November 1995 • NREL/TP-430-20473

Integrated Solid Waste Management of Minneapolis, Minnesota

National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, Colorado 80401

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A national laboratory of the U.S. Department of Energy
Managed by the Midwest Research Institute
for the U.S. Department of Energy
Under Contract No. DE-AC36-83CH10093

NREL/TP-430-20473 • UC Category: 1414 • DE96000483

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NREL technical monitor: Philip Shepherd

MASTER

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Prepared under Subcontract No. AAL-3-13185-01

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Abstract

The subject document reports the results of an in-depth investigation of the fiscal year 1992 cost of the City of Minneapolis, Minnesota (Hennepin County) integrated municipal solid waste management (IMSWM) system , the energy consumed to operate the system, and the environmental performance requirements for each of the system's waste-processing and disposal facilities.

Actual data from records kept by participants is reported in this document. Every effort was made to minimize the use of assumptions, and no attempt is made to interpret the data reported. Analytical approaches are documented so that interested analysts may perform manipulation or further analysis of the data. As such, the report is a reference document for municipal solid waste (MSW) management professionals who are interested in the actual costs and energy consumption for a one-year period, of an operating IMSWM system.

The report is organized into two main parts. The first part represents the Executive Summary and Case Study portion of the report. The Executive Summary provides a basic description of the study area and selected economic and energy information. Within the Case Study are detailed descriptions of each component operating during the study period. This includes the quantities of solid waste collected, processed, and marketed within the study boundaries, the cost of managing MSW in Hennepin County, and an energy usage analysis. In this report is a review of federal, state and local environmental requirement compliance, and a reference section and a glossary of terms.

The second part of the report focuses on a more detailed discourse on the above topics. In addition, the methodology used to determine the economic costs and energy consumption of the system components is found in the second portion of this report. The methodology created for this project will be helpful for those professionals who wish to break out the costs of their own integrated systems.

Other reports in the series include a Synopsis of Results and Methodologies which presents the principal findings from the case studies and case studies of the each of the six IMSWM systems evaluated in this program. In addition to the City of Minneapolis, Minnesota, Palm Beach County, Florida; Scottsdale, Arizona; Seattle, Washington; Sevierville, Tennessee; and Springfield, Massachusetts participated in the evaluation.

Key Words

Case Study
Composting
Cost Analysis
Energy Analysis
Energy Recovery
Hennepin County
Integrated Municipal Solid Waste Management (IMSWM)
Landfilling
Materials Recovery
Minneapolis, Minnesota
Municipal Solid Waste Recycling
Recycling
Resource Recovery
solid waste management (MSW)
Solid Waste Association
of America (SWANA)
Waste-to-Energy (WTE)

Foreword

This case study report is one of six developed for the following integrated municipal solid waste management systems:

- Minneapolis (Hennepin County), Minnesota; NREL/TP430-20473
- Palm Beach County, Florida; NREL/TP430-8131
- Scottsdale, Arizona; NREL/TP430-7977
- Seattle, Washington; NREL/TP430-8129
- Sevierville, Tennessee; NREL/TP430-8136
- Springfield, Massachusetts; NREL/TP430-8137

All the reports, including a summary report (NREL/TP430-20471), are available through the National Renewable Energy Laboratory, 1617 Cole Boulevard, Golden, Colorado, 80401, or call (303)275-4363.

The authors are extremely grateful for the support and cooperation of the six systems managers and participants in those six systems. Without their assistance, this effort would not have been possible.

Funding for the conduct of the case studies and the development of the six reports was provided by the American Plastics Council and the United States Department of Energy's National Renewable Energy Laboratory.

In conducting the studies, the authors experienced considerable difficulty in gathering economic and energy information. In municipal solid waste management, no standard accounting methods exist. Further, local governments by tradition and practice maintain their financial records in a variety of ways to serve their own specific needs. The lack of a standard accounting procedure in the United States, and of standard definitions of solid waste, made the collection and analysis of the economic data a challenge. The methods for developing the cost information for this effort will be helpful to those with responsibilities for planning and implementing integrated municipal solid waste management systems. Also, the six sets of cost data will be useful for guiding other systems managers in their planning, cost accounting, and measuring of performance.

The development of the energy information represents a major step forward in analyzing integrated municipal solid waste management systems. The information in the six studies and the analytical methodology will be extremely useful to integrated municipal solid waste management systems planners, decision makers, and managers in the future.

Finally, as might be expected, the environmental regulatory information is limited. Although landfill and combustion facilities are under well-defined regulations, other portions of integrated municipal solid waste systems are not. The end result of these limitations is that the information presented on conformance with environmental requirements is sketchy for systems that do not include combustion.

A final caution to the readers of these reports is to not attempt to try to compare one system against the other. The authors **deliberately** did not do so for the very sound reason that it is ill-advised to attempt to compare systems that:

- are geographically different,
- are politically different,
- are structurally different in providing municipal solid waste services,

- are at different stages of development, and
- face different regulatory requirements.

Rather, readers of these reports are encouraged to examine and analyze (using the techniques and analytical methods of the six studies) their own geographical, political, structure, stage of development, and regulatory status and then assess those findings against six other sets of data to see how they can best make the best decisions for their systems.

