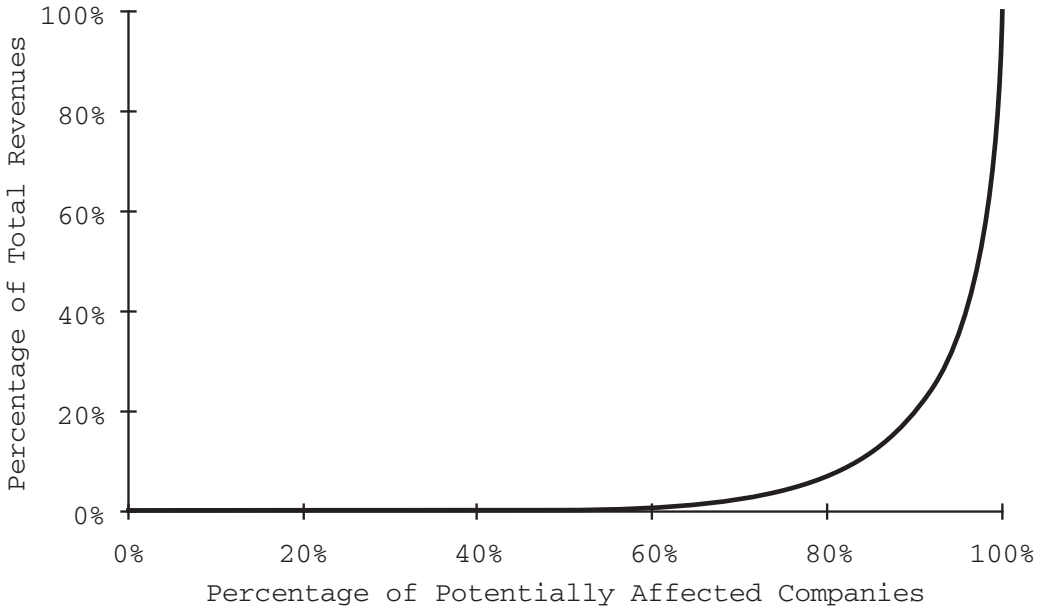

Figure 3-1. Size distribution of potentially affected companies.

Table 3-10 shows the average size OWR facility (measured in annual receipts) represented in each company size category. Two estimates of facility receipts are presented in Table 3-10. The first column of facility receipts corresponds to commercial waste treatment only. The second column corresponds to commercial as well as noncommercial waste treatment. (Note that noncommercial waste treatment is valued using market prices.) On average, large firms own larger facilities based on the measure of facility receipts that reflects both commercial and noncommercial waste treatment. However, most of the output for facilities owned by firms in the largest size category is from noncommercial waste treatment. Consequently, facility receipts from commercial waste treatment decline as firm size increases for firms over $600 million in annual receipts.

Table 3-11 shows the distribution of firms by the number of OWR facilities owned. Over three-fourths of the firms in this analysis own only one OWR facility. Only two firms in the smallest size category own more than one facility, and no firms in the smallest size category own more than two facilities. At the other end of the spectrum, approximately 40 percent of the firms in the largest size category own more than one facility. Firms in the two largest size categories account for over 85 percent of the multi-facility firms in this analysis. Unaffected facilities (facilities that do not perform off-site waste management) are not reflected in the distributions shown in Tables 3-10 and 3-11.

TABLE 3-10. AVERAGE SIZE OF OWR FACILITY BY COMPANY SIZE ($10^{6}/facility)[a,26,27]

Company size in annual receipts ($10^{6})	Commercial operations	Commercial and noncommercial operations
<6	2.9	4.8
6 to 60	12.6	15.9
60 to 1,000	20.9	166.0
Over 1,000	92.4	840.5

TABLE 3-11. DISTRIBUTION OF FIRMS BY NUMBER OF OWR FACILITIES OWNED[28-34]

Company size at baseline by volume of annual receipts (10^6)[a]	Number of facilities owned per firm				Total number of firms in size category	Total number of facilities in size category	Average number of facilities/ firm[b]
	1	2	3	4 or more			
<6	108	2	0	0	110	112	1.02
6 to 60	85	5	0	3	93	121	1.30
60 to 1,000	57	9	4	10	80	171	2.14
Over 1,000	61	18	11	15	105	239	2.28
Total	311	34	15	28	388	643	1.66

3.7.3 Vertical and/or Horizontal Integration

Vertical integration is a potentially important dimension in firm-level impacts analysis because the regulation could affect a vertically integrated firm on several levels. For example, the regulation may affect companies for whom waste treatment is not the company's primary focus but rather is an input into the company's other production processes such as chemical manufacturing. Consequently, vertically integrated companies tend to have proportionately more noncommercial waste treatment services than those for whom waste treatment is their primary business.

Figure 3-2 shows the value of commercial waste treatment services compared to the value of noncommercial waste treatment services for firms in each size category. Noncommercial waste treatment services are valued at market prices for the purposes of comparison. Noncommercial waste treatment services account for more than 90 percent of total waste treatment services in the largest size category compared to approximately 40 percent of total waste treatment services in the smallest size category and 20 percent of total OWR services in the second smallest size category. This difference in the share of noncommercial waste treatment is evidence that larger firms tend to be more vertically integrated than smaller firms. A regulation that increases the cost of waste treatment for vertically integrated firms will also affect the cost of producing the primary products. This cost increase may be reflected in higher prices for the primary products. Horizontal integration is also a potentially important dimension in firm-level impact analysis, because a diversified firm may own facilities in unaffected industries. This type of diversification would help mitigate the financial impacts of the regulation.

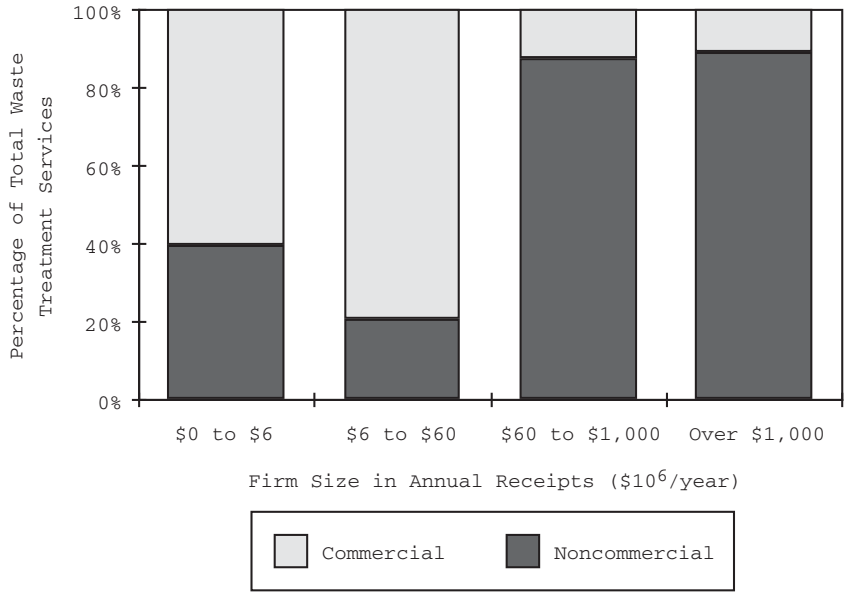

Figure 3-2. Share of commercial versus noncommercial waste treatment services.