Acknowledgements

The authors are especially grateful for the assistance and support of many individuals and organizations who contributed information for this Minneapolis Case Study. From the City of Minneapolis: Susan Young, Director of the Division of Solid Waste and Recycling; and Craig Cooper, Kathy Wells, Cheryl Cline, and Anne Davis. From Hennepin County: Tim Goodman, Solid Waste Operations Manager; Anthony Jeffries, Senior Environmentalist; Kathie Doty, Manager of Program Support; and Mark Zaban, Robert Thomas, and Sherry Holloway. From the Minnesota Department of Environmental Management: Tom Henan, Enforcement; and John Helgeson, Waste Flow. From various private firms and organizations: Steve Kollodge, Anoka Landfill; Don Biscoe, Biscoe Trucking; John Morley and Becky Hanky, Burnsville Landfill; Joe Hurley, Wayne Hanson, and Glenn Kaas, Elk River; Liz Kopp, Empire Organic; John Boquist, EPR, Inc.; Bert Maline, ESL Landfill; Ron Larson, Hennepin Transfer, Inc.; Allan Kramer, HERC; Ellen Johnson, Lynde and McLeod; Mike Hall and Doug Kruell, MRI; Roger Clark, NSP; Sandra Flier, Pine Bend Sanitary Landfill; Richard Pecar, R.D. Pecar; James Eggen, United Power Association; Bruce Weaver, Waste Management; and Dave Locey, Recycle Minnesota Resource.

Contents

Contents
(continued)

List of Tables

List of Figures

Executive Summary

Introduction

The following summary provides a short review of the key findings of this case study. Readers are advised to read the condensed Minneapolis Case Study, which follows this section, to fully understand how the economic, energy and environmental results were developed. In addition, all data collected and analyzed during this study are available in the detailed Minneapolis Case Study, with Appendices A through D.

Each IMSWM system is unique due to geography, climate, customs, politics, and time. However, readers may benefit from the findings of this study and the study techniques and methodology to develop actual economic, energy and environmental facts about their own IMSWM system. Since each system is unique, readers are cautioned not to compare the findings of this particular study with others systems or studies.

Background

The City of Minneapolis (the City), county seat of Hennepin County (the County), is located in the southeast part of the State of Minnesota. The Twin City Metropolitan Area, including both Minneapolis and St. Paul, is 250 miles north of Des Moines, Iowa, and 350 miles northwest of Chicago.

Of the approximately 2.3 million residents in the Twin City Metropolitan Area in FY 1992, more than 1 million of those residents lived in the County. Approximately 368,000 residents, or 37 percent of the County's residents lived in the City. The City had an estimated 161,000 households. Approximately 80,000 of these households were single family units, 30,000 multifamily dwellings with two to four units, and the remainder were multifamily dwellings with five or more units. The City currently encompasses an area of approximately 58.7 square miles with a population density of about 6,270.

During fiscal year 1992 (FY 1992), about 145,000 tons of MSW was managed by or on behalf of the City's Division of Solid Waste and Recycling. The division's services include the collection, processing, and disposal of garbage, recyclables, yard waste, and bulky waste. Pursuant to state regulations, the County is responsible for the processing and disposal of all non-recycled MSW generated in the County.

System Overview

In FY 1992, the IMSWM system used by the City consisted of the following integrated system components (since both city and county are involved in a cooperative effort, all components are listed):

Collection

- City-sponsored curbside/alley collection of residential household wastes
  (City-sponsored collection is equivalent to collection by municipal crews or collection by private vendors through contract with the City.)
- Commercial hauler collection of industrial, commercial and institutional (ICI) wastes
- City-sponsored curbside/alley collection of residential recyclables
- Commercial hauler collection of ICI recyclables
- City-sponsored curbside/alley collection of residential materials
- Commercial hauler collection of ICI materials
- City-sponsored collection of residential materials
- City-sponsored curbside/alley collection of household batteries
- Drop-off collection at County's permanent collection facility
- Household hazardous waste (HHW) collection days

- Drop-off at transfer stations (tires, construction & demolition)
- Drop-off at City garages (used oil).

Transfer

- Two City-owned and privately operated transfer stations
- One County-owned and privately operated transfer station
- One privately-owned and operated transfer station utilizing a County contract
- One City-owned transfer station used to consolidate materials prior to transport to private processing facilities
- Non-combustibles were hauled to a transfer station for processing
- Combustibles were transferred to privately owned waste-to-energy (WTE) facilities
- Household batteries are transferred to Hennepin County Vocational Services for sorting and consolidation
- HHW collected at the permanent collection facility is consolidated and prepared at the Brooklyn Park Transfer Station for transport
- HHW collected at "events" was transported directly off-site for reuse or disposal.

Processing

- Three privately-owned and operated waste processing facilities with County-sponsored processing
- One privately-owned and operated mass burn WTE facility with County-sponsored processing
- County waste designation/flow control
- City-sponsored source-separated materials processing through contract with Recyclable Minnesota Resource
- ICI recyclables processed at a series of private materials processing facilities
- Residential materials collected/processed via contracts with a set of private processors
- ICI materials processed by private processors
- Metals recovery from the non-combustible materials
- Recovery of mercury switches
- Freon recovery and reuse by City
- Reclaimable materials transported to designated facilities for fuel blending and solidification
- Tires recovery for fuel
- Crushing and reuse of recoverable construction & demolition (C&D) materials in road projects
- Used oil recovery (for use as fuel).

Disposal

- County contracts with regional landfills for disposal of residue, non-processibles, and bypass
- County waste sharing agreements with other metropolitan counties
- County contracts for out-of-state landfill disposal of ash
- PCB laden capacitors and fluorescent light ballasts removed and disposed at an out-of-state waste disposal facility
- Non-recoverable or non-reusable items transported to a hazardous waste incinerator or landfill for disposal

Since ICI wastes were managed exclusively by the private sector, this analysis does not focus upon these generator types.

Collection

Municipal crews and Minneapolis Refuse Incorporated (MRI), a consortium of private haulers contracting with the City, provided curbside collection of MSW, recyclables, yard waste, and bulky wastes/problem materials. In 1992, approximately 116,500 households were provided collection. Those households provided collection were predominantly single family residences and multi-family dwellings of five units or less. Multi-family dwellings with five or more units could request collection service from the City, and a small number of these households were provided collection in 1992. Of the total 116,500 households provided collection service, approximately 80 percent received alley collection service.

Yard waste was collected weekly from approximately April 15 through November 30 through City-sponsored collection. Residents were asked to set out their yard waste in plastic bags on garbage collection day for collection by 20 cubic yard packers. Christmas trees were collected for two weeks in January.

Bulky oversized items, which are defined as being composed of 50 percent or more of metal, such as appliances, aluminum doors, swing sets, etc., were collected on recyclable materials collection day. Those items that were less than 50 percent metal such as chairs, carpeting, wooden tables, etc., were collected separately on garbage collection day with 16 cubic yard flat bed trucks.

Transfer

In 1992, the City owned two transfer stations, the North and South Transfer Stations, which were privately operated by Hennepin Transfer Inc. (HTI), a subsidiary of Browning-Ferris Industries Inc. The County reimbursed the City for expenses related to the management of MSW at the South Transfer Station. In addition, two other transfer stations were considered a part of the IMSWM system. The Brooklyn Park Transfer Station was a County-owned facility located in northeastern Hennepin County and was operated by HTI. The Freeway Transfer Station, located in northern Dakota County, was privately owned and operated by HTI and managed solid waste via County contract.

The North Transfer Station received much of the yard waste collected through the City-sponsored yard waste collection program. A small quantity of yard waste was hauled directly to processing sites. In 1992, a site owned by the City adjacent to the North Transfer Station served as a processing area for recovering bulky materials.

The South Transfer Station served primarily to receive MSW not directly hauled to a processing or disposal facility.

Processing

Municipal Solid Waste and Non-Recoverable Bulky Wastes

The MSW and non-recoverable bulky wastes collected in 1992 through the City-sponsored program were primarily transferred to a mass burn WTE facility in the City or one of three waste processing facilities in the region. The materials transferred to the waste processing facilities were primarily processed into refuse-derived fuels (RDF) and combusted for energy recovery after processing.

The facilities receiving the City's MSW and non-recoverable bulky wastes were:

- Hennepin Energy Resource Company WTE Facility (HERC)
- Northern States Power (NSP) Elk River Resource Recovery Facility (Elk River)
- EPR RDF Facility (EPR)
- Northern States Power Newport Resource Recovery Facility (Newport).

HERC ia a 365,000 ton per year, mass-burn WTE facility located in downtown Minneapolis, which began operation in October 1989. HERC is privately owned and operated by Ogden Projects, Inc. (Ogden) and sponsored by the County. It receives MSW seven days a week. Under an existing contract between the County and Ogden, the County is required to provide 365,000 tons per year of acceptable waste through the year 2018. If the County does not meet this annual guarantee of waste, then it must compensate Ogden for the lack of acceptable waste delivered to the Ogden municipal waste combustor.

Elk River is a privately owned and operated facility processing MSW into RDF. The Elk River facility is jointly owned by NSP and United Power Associates (UPA). The Elk River facility became operational in 1989 and accepts MSW from Anoka, Benton, Sherburne, Stearns, and Hennepin Counties pursuant to contracts with each of these counties. The Elk River facility accepts MSW six days per week and processes waste 307 days per year.

The County may deliver up to 234,548 tons of MSW per year to the Elk River facility through the year 2009 to meet its financial obligations as related to the facility's fixed costs associated with processing capacity. Under this contractual agreement, NSP may divert up to 11,052 tons per year of County MSW. In 1992, the County delivered a total 225,517 tons to the facility.

In addition to the two waste processing facilities described above, the County currently has waste sharing agreements with the Newport facility. If HERC or Elk River receive more waste than they have the capacity to process, the County can transfer waste materials to Newport under existing waste sharing agreements. This is consistent with Minnesota Statute 473.8480, which establishes limitations on the disposal of "unprocessed" waste.

The Newport facility is also owned and operated by NSP and is similar in design to the Elk River facility. Much of the RDF produced at the Newport facility is combusted at the Wilmarth or Red Wing Power Plants. The Red Wing facility, similar to the Wilmarth facility, is retrofitted by NSP to combust RDF.

The County passed an ordinance in 1985 requiring that MSW be delivered to designated facilities. This ordinance granted exclusions for certain facilities, which were already receiving and processing the County's MSW. The intent of these exclusions from the County's designation authority was to allow for the development of private sector initiatives that promote landfill abatement.

One of the facilities granted an exclusion under the designation ordinance was EPR. The EPR facility is located in the City of Eden Prairie and is authorized to receive up to 146,000 tons per year of MSW from the County. In 1992, the facility was operated to produce RDF. Materials were deposited on the tipping floor and processed both manually and mechanically to separate out the recyclable materials. The remaining materials were then shredded to make either fluff RDF or densified RDF. This fuel was produced and marketed to various power plants. The rejects and non-processible materials were transported to HERC for combustion.

Recyclables and Recoverable Bulky Wastes

The recyclable materials collected curbside through the City-sponsored programs in 1992 were processed at the Recyclable Minnesota Resource (RMR) Materials Recovery Facility (MRF). Residents source-separated their recyclables, which were collected curbside/alley by municipal crews. Only minimal processing was necessary at the MRF.

Major appliances and bulky items with more than 50 percent metal were also recovered. These materials were processed at a site adjacent to the North Transfer Station. Specifically, PCB laden compactors, fluorescent lights, and mercury switches were removed from the appliances and properly managed. Moreover, freon was removed, filtered, and reused in City air conditioning equipment.