Figure 3-3 shows the share of total receipts from business activities other than commercial waste treatment for firms in each receipts size category. Firms in the two largest size categories receive more than 90 percent of their revenues from activities other than waste treatment. As noted above, this high degree of diversification will help mitigate the financial impacts of the regulation for large firms. Firms with $6 million to $60 million in annual receipts receive approximately 75 percent of their receipts from waste treatment, and firms in the smallest size category receive less than 20 percent of their revenues from activities other than waste treatment. Consequently, smaller firms are likely to be more directly affected by the regulation because a higher proportion of their revenues are from waste treatment.

3.7.4 Cost of Capital and Capital Structure

A firm's cost of capital and its capital financing policy will potentially affect the firm-level responses to the regulation and the magnitude of the financial impacts associated with those responses. This section presents a framework for estimating the

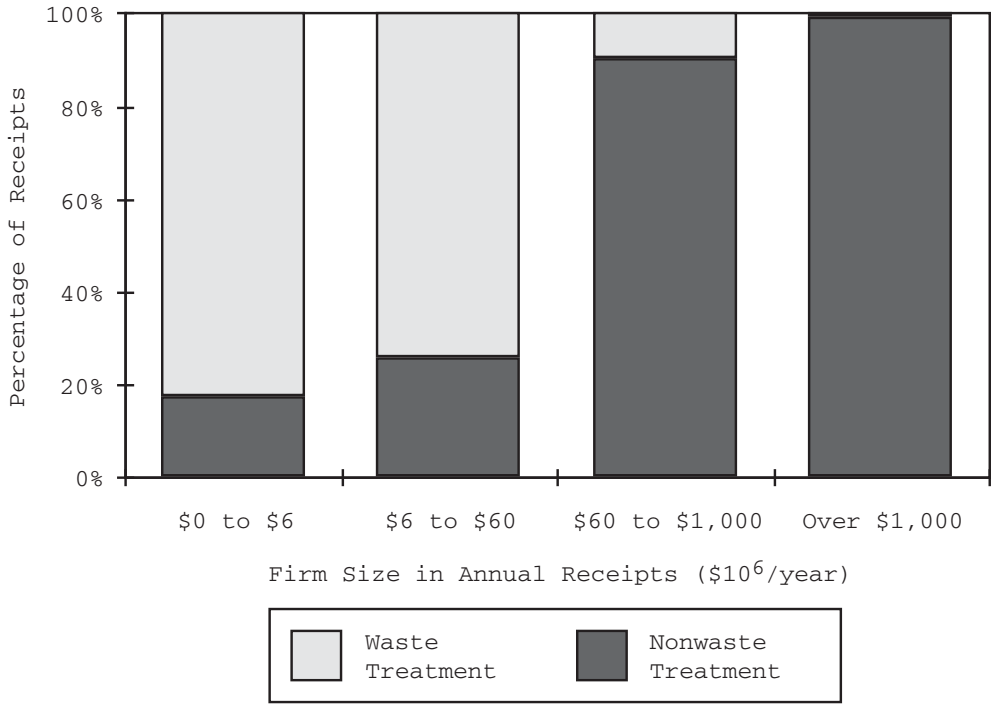

Figure 3-3. Share of total receipts from waste treatment and all other activities.

firm-specific cost of capital used to evaluate investment decisions and a description of capital structure employed by potentially affected firms.

In making investments, companies generally use two sources of funds: equity and debt. Each source differs in its exposure to risk, its taxation, and its cost. Equity financing involves obtaining additional funds from owners: proprietors, partners, or shareholders. Partners and shareholders, in turn, can be existing owners or new owners. Obtaining new capital from existing owners can be further dichotomized into internal and external financing. Using retained earnings is equivalent to internal equity financing. Obtaining additional capital from the proprietor, one or more existing partners, or existing shareholders constitutes external equity financing. Debt financing involves obtaining additional funds from lenders who are not owners; they include buyers of bonds, banks, or other lending institutions.

EPA's CWT Survey contains firm-specific data on the cost of capital used to evaluate investments in pollution control equipment for a portion of the firms included in this analysis.[35] To estimate the cost of capital for the remaining firms, the weighted average costs of equity and debt financing (after tax) were computed using information from firms' financial statements and assumptions grounded in financial theory. The cost of debt financing was estimated for these firms using the following equation:

$$WACC = W_d(1-t)\bullet K_d + W_e\bullet K_e, \qquad (3-1)$$

where

WACC = weighted average cost of capital

W_d = weighting factor on debt

t = marginal effective State and Federal corporate tax rate averaged for U.S. firms

K_d = the cost of debt or interest rate

W_e = weighting factor on equity.

K_e = cost (required rate of return) of equity

This formula implicitly assumes that investments in pollution control equipment are similar in risk to other projects that the company has taken or is considering. In addition, the formula assumes that the method of financing for control equipment is similar to other investments by the firm.

To estimate the WACC, first values for K_d and K_e were estimated. All else being equal, the cost of both debt and equity capital is generally higher for firms in below-average financial condition than for firms in above-average financial condition. This analysis estimated the cost of debt for firms in above-average, average, and below-average financial health categories to be 8.29 percent, 9.16 percent, and 12.91 percent, respectively. However, because debt interest payments are deductible for State and Federal income tax purposes, a more meaningful measure of the cost of debt financing is the after-tax cost of debt capital. The after-tax debt costs used in this analysis for firms in three different financial health conditions are

- 5.78 percent for firms in above-average financial condition,
- 6.38 percent for firms in average financial condition, and
- 9.00 percent for firms in below-average financial condition.

The Agency used the Capital Asset Pricing Model described in detail in Appendix E, and assumptions based on data obtained from the literature to estimate the cost of equity capital for firms in each of three financial conditions. The following equity capital costs were chosen as most appropriate:

- 14.57 percent for firms in above-average financial condition,
- 15.96 percent for firms in average financial condition, and
- 19.88 percent for firms in below-average financial condition.

Next, the weighting factors for debt (W_d) and equity (W_e) were calculated for each company. These weights reflect the share of firm assets that are financed with debt and equity. The theoretically correct weights are target weights rather than historical weights. Target weights reflect individual firms'

TABLE 3-12. SUMMARY STATISTICS BY FIRM SIZE CATEGORY OF WEIGHTING FACTORS FOR DEBT USED TO CALCULATE FIRMS' BASELINE WACC[36-43]

	Company size in annual receipts (10^6/year)			
	$0 to $6	$6 to $60	$60 to $1,000	Over $1,000
Number of observations	110	93	80	105
Mean	0.2751	0.2977	0.2888	0.3945
Standard deviation	0.1554	0.188	0.2082	0.1986
Quartiles				
Upper	0.3364	0.375	0.3823	0.5317
Median	0.2745	0.2679	0.2682	0.379

subjective preferences in the tradeoff between the tax advantages of debt financing vs. the financial distress costs associated with higher levels of debt.* For this analysis the Agency assumed that the capital structure witnessed for firms at baseline approximates their target or optimal capital structure and that firms minimize their cost of capital at baseline. Furthermore, it was assumed that book-value weights approximate market-value weights in instances where market value weights are not available.

Table 3-12 summarizes the capital structure of potentially affected firms in this analysis. The debt-to-firm-value ratios summarized in Table 3-13 are the weighting factors for debt (W_d) used to compute the WACC. The equity weighting factors are simply 1 - W_d. Some of the potentially affected firms in this analysis have a W_d greater than 100 percent, indicating that the book value of equity is actually negative. It was assumed that the correct W_d for these firms is 0 percent, reflecting the assumption that the debtholders are, in effect, the owners of the firm. Consequently, the required return is equal to K_e with W_e at 100 percent.