Yard Waste

At the three yard waste composting facilities, the composting method utilized was either static pile or windrow. Yard waste was frequently turned to promote aerobic decomposition. At the Lynde and McLeod County Land Spreading operation in Maple Grove, yard waste was spread on farmland and tilled into the soil. The Ceres Tree Company, also in Maple Grove, accepted Christmas trees under a contract with the County and processed them into mulch using a tub grinder.

Disposal

Municipal Solid Waste

The MSW processed at the various waste processing facilities generates residue, non-processible waste, by-passed waste, and ash. In 1992, all of the ash generated from the HERC facility was disposed at the Laraway Recycling and Disposal facility (Laraway Facility) in Elwood, Illinois. It is designed with a double composite liner and an extensive leachate collection and management system.

The ash resulting from the combustion of RDF at Elk River-UPA WTE facility was disposed of at the NSP monofill located adjacent to its Sherco power plant in the City of Becker. The Becker Ash Monofill has a composite liner of HDPE over two feet of clay.

The process residues and non-processibles from the Elk River and HERC facilities were landfilled in the Anoka, Woodlake, and Elk River landfills in 1992 pursuant to contracts with the County. The Woodlake and Anoka landfills were subsequently closed. In addition to those landfills, the County had contractual agreements for the disposal of MSW when necessary with the Burnsville Landfill, Forest City Road Landfill, and Pine Bend Landfill. These landfills were used primarily for by-pass waste when a processing facility was unable to manage the waste received.

Key Definitions

MSW is categorized in this case study as including garbage, recyclables, yard wastes, bulky wastes (including white goods), and HHW.

ANALYZED MSW: That portion of the total MSW stream for which the associated management net costs are known, or at a minimum, can be reasonbly estimated. The reason for limiting the types of MSW included in Analyzed MSW is to include only that portion of MSW for which sufficient data were available to draw defensible conclusions regarding the allocation of costs to the tons of MSW managed. Consequently, the types of MSW included in Analyzed MSW will vary between IMSWM systems.

BULKY WASTES: oversized items, including white goods and furniture, that have been separated from the MSW stream for separate collection.

GARBAGE: Garbage is all MSW exclusive of source-separated trash, recyclables, yard waste, HHW, and bulky waste.

PROGRAM INCREMENTAL COSTS (OR SAVINGS): Determined for MSW management components (or programs) of each IMSWM system by calculating the system cost of MSW management, first with the inclusion of a specific program, and then calculating the cost of MSW management without that program. Landfilling is considered the basic program that is not optional. Therefore, the Program Incremental Cost is the different between the cost of managing MSW with or without the inclusion of a particular program.

RECYCLABLES: Materials that still have useful physical or chemical properties after serving their usefulness for a given individual or firm, and can, therefore, be reused or recycled for the same or other purposes.

YARD WASTE: Vegetative material that is segregated from the MSW stream for separate collection and/or processing, including grass, prunings, plants, and small tree limbs, but excluding tree stumps, land-clearing debris, and other large vegetative matter.

Key Findings

Discussion of Costs

Of the approximately 145,000 tons of MSW managed by the city of Minneapolis in FY 1992, about 142,900 tons were analyzed (Analyzed MSW) to determine the costs of IMSWM. The cost to manage the remaining 2,100 tons is excluded because collection costs are not know for certain self-hauled wastes and 151 tons of HHW. The estimated total quantity of materials diverted from disposal in 1992 was approximately 110,000 tons, which represented approximately 75 percent of the total waste stream by weight.

Overall Program Costs

The total FY 1992 net cost to manage the 142,900 tons of Analyzed MSW was about $23,800,000, or an average of $167 per ton. This total net cost breaks down to the rounded numbers displayed in following table.

Table 1
Net Costs to Manage MSW FY 1992

Category	Tonnage	Total Cost	Total Cost per Ton
Garbage	102,030	$16,918,500	$166
Recyclables	21,500	$3,645,150	$170
Yard Waste	16,160	$2,554,000	$158
Bulky Waste	3,220	$680,670	$211
Total/Average	142,910	$23,800,000	$167

Collection costs account for 49 percent of the total cost, while general and administrative (G&A) expense is 19 percent, landfill is 6 percent, transfer and haul is 6 percent, processing facilities are 21 percent, and promotion, education, etc., is less than 2 percent.

Program Incremental Costs

The incremental cost for each of the resource recovery programs, i.e., the cost (or savings) associated with adding the resource recovery program to the IMSWM system, is the difference between the cost of managing all the MSW with and without that program. The program incremental cost (or savings) is, therefore, a mreasure of the impact of any particular program on the cost of managing all MSW.

The FY 1992 Hennepin County system includes four programs that were intended to divert MSW from landfills. It should be noted that in some instances, legislative plans preclude the "actual" ability to eliminate all management programs except landfilling. Specificially, yard waste is not allowed to be disposed in landfills in the state of Minnesota. The program incremental cost (or savings) of each of the resource recovery programs used in Minneapolis in FY 1992 are included in Table 2.

Table 2
Program Incremental Cost (or Savings) of the Resource Recovery Programs in FY 1992

Program	Tonnage	Incremental Cost (saving)	
		Dollars	$ per Ton
Waste-to-energy	95,700	$ 612,871	$6.40
Curbside Recycling	21,500	$1,135,900	$52.84
Yard Waste	16,160	$ 571,394	$35.36
Bulky Waste (problem Waste)	2,718	($ 186,559)	($68.64)

In addition to the incremental cost or savings that can be attributed to each of the resource recovery programs, each of them contributes energy and/or materials to the economy and reduces the utilization of available landfill capacity. More complete descriptions of the methodologies to calculate the program incremental costs are given in the appendices to the Detailed Minneapolis Case Study.

Energy Usage Analysis

The primary forms of energy used within the Hennepin County IMSWM system are No. 2 fuel oil, electricity, and transportation fuels for collection, haul to market, and facility vehicles. Energy consumed in the use of recovered materials to make new products is excluded because it is beyond the IMSWM boundary. However, since many manufacturing processes which utilize recovered materials (i.e., aluminum recycling) use less energy than virgin material processes; this exclusion may understate the overall energy efficiency of recycling.

Energy usage data were collected from the City and the County, and from some of the service providers. Table 3 shows the results of the analysis of energy consumed in the collection function. Other energy data can be found in the condensed case study. Due to the complexity of the management programs, much of the information presented in this section is limited by the availability of data.

Table 3
Energy Consumption to Collect Garbage, Yard Waste, Bulky Waste, and Recyclables FY 1992

Variables	Garbage	Bulky Waste	Yard Waste	
City Truck Hours	41,089	6,247	9,402	
Percent of Truck Hours	72.42	11.01	16.57	
Tons Collected	48,355	3,220	7,823	21,499
Millions of Btus	10,689	1,625	2,446	8,648
Diesel Fuel (Equivalent Gallons)	73,020	11,100	16,710	59,070
Gallons Per Ton	1.5	3.4	2.1	2.7

Data for garbage, yard waste, and bulky waste are from the City only.
Data for Recyclables are for both the City and MRI.
MRI fuel consumption assumes average price of gasoline and diesel fuel were $1.10 and $1.25 per gallon, respectively. (Telephone conversation with Mr. D. Kruell, MRI, October 29, 1994).
Conversion to millions of Btus for diesel fuel assumes 146,390 Btus per gallon.
Conversion to millions of Btus for gasoline assumes 127,650 Btus per gallon.
Sources:
1. City of Minneapolis, "Fuel Use Data," Computer Printouts.
2. Minneapolis Refuse, Inc., "Monthly Invoices," December 30, 1991 through December 31, 1992.

Environmental Regulations and Permit Requirements

The goal of the Minnesota Waste Management Act of 1980 (the "Act") is to foster a IMSWM system in a manner appropriate to the characteristics of the waste streams managed. The following waste management practices are in order of preference:

- Waste reduction and reuse
- Waste recycling
- Composting of yard waste and food waste
- Resource recovery through mixed MSW composting or incineration
- Land disposal.

The Act prohibits the disposal of unprocessed MSW and bans certain items such as appliances, batteries, HHW, and yard waste from landfills or processing facilities. To comply with the Minnesota Rules promulgated pursuant to the Act, additional separate collections of yard waste, batteries, and bulky items were implemented.

Pursuant to the Act, each county within the seven-county Minneapolis/St. Paul metropolitan area was required to recycle a minimum of 35 percent by weight of total solid waste generation by December 31, 1993. In addition, each county will have a goal to recycle 45 percent by weight of total solid waste generation by December 31, 1996. Counties must ensure that residents have an opportunity to recycle. Opportunity to recycle means availability of recycling and curbside pickup or collection centers for recyclable materials at sites that are convenient for persons to use. Counties must also provide for the collection and processing of household hazardous waste and major appliances.

Counties must ensure that their residents have the opportunity to recycle used major appliances. Recycling includes the removal of capacitors that may contain PCBs, the removal of ballasts that may contain PCBs, the removal of chlorofluorocarbon refrigerant gas, and the recycling or reuse of the metals, including mercury.

The Minnesota Pollution Control Agency (MPCA) is responsible for the execution and enforcement of the provisions of the Act as contained in Minnesota Rules, Chapter 7035-MPCA, Solid Waste Rules (referred to as the Solid Waste Rules, unless otherwise noted).[1] In accordance with the Solid Waste Rules, the Metropolitan Council is the governmental unit responsible for the environmental oversight of solid waste management policy in Minneapolis and the seven-county metropolitan area surrounding the City. This oversight includes the review of MSW disposal, transfer, energy recovery, and compost facilities (new or expansion projects).

The Solid Waste Designation Ordinance (Number Twelve), adopted on December 10, 1985, and amended on April 24, 1990, requires a Department of Environmental Management (DEM) licensing of solid waste haulers and regulates all designated waste generated, collected, transported, or disposed of in Hennepin County. Designated waste is defined as "mixed MSW generated in the County and destined for in-state and out-of-state disposal, excluding hazardous waste, infectious waste, and undesignatable waste." Exclusions from designation have been granted to solid waste facilities for the purpose of resource recovery, recycling, or composting. This ordinance requires that all MSW be delivered to one of the County's designated facilities. However, materials which are not recyclable and have no resource recovery value may be granted a DEM exception.

The Solid Waste Source Separation and Recycling Ordinance (Number Thirteen) regulates the separation of materials which must be separated from MSW by generators, before collection of such materials.

Specific permit requirements for the various facilities varied widely. Details of these permits are given in the detailed case study. Compliance with the environmental regulations and permit requirements is reflected in the costs and energy consumption levels reported in this Case Study. In FY 1992, the operation of all of the facilities comprising the Hennepin County IMSWM System were in general compliance with all of the environmental and safety regulations.

[1] Minnesota Rules, Chapter 7035-MPCA, Groundwater and Solid Waste Division-Solid Waste Rules; Adopted January 12, 1970; most recently amended March 18, 1991.

Introduction to Condensed Report

The City of Minneapolis (the City) is the seat of Hennepin County (the County) in the southeast part of the State of Minnesota. The Twin City Metropolitan Area, which includes both Minneapolis and St. Paul, is located approximately 250 miles north of Des Moines, Iowa and 350 miles northwest of Chicago.