A real (inflation-adjusted) cost of capital is desired, so employing the gross national product (GNP) implicit price deflator for the 10-year period 1983 to 1992 adjusts nominal rates to real rates. Using an adjustment factor of 3.72 percent assumes that the inflation premium on real rates is the actual rate of inflation averaged over the last 10 years.[44] Table 3-13 summarizes

*See Appendix E for a more detailed discussion of a firm's optimal capital structure.

TABLE 3-13. SUMMARY STATISTICS BY FIRM SIZE CATEGORY OF FIRMS' BASELINE WACC[45-52]

	Company size in annual receipts (10^6/year)			
	$0 to $6	$6 to $60	$60 to $1,000	Over $1,000
Number of observations	110	93	80	105
Mean	0.0988	0.0968	0.0904	0.083
Standard deviation	0.0194	0.0178	0.0186	0.0185
Quartiles				
Upper	0.103	0.103	0.1015	0.0932
Median	0.0963	0.0955	0.0926	0.0822
Lower	0.0875	0.0869	0.0816	0.0687

the baseline WACC for potentially affected firms as reported in the CWT Survey or estimated as described above.

SECTION 4
DEVELOPMENT OF THE OWR INDUSTRY BASELINE

Estimating the impacts of the regulatory alternatives on the OWR facilities managing the 60 waste types introduced in Section 2 of this report requires detailed information about the quantity of individual types of waste that are treated at each OWR facility, as well as an understanding of how the average costs of treating different types of waste may vary.

Much of the waste managed at some OWR facilities is either generated on site or is generated at off-site facilities owned by the same company as the OWR facility. For several reasons, EPA chose to analyze the impacts of the regulatory alternatives on commercial OWR activities separately from its analysis of impacts on noncommercial OWR services. Many companies owning OWR facilities treating off-site noncommercial waste may elect to continue treating those wastes regardless of the profitability of their commercial waste management operations (if any) and the increased costs of treating the off-site noncommercial wastes. Also, facilities may or may not receive revenue for managing noncommercial waste. Thus, although the analysis of impacts on commercial OWR services estimates impacts for each facility managing off-site waste commercially, the increased costs of noncommercial OWR services were assumed to be felt by the company as a whole. Most of the computations described in this section were performed for all affected facilities.

This section profiles baseline conditions at the facility level, market level, and the company level.

4.1 BASELINE FACILITY CONDITIONS

Baseline conditions at the facility level can be characterized in terms of the quantity of specific waste types managed at each OWR facility, the costs associated with treating or disposing of each waste type managed, and the market prices charged for each management service provided commercially.

4.1.1 Estimating Baseline Quantities

Three sources of information were used to estimate the baseline quantity of individual waste types managed at affected OWR facilities. Baseline quantities managed at the 710 RCRA-regulated facilities were estimated by combining information from the TSDR and GENSUR Surveys. As described in Section 2 of this report, the TSDR Survey provides the total quantity of waste managed commercially and noncommercially in each treatment process at each facility but does not provide any information on the characteristics of specific waste streams managed in each process. The GENSUR, on the other hand, offers a detailed characterization of wastes generated in 1986 and identifies the quantity of each waste sent off site for management. The GENSUR also asks generators to identify the OWR facilities to which each waste stream was sent as well as for the generators' best guess of which treatment, recovery, or disposal processes would be used to manage each waste stream at the destination OWR facility.

The Agency employed a very elaborate approach (described in great detail in Appendix F) to combine useful information from both surveys to prepare its best estimate of the quantity of each of the 60 waste types described in Section 2 that was managed, commercially and noncommercially, at each OWR facility. In this approach, the Agency used waste form information from the GENSUR to disaggregate the total process quantities reported in the TSDR Survey into different waste types based on composition. Table 4-1

TABLE 4-1. ESTIMATED AGGREGATE QUANTITIES OF EACH WASTE FORM PROCESSED IN EACH TREATMENT CATEGORY BY THE 710 OWRs THAT RESPONDED TO THE TSDR SURVEY (Mg)

Process	Form 1	Form 2	Form 3	Form 4	Form 5	Form 6	Total
Q1	1,702,201	907,625	1,449,173	2,546,803	1,669,137	2,973,327	11,248,266
Q2	12,548	20,887	193,023	516,336	1,494,438	76,463	2,313,695
Q3	436	17,404	23,726	1,474,160	1,212,459	14,692	2,742,877
Q4	102,299	236,395	146,897	167,743	302,685	138,899	1,094,918
Q5	4,504	4,946	42,380	1,635,969	1,144,017	150,379	2,982,195
Q6	413,656	130,628	188,821	24,890	30,651	224,405	1,013,051
Q7	197,312	2,300,764	56,502,062	5,562,605	2,483,969	59,902,603	126,949,315
Q8	9,754,040	9,441,337	1,203,394	768,480	4,331,883	40,262,473	65,761,606
Q9	86	4,234	1,894,638	18,248	317,694	609,535	2,844,435
Q10	358,023	211,342	4,985,376	171,007	6,706,910	37,431,697	49,864,355
Total	12,545,105	13,275,561	66,629,490	12,886,241	19,693,843	141,784,473	266,814,713

presents these estimates for the 710 RCRA-regulated OWR facilities. Figure 4-1 presents the same information graphically. Approximately half of the 266,814,713 Mg of waste that was reportedly managed in regulated processes at affected RCRA-regulated OWR facilities was managed using wastewater treatment (process Q7) and about a quarter was managed in OWR facility landfills (process Q8).

All waste quantity information for the 15 non-RCRA wastewater treatment OWR facilities was obtained from the 1989 CWT Survey conducted by EPA's Office of Water. These facilities manage an estimated 22,067,009 Mg of waste from off site annually. The Agency assumes that all of this waste is of Form 3 and is managed in wastewater treatment (process Q7).

4.1.2 Estimating Baseline Costs

Process-specific waste management costs were estimated using production and cost functions developed by Research Triangle Institute (RTI) and published in A Profile of the Market for Hazardous Waste Management Services for EPA's Office of Air Quality Planning and Standards. The waste treatment categories for which production and cost functions were developed include rotary kiln/hearth incineration, chemical precipitation, chemical stabilization/fixation, steam stripping, and landfills. Using these functions, the Agency estimates baseline cost per Mg of treatment that vary with the quantity treated. Appendix G provides a more detailed description of these production and cost functions and their use in estimating costs per Mg for each process at each OWR facility.

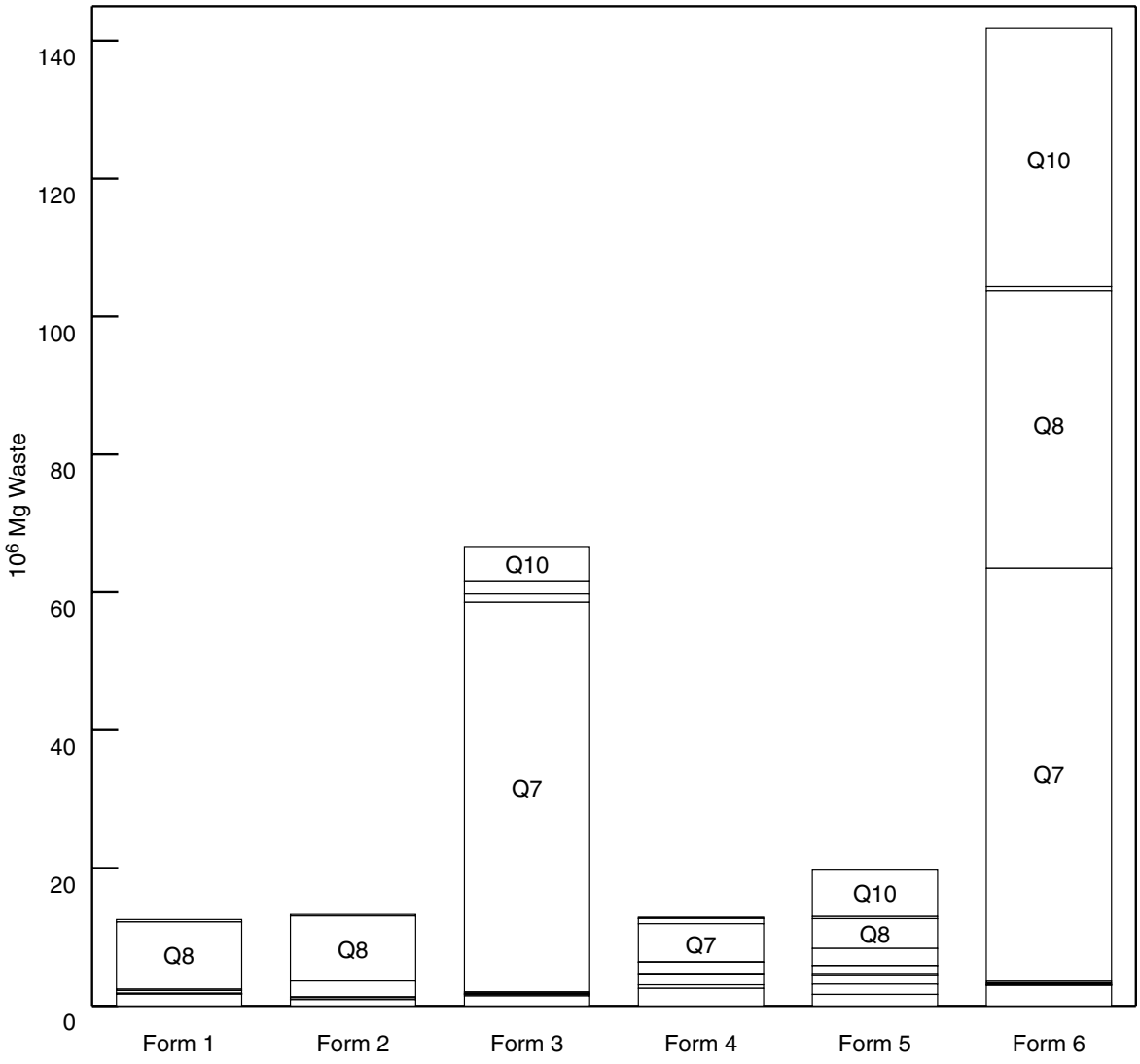

Figure 4-1. Treatment categories most commonly used to manage each waste form.

TABLE 4-2. MODEL PROCESSES USED TO ESTIMATE COSTS

OWR treatment category		Process used for input factor quantity and cost estimation
Q1	Incineration	Rotary kiln/hearth incineration
Q2	Reuse as fuel	Rotary kiln/hearth incineration without fuel as a required input[a]
Q3	Fuel blending	Chemical precipitation without chemicals as required inputs[b]
Q4	Solidification	Chemical stabilization/fixation
Q5	Solvent recovery	Steam stripping
Q6	Metals recovery	Chemical precipitation with doubled lime and polymer requirements[c]
Q7	Wastewater treatment	Chemical precipitation
Q8	Landfills	Landfills
Q9	Underground injection	Underground injection
Q10	Other	Average unit costs of all other processes

[a] Fuel is omitted from the list of input factors because the wastes managed in this process have a high enough Btu content to fuel the kiln or furnace.

[b] A production function specifically for fuel blending was not available. Fuel blending generally involves storage tanks with mixing and transfer capabilities. If chemicals are not included, the remaining input requirements of labor, electricity, water, and indirect operation and maintenance (O&M) are roughly comparable to a chemical precipitation process.

[c] The greater the concentration of the waste stream processed, the greater the chemical requirements for chemical precipitation.

Table 4-2 identifies which of these production and cost functions was used to estimate costs for each of the 10 OWR treatment processes affected by the proposed regulation. Each production function was used to estimate the quantity of each management process input that is required to treat, recover, or dispose of 1 Mg of waste; the required input quantity per unit of waste throughput as specified as a function of the waste volume managed. The Agency has limited information about how the required quantity of each input to a given treatment process may vary across each of the six waste forms potentially managed in the given process. Because of these data limitations, the Agency used a single production function to estimate input requirements for each waste form managed in each treatment process at each facility. The estimated quantity of each required input to a given treatment process will vary across each waste form managed in the process, because the input requirements are estimated as a function of the quantity managed. Input requirements for individual waste forms were estimated separately for each treatment process, based on the volume of each waste form managed in each process.

After identifying the input quantities needed to manage 1 Mg of each waste form in each process at a given OWR facility, the Agency calculates the average variable cost per Mg of each waste type managed at the facility by multiplying the relevant input quantities by mid-year 1991 input factor prices for each input to the process, and then summing across all process inputs. Total variable costs of managing each of the 60 waste types at each facility were calculated by multiplying the estimated cost per Mg by the facility's total throughput volume (Mg) of the corresponding waste type.

4.1.3 Estimating Baseline Prices

For this analysis, the Agency grouped the 27,000 OWR transactions identified from the 1986 GENSUR and TSDR Surveys into 60 competitive markets for OWR services. Modeling the OWR industry as a competitive market assumes that individual

facilities are price-takers not price-setters. Each waste type (waste form-treatment category combination) was assumed to be a homogeneous service with a single market price. Thus the Agency selected 60 market prices for the 60 waste types defined in this analysis. This simplifying assumption recognizes the competitive forces at work in the OWR industry but doesn't account for the complexity of actual operations at OWR facilities. In fact, OWR facilities may set prices on a batch-by-batch basis, based on the characteristics of each batch accepted, such as the following:

- concentration (percentage of solids),
- percentage of oil,
- percentage of total organic carbon,
- content of various metals, and
- Btu content.

In addition, the per-batch price of a given waste type may vary based on the way it is packaged upon delivery to the OWR facility. For example, a batch of waste of a given volume and constituent make-up will generally be accepted at a somewhat lower price if it is delivered to an OWR facility in bulk form aboard a tanker or a dump-truck, than if it is packaged in 55 gallon drums. A batch will be accepted at an even higher price per megagram if it is delivered as the residue left in "empty" 5 or 1 gallon containers, as lab-packs, or in small vials. The market prices chosen for this analysis reflect the prices of managing representative wastes when delivered in bulk form.

Therefore, although all wastes of a given waste type are similar, enough difference in the constituent make-up within each market exists that a wide range of competitive prices may actually be charged for managing wastes treated here as homogeneous. The price information that was available from the TSDR Survey was found to be incorrect, either because it had never been satisfactorily verified or because prices have changed considerably since 1986.