Of the approximately 2.3 million residents in the Twin City Metropolitan Area in FY 1992, more than 1 million of those residents lived in the County. Approximately 368,000 residents, or 37 percent of the County's residents lived in the City. The City had an estimated 161,000 households; approximately 80,000 of these households were single family units; 30,000 multifamily dwellings with two to four units; and the remainder were multifamily dwellings with five or more units. The City currently encompasses an area of approximately 58.7 square miles with a population density of about 6,270.

During FY 1992, about 145,000 tons of MSW was managed by or on behalf of the City's Division of Solid Waste and Recycling. The division's services include the collection, processing, and disposal of garbage, recyclables, yard waste, and bulky waste. Pursuant to state regulations, the County is responsible for the processing and disposal of all non-recycled MSW generated in the County.

Integrated Municipal Solid Waste Management System

System Overview

In FY 1992, the City's IMSWMS consisted of the following integrated system components:

Collection

- City-sponsored curbside/alley collection of residential household wastes
  (City-sponsored collection is equivalent to collection by municipal crews or collection by private vendors through contract with the City.)
- Commercial hauler collection of ICI wastes
- City-sponsored curbside/alley collection of residential recyclables
- Commercial hauler collection of ICI recyclables
- City-sponsored curbside/alley collection of residential materials
- Commercial hauler collection of ICI materials
- City-sponsored collection of residential materials
- City-sponsored curbside/alley collection of household batteries
- Drop-off collection at County's permanent collection facility
- HHW collection days
- Drop-off at transfer stations (tires, C&D)
- Drop-off at City garages (used oil).

Transfer

- Two City-owned and privately operated transfer stations (North and South).
  In 1992, the City used only the South Transfer Station for the consolidation and transfer of MSW to HERC. Significant quantities of MSW also were hauled directly to HERC for processing.
- One County-owned and privately operated transfer station (Brooklyn Park)
- One privately-owned and operated transfer station (Freeway) utilizing a County contract
- One City-owned transfer station used to consolidate materials prior to transport to private processing facilities
- Non-combustibles were hauled to a transfer station for processing

- Combustibles were transferred to privately owned WTE facilities
- Household batteries are transferred to Hennepin County Vocational Services for sorting and consolidation
- HHW collected at the permanent collection facility is consolidated and prepared at the Brooklyn Park Transfer Station for transport
- HHW collected at "events" was transported directly off-site for reuse or disposal.

Processing

- Three privately-owned and operated waste processing facilities (Elk River, Newport, EPR) with County-sponsored processing
- One privately-owned and operated mass burn WTE facility (HERC) with County-sponsored processing
- County waste designation/flow control
- City-sponsored source-separated materials processing through contract with RMR
- ICI recyclables processed at a series of private materials processing facilities
- Residential materials collected/processed via contracts with a set of private processors
- ICI materials processed by private processors
- Metals recovery from the non-combustible materials
- Recovery of mercury switches
- Freon recovery and reuse by City
- Reclaimable materials transported to designated facilities for fuel blending and solidification
- Tires recovery for fuel
- Crushing and reuse of recoverable C&D materials in road projects
- Used oil recovery (for use as fuel).

Disposal

- County contracts with regional landfills for disposal of residue, non-processibles, and bypass
- County waste sharing agreements with other metropolitan counties
- County contracts for out-of-state landfill disposal of ash
- PCB laden capacitors and fluorescent light ballasts removed and disposed at an out-of-state waste disposal facility
- Non-recoverable or non-reusable items transported to a hazardous waste incinerator or landfill for disposal

The various segments of the MSW stream were managed by the City. Note that the ICI wastes were managed exclusively by the private sector, and therefore, this analysis does not focus upon these generator types.

System Component Summary Descriptions

Collection

The City sponsored separate collection of MSW, recyclables, yard waste, household batteries, bulky wastes, tires, used oil, and paving and construction materials. HHW collection was a cooperative effort between the City and the County. Specifically, HHW could be dropped off at the County's permanent collection facility and HHW collection events were periodically co-sponsored by the City and County with the City providing the promotional resources and the County funding reclamation and disposal. Moreover, consumer electronics and fluorescent lamps also could be dropped off at a County-owned transfer station or at a collection event.

Municipal crews and MRI, a consortium of private haulers contracting with the City, provided curbside collection of MSW, recyclables, yard waste, and bulky wastes/problem materials. In 1992, approximately 116,500 households were provided collection. Those households provided collection were predominantly single family residences and multi-family dwellings of five units or less. Multi-family dwellings with five or more units could request collection service from the City, and a small number of these households were provided collection in 1992. Of the total 116,500 households provided collection service, approximately 80 percent received alley collection service.

Municipal crews and MRI collected recyclable materials every other week on the same day each individual household received MSW collection. In 1992, the City provided each household with a 23-gallon recycling bin for the collection of metal, glass, plastic bottles and containers, corrugated cardboard, newspaper, and household batteries. Pilot programs for the collection of mixed paper, magazines, and boxboard were implemented in 1992. As of April of 1995, the City has added magazines, phone books, milk cartons, and drink boxes to its recyclable materials collection program.

City-sponsored curbside collection of recyclables was initiated in 1992. The collection vehicles used included 20 to 25 cubic yard packers for the newspaper and recycling trucks pulling 8 to 11 cubic yard trailers. The metal cans and plastic containers were placed in the trailers and the glass, corrugated, and household batteries were placed in compartments in the recycling trucks.

Yard waste was collected weekly from approximately April 15 through November 30 through City-sponsored collection. Residents were asked to set out their yard waste in plastic bags on garbage collection day for collection by 20 cubic yard packers. Christmas trees were collected for two weeks in January.