To estimate the "market price" for waste management in each of the 60 markets, the Agency performed a statistical comparison of all wastes managed in each of the 60 OWR markets in terms of

the constituent characteristics listed above. The Agency then identified a model waste for 48 of the 60 markets and asked several OWR facilities how much they would charge to accept each of the model wastes that they are equipped to manage.[53] Interpretation of the responses received from industry representatives was the basis for choosing market prices for the six waste forms managed in each of the following processes:

- incineration,
- reuse as fuel,
- fuel blending,
- solidification/stabilization,
- solvent recovery,
- metals recovery,
- wastewater treatment, and
- landfills.

The estimated market prices for each of the waste forms managed with underground injection were determined by setting the market price of managing each waste form equal to the estimated unit cost of the highest cost facility in operation at baseline. The market prices for managing each of the six waste forms with "other treatments" were estimated by averaging the chosen market prices for managing the corresponding waste form in the other nine processes.

In simplifying the complex pricing mechanism at work in this industry to a single market price per Mg for each of the 60 OWR services, the Agency recognizes that the analysis may be understating the waste management revenues (and costs) of facilities that accept wastes not delivered in bulk form. EPA also may over- or underestimate revenues from waste management at facilities that specialize in treating wastes that differ significantly from our model wastes. Table 4-3

TABLE 4-3. ESTIMATED MARKET PRICES FOR MANAGEMENT OF 60 WASTE TYPES PROFILED

Waste type	Market price($/Mg)
Incinerated wastes	
p1_1	3,528.00
p2_1	3,528.00
p3_1	2,072.00
p4_1	2,072.00
p5_1	3,528.00
p6_1	3,528.00
Wastes reused as fuel	
p1_2	1,654.00
p2_2	1,830.00
p3_2	1,047.00
p4_2	331.00
p5_2	1,654.00
p6_2	1,830.00
Wastes blended for fuel	
p1_3	64.00
p2_3	64.00
p3_3	1,047.00
p4_3	331.00
p5_3	195.00
p6_3	191.00
Solidified wastes	
p1_4	388.00
p2_4	388.00
p3_4	388.00
p4_4	682.00
p5_4	682.00
p6_4	682.00
Wastes managed in solvent recovery	
p1_5	275.00
p2_5	240.00
p3_5	1,047.00
p4_5	928.00
p5_5	933.00
p6_5	268.00

(continued)

TABLE 4-3. ESTIMATED MARKET PRICES FOR MANAGEMENT OF 60 WASTE TYPES PROFILED (continued)

Waste type	Market price($/Mg)
Wastes managed in metals recovery	
p1_6	495.00
p2_6	426.00
p3_6	550.00
p4_6	125.00
p5_6	880.00
p6_6	125.00
Wastes managed in wastewater treatment	
p1_7	817.00
p2_7	555.00
p3_7	211.00
p4_7	206.00
p5_7	1,654.00
p6_7	1,276.00
Wastes landfilled	
p1_8	251.00
p2_8	303.00
p3_8	481.00
p4_8	550.00
p5_8	550.00
p6_8	661.00
Underground injected wastes	
p1_9	8.28
p2_9	7.03
p3_9	8.52
p4_9	8.75
p5_9	8.75
p6_9	8.52
Wastes managed with other types of treatment	
p_110	1,015.00
p_210	1,028.00
p_310	768.00
p_410	672.00
p_510	1,289.00
p_610	1,225.00

lists the selected market prices for management of each of the 60 waste types modeled in this analysis.

4.2 BASELINE COMPANY FINANCIAL CONDITIONS

Several firms in this analysis reported very low earnings or net losses for the period 1987 through 1991. Factors that may contribute to this poor performance include the following:

- a changing regulatory environment, including regulations affecting hazardous waste generators as well as regulations affecting waste treaters;
- uneven demand patterns due to recessionary pressures that resulted in less waste generation and delay in cleanup activities;
- increased source reduction and recycling;
- uncertainty regarding costs; and
- new competitive forces in the industry, including the threat of entry by large generators and other nontraditional players.[54]

According to a recent Standard and Poor's report, the industry's overall credit quality has improved in the last few years, and the industry is expected to rebound.[55] This analysis evaluated the baseline financial status using data from the firm's financial statements reported for the period 1989 through 1992. Consequently, potentially affected firms are likely to be in better baseline financial condition than this analysis indicates.

Baseline financial condition was evaluated using financial ratio analysis. Financial ratio analysis is a widely accepted way of summarizing the financial condition of a firm using statistics reported on the firm's financial statements. In addition, the financial failure was predicted using a multidiscriminant function called the Z-score.[56] The Z-score is a measure used to assess bankruptcy potential developed specifically for manufacturing firms.

4.2.1 Financial Ratio Analysis

Financial ratios are computed using data contained in company financial statements. As mentioned in Section 3.7.1, authentic financial statements were available from reliable published sources for only 158 of the companies included in this company-level impacts analysis. The financial statement data used for each of the remaining 230 potentially affected firms were constructed from a single point estimate of the target company's level of sales (or in some cases assets) and published financial ratios of the "statistically typical" company in each of three financial health categories (above average = 75th percentile, average = median, or below average = 25th percentile) for the target firm's SIC code. Each of these 230 firms was assigned to its financial health category at random, in such a way as to have a realistic distribution of firms in each of the financial health categories for each SIC code, but not necessarily to have an accurate assessment of each firm's financial health. Thus, for over half of the companies for which impacts are assessed in this analysis, the Agency is using baseline financial data that, while not accurate for individual firms, are representative of actual baseline financial conditions among firms potentially affected by the regulation.

The five fundamental types of financial ratios each address a specific component of a firm's financial well-being. The five areas of company finances for which financial ratios are most commonly used are the following:

- liquidity: the ability of a firm to meet its near-term financial obligations as they come due;
- asset management: the efficiency with which a firm uses its resources to generate revenues;
- debt management: the degree to which a firm uses debt (vs. equity) to finance its operations;
- profitability: comprehensive measures of firm operating efficiency that compare a firm's net income (profits or losses) to other financial stocks (such as assets or equity) or flows (such as annual sales) that result from

the interplay of the firm's historical liquidity, asset management, and debt management decisions; and

- market value: a comparison of measures of a firm's past performance (book value) with indicators of investors' expectations of its potential for future cash flows (market value).

The first three types of financial ratios listed are ambiguous indicators of a firm's overall financial well-being. They are difficult to interpret when considered in isolation of other indicators of financial health. Potential creditors, for example, might offer preferential credit to a firm with a low debt-to-total-assets ratio (one of the more common debt management ratios), while a potential stockholder might prefer a higher value for that same ratio, in expectation of greater returns on his investment due to the tax advantages of debt financing. Profitability ratios and market value ratios, on the other hand, are much clearer indicators of a firm's financial health. Higher values for profitability ratios are unambiguously preferred over lower values. For this reason, the Agency has limited its analysis of individual financial ratios to profitability and market-value ratios. The Agency has also investigated a composite measure of financial condition, called the Z-score, which simultaneously addresses firm liquidity, asset management, debt management, profitability, and market value to provide a discrete indicator of firms' financial viability. Section 4.2.2 discusses the baseline analysis of affected firms' Z-scores.