Bulky oversized items not appropriate to place in individual carts were collected curbside through a City-sponsored program. Bulky oversized items, which are defined as being composed of 50 percent or more of metal, such as appliances, aluminum doors, swing sets, etc., were collected on recyclable materials collection day. Those items that were less than 50 percent metal such as chairs, carpeting, wooden tables, etc., were collected separately on garbage collection day with 16 cubic yard flat bed trucks.

The City sponsored collection of other specific materials, which included tires, used oil, and paving and construction materials. Tires and paving and construction materials could be dropped off at the City's South Transfer Station. In 1992, the City offered drop-off collection of tires at no charge. However, there was a minimal charge for the drop-off of paving and construction materials. Used oil could be dropped off at City garages or several service stations around the City.

Overall, the City sponsored separate collection of a comprehensive set of residentially generated materials. Most uniquely, these collection services were provided in 1992 with minimal additional costs to each resident beyond their flat monthly fees.

Transfer

Once the various materials were collected, they were either directly hauled to processing or disposal facilities or to transfer facilities for additional handling. In 1992, the City owned two transfer stations, the North and South Transfer Stations, which were privately operated by HTI, a subsidiary of Browning-Ferris Industries Inc. The County reimbursed the City for expenses related to the management of MSW at the South Transfer Station. In addition, two other transfer stations were considered a part of the IMSWM system. The Brooklyn Park Transfer Station was a County-owned facility located in northeastern Hennepin County and was operated by HTI. The Freeway Transfer Station, located in northern Dakota County, was privately owned and operated by HTI and managed solid waste via County contract.

The North Transfer Station served primarily to receive much of the yard waste collected through the City-sponsored yard waste collection program. A small quantity of yard waste was hauled directly to processing sites. In 1992, a site owned by the City adjacent to the North Transfer Station served as a processing area for recovering bulky materials. The North Transfer Station was not used for the transfer and haul of MSW.

The South Transfer Station served primarily to receive MSW not directly hauled to a processing or disposal facility. As highlighted in the subsection above, this transfer station served as drop-off for tires and paving and construction materials. Moreover, the non-recoverable, bulky oversized materials were delivered to this transfer station before being hauled to designated facilities for combustion.

Processing

Municipal Solid Waste and Non-Recoverable Bulky Wastes

The MSW and non-recoverable bulky wastes collected in 1992 through the City-sponsored program were primarily transferred to a mass burn WTE facility in the City or one of three waste processing facilities in the region. The materials transferred to the waste processing facilities were primarily processed into RDF and combusted for energy recovery after processing. The facilities receiving the City's MSW and non-recoverable bulky wastes were:

- Hennepin Energy Resource Company WTE Facility (HERC)
- Northern States Power (NSP) Elk River Resource Recovery Facility (Elk River)
- EPR RDF Facility
- Northern States Power Newport Resource Recovery Facility (Newport).

In FY 1992, the HERC was a 365,000 ton per year, mass-burn WTE facility located in downtown Minneapolis, which began operation in October 1989. HERC was privately owned and operated by Ogden Projects, Inc. (Ogden) and sponsored by the County. It received MSW seven days a week. It had two water-wall mass combustion units where MSW was burned. Under an existing contract between the County and Ogden, the County is required to provide 365,000 tons per year of acceptable waste through the year 2018. If the County does not meet this annual guarantee of waste, then it must compensate Ogden for the lack of acceptable waste delivered to the Ogden municipal waste combustor.

In FY 1992, the County shared the revenues from the sale of the electricity generated from the combustion process. The electricity produced was sold to NSP. The County also shared in the revenues from the sale of ferrous metals, which were removed from the ash using a mechanical magnetic system. Moreover, large sources of metals were separated out at the tipping floor prior to combustion.

In FY 1992, Elk River was a privately owned and operated facility that processed MSW into RDF. The Elk River facility was jointly owned by NSP and United Power Associates (UPA). The Elk River facility became operational in 1989 and accepted MSW from Anoka, Benton, Sherburne, Stearns, and Hennepin Counties pursuant to contracts with each of these counties. The Elk River facility accepted MSW six days per week and processed waste 307 days per year. The waste was shredded and separated through a series of screens, air classifiers, and magnets into a non-processible fraction, a ferrous metal fraction, a residue fraction, and an RDF burnable fraction.

The County may deliver up to 234,548 tons of MSW per year to the Elk River facility through the year 2009 to meet its financial obligations as related to the facility's fixed costs associated with processing capacity. Under this contractual agreement, NSP may divert up to 11,052 tons per year of County MSW. In 1992, the County delivered a total 225,517 tons to the facility.

In addition to the two waste processing facilities described above, the County currently has waste sharing agreements with the Newport facility. If HERC or Elk River receive more waste than they have the capacity to process, the County can transfer waste materials to Newport under existing waste sharing agreements. This is consistent with Minnesota Statute 473.8480, which establishes limitations on the disposal of "unprocessed" waste.

In FY 1992, the Newport facility was also owned and operated by NSP and was similar in design to the Elk River facility. Much of the RDF produced at the Newport facility was combusted at the Wilmarth or Red Wing Power Plants. The Red Wing facility, similar to the Wilmarth facility, was retrofitted by NSP to combust RDF.

The County passed an ordinance in 1985 requiring that MSW be delivered to designated facilities. This ordinance granted exclusions for certain facilities, which were already receiving and processing the County's MSW. The intent of these exclusions from the County's designation authority was to allow for the development of private sector initiatives that promote landfill abatement.