The analysis evaluates the baseline financial status of potentially affected firms by comparing the firms' financial ratios with specific industry benchmark ratios such as those reported in Dun & Bradstreet's Industry Norms and Key Business Ratios. Tables H-1 and H-2 in Appendix H contain the benchmark ratios for profitability (by SIC code) used to evaluate the financial condition of potentially affected firms. Where specific industry benchmarks are not available, benchmarks reported for SIC 4953, Refuse Systems, were used.

The firms evaluated for this analysis are larger on average than those used to compute the benchmark ratios reported in Tables H-1 and H-2. Although most financial ratios are generally insensitive to differences in size, some industry ratios may not represent appropriate benchmarks for evaluation because of the size differences. In addition, SIC 4953 (the default industry classification) represents firms involved in waste disposal, sewage treatment and disposal, and other waste treatment processes not directly affected by the OWR regulation. Notwithstanding these qualifications, an evaluation of the baseline financial condition of potentially affected firms is useful. In particular, a comparison of the baseline ratios and the "with-regulation" ratios may provide insight into the financial impacts of the regulation.

4.2.1.1 Profitability. Profitability is the most comprehensive measure of the firm's performance because it measures the combined effects of liquidity, asset management, and debt management. Several ratios are commonly used to measure profitability, including return on sales (ROS), return on equity (ROE), and return on assets (ROA). For all these measures, higher values are unambiguously preferred over lower values.

ROS, computed by dividing net income or net loss by annual sales, shows the operating efficiency of the firm. Negative values result if the firm experiences a loss. Median ROS values

reported in Table 4-4 range from a 3.2 to 5.5 percent. Mean ROS values range from -21 percent to 4.1 percent. Under both measures, firms in the smallest size category have the highest ROS. The mean profit-to-sales ratio is lower than the median for all four firm size categories, and for very large firms the difference is substantial. This substantial difference indicates that the distribution contains one or more outlier firms with very negative ROS values. Consequently, the median is a better measure of central tendency.

TABLE 4-4. BASELINE FINANCIAL RATIO: RETURN ON SALES[57-64]

	Firm size in annual receipts (10^6/year)			
Statistic	$0 to $6	$6 to $60	$60 to $1,000	Over $1,000
Number of observations	110	93	80	105
Mean (percent)	4.1	-12.0	-21.40	0.04
Standard deviation (percentage points)	18.2	66.0	132.00	25.10
Quartiles (percent)				
Upper	6.7	6.7	5.85	5.90
Median	5.5	3.3	3.20	3.50
Lower	2.1	1.3	0.40	-0.40

Notes:
1. The ROS ratio is a measure of a firm's profitability and is computed by dividing net income by sales revenue. A value of 10 percent indicates that net income is equal to 10 percent of sales. Negative values indicate net losses.

Figure 4-2 compares the ROS values computed for potentially affected firms with industry-specific benchmark (median and lower quartile) values. Approximately 60 to 70 percent of firms in all size categories have ROS ratios that are equal to or below the industry median benchmarks. Firms in the two smallest size categories performed slightly better than firms in the larger size categories.

The second profitability ratio referred to above, ROE, is computed by dividing net income or loss by owners' equity and

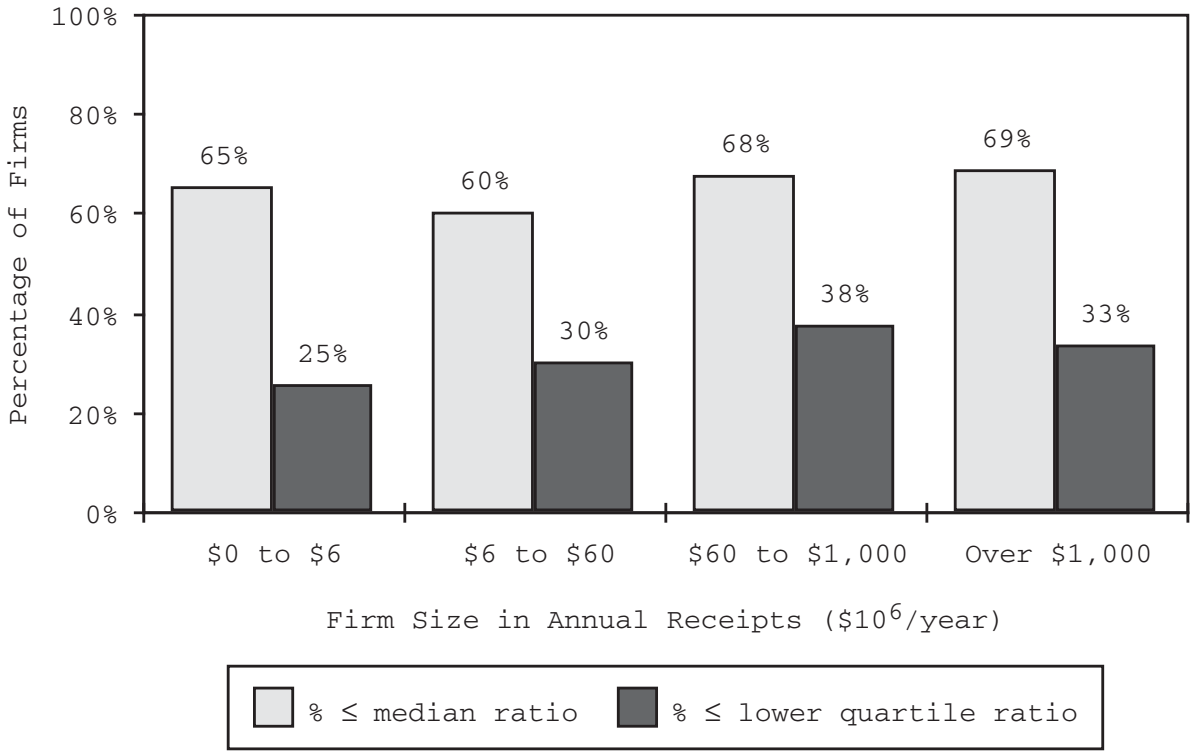

Figure 4-2. Percentage of firms equal to or below the industry benchmark ratio: return on sales.

1. The ROS ratio is a measure of a firm's profitability. It is the ratio of a company's net income to its total sales, expressed as a percentage. For example, a value of 6.5 indicates that a company's net income is equal to 6.5 percent of its total sales. A high ROS value is preferable to a lower value.

2. Each company's ROS ratio is compared to the Dun & Bradstreet published median and lower quartile benchmarks for companies sharing the same SIC code. If the SIC code is not known, the company ratio is compared to the

measures the return on capital invested by the owners of the firm. Table 4-5 reports a statistical summary of ROE values for potentially affected firms in each size category. Median values range from 9.5 to 22.4 percent. Mean values are much more variable and range from -61.4 percent to a +41.9 percent. Again, the presence of outliers makes the median values the preferred measure.

TABLE 4-5. BASELINE FINANCIAL RATIO: RETURN ON EQUITY[65-72]

	Firm size in annual receipts (10^6/year)			
Statistic	$0 to $6	$6 to $60	$60 to $1,000	Over $1,000
Number of observations	109	92	77	104
Mean (percent)	41.9	-61.4	-55.9	2.1
Standard deviation (percentage points)	236.4	323.8	341.2	61.2
Quartiles (percent)				
Upper	25.8	25.5	17.2	15.4
Median	20.4	14.4	9.5	9.9
Lower	7.6	5.1	1.2	1.2

Notes:1. The ROE ratio is a measure of a firm's profitability and is computed by dividing net income by the owners' equity. A value of 20 percent indicates that net income is equal to 20 percent of the owners' equity. Negative values indicate net losses.

2. High ratios indicate that the firm is operating efficiently.

Figure 4-3 shows the share of firms with ROE values equal to or below the industry median benchmark and the industry lower quartile benchmark values. Approximately 40 percent of the firms in the two smallest size categories have ROE values equal to or below the industry median benchmark. Larger firms are not performing as well with 66 to 78 percent equal to or below the industry benchmark.

ROA, the final measure of profitability, is net profit or loss divided by total assets. ROA measures how efficiently a firm is using its assets to earn a return. Table 4-6 reports the distribution of ROA values for potentially affected firms. Median values range from 3.5 for firms in the largest size category to

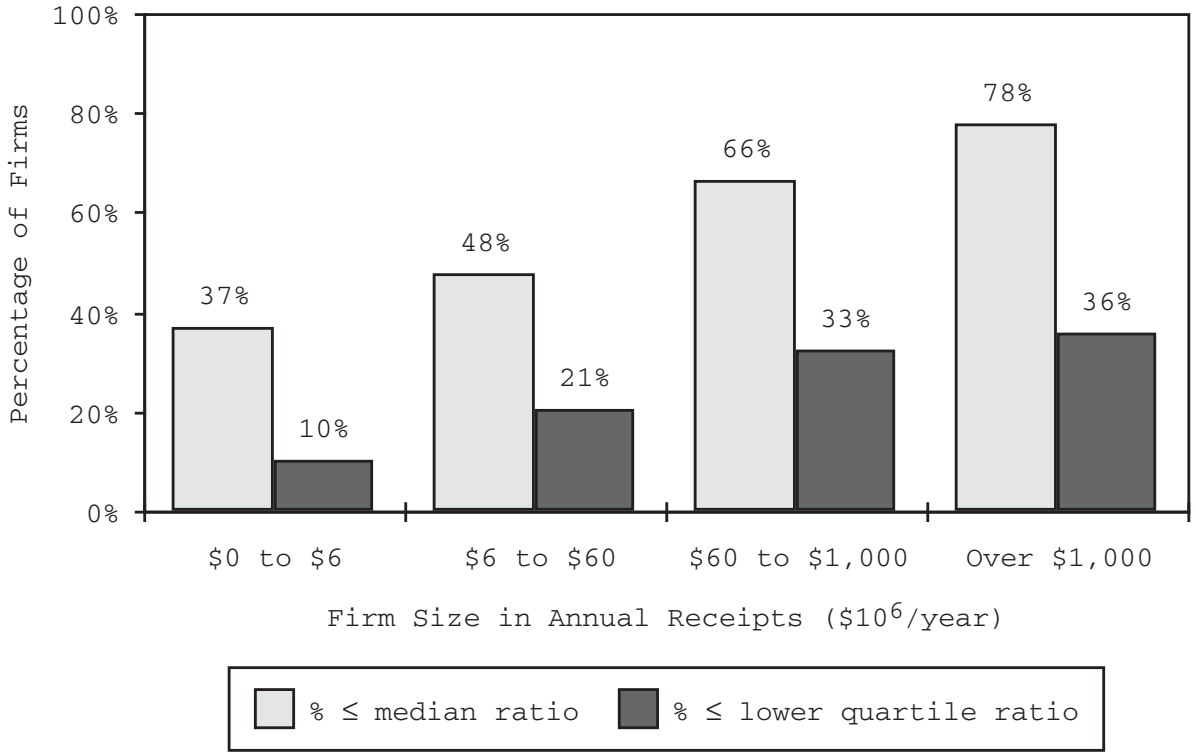

Figure 4-3. Percentage of firms equal to or below the industry benchmark ratio: return on equity.

TABLE 4-6. BASELINE FINANCIAL RATIO: RETURN ON ASSETS[73-80]

Statistic	Firm size in annual receipts (10^6/year) $0 to $6	$6 to $60	$60 to $1,000	Over $1,000
Number of observations	110	93	80	105
Mean (percent)	13.1	-6.4	-11.1	1.1
Standard deviation (percentage points)	35.6	64.5	63.8	20.9
Quartiles (percent)				
Upper	17.1	12.7	10.1	6.4
Median	11.0	7.3	5.8	3.5
Lower	2.6	1.8	0.5	-0.6

Notes:
1. The ROA ratio is a measure of a firm's profitability and is computed by dividing net income by total assets. A value of 15 percent indicates that net income is equal to 15 percent of total assets. Negative values indicate net losses.

2. High ratios indicate that the firm is operating efficiently.

1. The ROE ratio is a measure of a company's profitability. It is the ratio of a company's net income to its total net worth, expressed as a percentage. For example, a value of 3.9 indicates that a company's net income is equal to 3.9 percent of its total net worth. A high ROE value is preferable to a lower value.

2. Each company's ROE ratio is compared to the Dun & Bradstreet published median and lower quartile benchmarks for companies sharing the same SIC code. If the SIC code is not known, the company ratio is compared to the benchmark ratios for SIC code 4953: Refuse Systems.

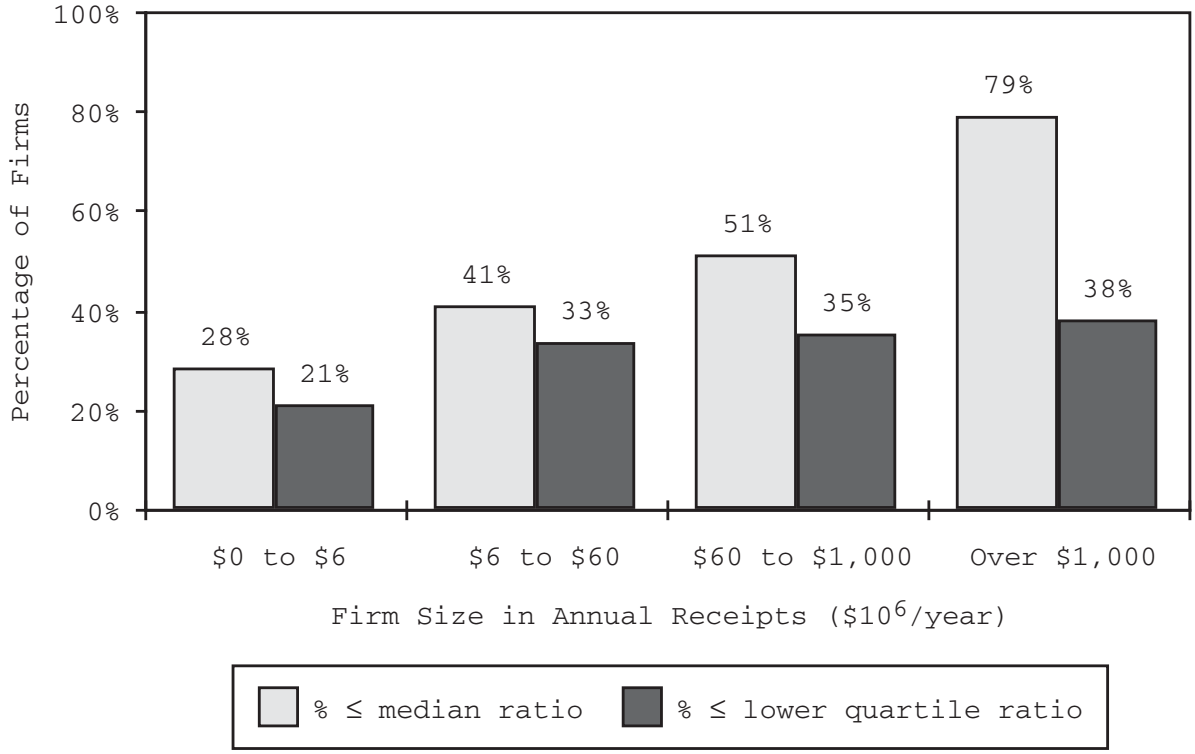

Figure 4-4. Percentage of firms equal to or below the industry benchmark ratio: return on assets.

11 percent for firms in the smallest size category. Figure 4-4 shows the share of firms performing equal to or below the industry benchmarks for ROA. Again, a higher proportion of large firms is below the benchmark, indicating that small firms appear to be performing better on average than large firms.

4.2.1.2 Market Value. Market value ratios indicate investors' expectations regarding the firm's past performance and future cash flows. Generally, if a firm's financial ratios in each of the other four categories of performance are good, then the market value ratios will also be good. The market-value-of-equity to book-value-of-equity ratios are particularly useful for evaluating investors' expectations. Market-to-book ratios less than one clearly indicate that investors believe the firm's value is deteriorating. Conversely, ratios greater than one indicate that investors believe that the firm's operations are adding value to the firm.

1. The ROA ratio is a measure of a company's profitability. It is the ratio of a company's net income to its total assets, expressed as a percentage. For example, a value of 4.3 indicates that a company's net income is equal to 4.3 percent of its total assets. A high ROA value is preferable to a lower value.

2. Each company's ROA ratio is compared to the Dun & Bradstreet published median and lower quartile benchmarks for companies sharing the same SIC code. If the SIC code is not known, the company ratio is compared to the

Table 4-7 reports market-to-book ratios for firms in the two largest size categories only because very few firms in the other size categories have publicly traded stock. Consequently, stock price data are largely unavailable for firms in the two smallest size categories. The quartile values for firms with $60 million to $1 billion in sales range from 1 for the lower quartile to 5.57 for the upper quartile. This difference indicates that investors value most of the potentially affected firms in this size category at about 100 percent to 557 percent of the firm's

TABLE 4-7. BASELINE FINANCIAL RATIO: MARKET-TO-BOOK RATIO[81-88]

	Firm size in annual receipts (10^6/year)			
Statistic	$0 to $6	$6 to $60	$60 to $1,000	Over $1,000
Number of observations	0	0	7	45
Mean	N/A	N/A	3.32	1.99
Standard deviation (percentage points)	N/A	N/A	2.25	1.38
Quartiles				
Upper	N/A	N/A	5.57	2.12
Median	N/A	N/A	3.68	1.62
Lower	N/A	N/A	1.02	1.21

Notes:
1. The market-value-of-equity to book-value-of-equity ratio is a measure of the firm's market value and is computed by dividing average price per share by net worth per share.

2. Values above one indicate that investors value the firm above the book value of its equity. Conversely, values below one indicate that investors value the firm below the book value of its equity.

3. Values are not reported for the $6 to $60 million firm size category because data are available for only one firm in this category.

book value. Quartile values for the largest size category range from 1.21 to 2.12. Investors value these firms at about 121 percent to 212 percent of book value. Benchmark values are not reported for this ratio.

4.2.2 Bankruptcy Analysis

A composite ratio of financial condition, called the Z-score, was also computed to characterize baseline financial conditions of potentially affected firms. Developed specifically for manufacturing firms, the Z-score is a multi-discriminant function used to assess bankruptcy potential.[89] It simultaneously addresses liquidity, asset management, debt management, profitability, and market value.

The function is given in Eq. (4-4):

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 0.999X_5 \qquad (4\text{-}4)$$

where

Z = overall index
X_1 = working capital/total assets
X_2 = retained earnings/total assets
X_3 = earnings before interest and taxes/total assets
X_4 = market value of equity/book value of total debt
X_5 = sales/total assets.

The market value component (X_4) uses stock price data. Consequently, the Z-score is only applicable to firms with publicly traded stock. This analysis used a modified function developed for private firms referred to as the Z"-score, given in the following equation:

$$Z'' = 6.56X_1 + 3.26X_2 + 6.72X_3 + 1.05X_4 \qquad (4\text{-}5)$$

where Z" is the overall index, X_1 through X_3 are as defined for Z above, and X_4 is net worth to total liabilities.

Taken individually, each of the ratios given above is higher for firms in good financial condition and lower for firms in poor financial condition. Consequently, the greater a firm's bankruptcy potential, the lower its discriminant score. A Z-score

below 1.81 indicates that bankruptcy is likely, and a score above 2.99 indicates that bankruptcy is unlikely. Z-scores between 1.81 and 2.99 are indeterminate. Similarly, a Z"-score below 1.10 indicates that bankruptcy is likely, and a score above 2.60 indicates that bankruptcy is unlikely. Z"-scores between 1.10 and 2.60 are indeterminate.

Table 4-8 shows the distribution of publicly traded firms by Z-score prediction and the distribution of firms that do not issue publicly traded stock by Z"-score prediction. Financial failure is predicted for less than approximately 10 percent of firms in the two smallest size categories. By contrast, bankruptcy is predicted for approximately 15 to 17 percent of the firms in the two largest size categories. Overall, the model predicts that approximately one in seven potentially affected firms is likely to fail even without the regulation. These predicted failure rates do not compare favorably with average reported failure rates for the U.S. The 1990 failure rate averaged 0.92 percent for all manufacturing firms, 0.49 percent for all service firms, and 0.76 percent for all U.S. firms.[90] As noted in the previous section, firms in the waste treatment business performed poorly during the 1987 to 1990 time period. Consequently, it is not surprising that the predicted failure rates computed for the waste treatment firms in this analysis are significantly higher than average 1990 rates for U.S. firms in general.

TABLE 4-8. BASELINE BANKRUPTCY PREDICTION

Bankruptcy prediction	Firm size in annual receipts (10^6/year)				
	$0 to $6	$6 to $60	$60 to $1,000	Over $1,000	Total
Publicly traded companies[a]					
Likely	0	0	2	9	11
Indeterminate	0	1	1	22	24
Unlikely	0	0	5	14	19
Subtotal	0	1	8	45	54
Other companies[b]					
Likely	1	2	4	6	12
Indeterminate	0	7	5	11	23
Unlikely	10	11	17	26	65
Subtotal	11	20	26	43	100
All companies					
Likely	1	2	6	15	23
Indeterminate	0	8	6	33	47
Unlikely	10	11	22	40	84
Subtotal	11	21	34	88	154

[a] Bankruptcy prediction is based on the Z-score for companies with publicly traded stock. If a company's Z-score is less than 1.81, the model predicts that bankruptcy is likely. If a company's Z-score is greater than 2.99, the model predicts that bankruptcy is unlikely. Z-scores between 1.81 and 2.99 fall in the indeterminate range, and the model makes no prediction for these companies.

[b] Bankruptcy prediction is based on the Z"-score for companies that do not issue publicly traded stock. If a company's Z"-score is less than 1.10, the model predicts that bankruptcy is likely. If a company's Z"-score is greater than 2.60, the model predicts that bankruptcy is unlikely. Z"-scores between 1.10 and 2.60 fall in the indeterminate range, and the model makes no prediction for these companies.

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