One of the facilities granted an exclusion under the designation ordinance was EPR. The EPR facility is located in the City of Eden Prairie and is authorized to receive up to 146,000 tons per year of MSW from the County. In 1992, the facility was operated to produce RDF. Materials were deposited on the tipping floor and processed both manually and mechanically to separate out the recyclable materials. The remaining materials were then shredded to make either fluff RDF or densified RDF. This fuel was produced and marketed to various power plants. The rejects and non-processible materials were transported to HERC for combustion.

Recyclables and Recoverable Bulky Wastes

The recyclable materials collected curbside through the City-sponsored programs in 1992 were processed at the Recyclable Minnesota Resource (RMR) MRF. Residents source-separated their recyclables, which were collected curbside/alley by municipal crews. Only minimal processing was necessary at the RMR MRF. Primarily, the collected materials were stored and baled in preparation for shipping to a facility for use/remanufacture. However, automated processing was necessary for the separation of bi-metal aluminum cans. The materials received at the RMR MRF included metal, glass, plastic food and beverage containers, along with corrugated cardboard and newspaper.

Major appliances and bulky items with more than 50 percent metal were also recovered. These materials were processed at a site adjacent to the North Transfer Station. Specifically, PCB laden compactors, fluorescent lights, and mercury switches were removed from the appliances and properly managed. Moreover, freon was removed, filtered, and reused in City air conditioning equipment.

Yard Waste

In 1992, upon collecting the yard waste in packer trucks, the materials were off loaded at the North Transfer Station. The materials were then consolidated and transferred to one of five different processing sites:

- Yard Waste Composting Facility at the Burnsville Landfill
- Yard Waste Composting Facility at the Pine Bend Landfill
- Empire Organic Composting Facility
- Lynde and McLeod's Land Spreading Site
- Ceres Tree Company Processing Site.

At the three yard waste composting facilities, the composting method utilized was either static pile or windrow. Yard waste was frequently turned to promote aerobic decomposition. At the Lynde and McLeod County Land Spreading operation in Maple Grove, yard waste was spread on farmland and tilled into the soil. The Ceres Tree Company, also in Maple Grove, accepted Christmas trees under a contract with the County and processed them into mulch using a tub grinder.

Household Hazardous Waste and Household Batteries

The recoverable/reclaimable HHW and household batteries were transported out-of-County to designated facilities for reclamation when feasible.

Other Materials

The tires collected at the South Transfer Station drop-off were combined with those collected in the neighborhood cleanup programs for processing. The City contracted for the processing of these tires with HTI. The used oil dropped off at City garages or service stations was processed for the reuse as fuel at local and regional asphalt plants. In 1992, a small portion of this material was being re-refined into new oil for reuse. Paving and construction materials that were dropped off at the South Transfer Station were also processed. Concrete was eventually crushed and reused as road bed materials, and the asphalt was also crushed and used for new roadway projects.

Disposal

Municipal Solid Waste

The MSW processed at the various waste processing facilities generates residue, non-processible waste, by-passed waste, and ash. In 1992, all of the ash generated from the HERC facility was disposed at the Laraway Recycling and Disposal facility (Laraway Facility) in Elwood, Illinois. In FY 1992, the Laraway Facility was owned and operated by Waste Management of Illinois, a subsidiary of WMX, Inc. It was designed with a double composite liner and an extensive leachate collection and management system.

The ash resulting from the combustion of RDF at Elk River-UPA WTE facility was disposed of at the NSP monofill located adjacent to its Sherco power plant in the City of Becker. The Becker Ash Monofill had a composite liner of HDPE over two feet of clay.

The process residues and non-processibles from the Elk River and HERC facilities were landfilled in the Anoka, Woodlake, and Elk River landfills in 1992 pursuant to contracts with the County. The Woodlake and Anoka landfills were subsequently closed. In addition to those landfills, the County had contractual agreements for the disposal of MSW when necessary with the Burnsville Landfill, Forest City Road Landfill, and Pine Bend Landfill. These landfills were used primarily for by-pass waste when a processing facility was unable to manage the waste received.

Household Hazardous Waste

The household batteries that could not be recycled in 1992, such as the lithium, alkaline, and carbon zinc batteries, were either incinerated at a hazardous waste facility or disposed at a hazardous waste landfill. Moreover, other HHW that could not be reused or recycled was managed in a similar manner.

Recoverable Bulky Materials

The PCB laden compactors and fluorescent light ballasts removed from the bulky oversized waste materials were disposed of at out-of-state hazardous waste management facilities. Any mercury switches removed from the items collected were transported to the Mercury Refining Company in New York for recovery.

Municipal Solid Waste Collected, Processed, and/or Disposed

The City managed a total of 145,087 tons of MSW in FY 1992 representing approximately 116,500 households. Of the 145,087 tons of materials managed by the City in 1992, the different types of materials and their quantities were as follows:

- Mixed Municipal Solid Waste: 104,059
- Recyclables: 21,498
- Yard Waste: 16,159
- Problem Materials/Bulky Waste: 3,220
- Household Hazardous Waste: 151
- Other Material: Negligible.

Figure 1 depicts the quantity of materials in percent by weight for each material type managed in the IMSWM system and Figure 2 illustrates the MSW waste flow for Minneapolis.

The estimated total quantity of materials diverted from disposal in 1992 was approximately 110,000 tons, which represented approximately 75 percent of the total waste stream by weight. The diversion of these materials resulted from the use of mass combustion, RDF production, mixed waste processing, composting and chipping, and recyclable materials recovery. The resulting disposition of the use of these processes was as follows:

- Materials Recovered for Energy: 67,043
- Materials Composted, Mulched, and Landspread: 16,161
- Materials Recovered Through Recycling: 26,571.

The above represents the use of energy recovery, composting, and recycling to divert approximately 46 percent, 11 percent and 18 percent, respectively, of the total MSW managed by the City in FY 1992. It should be noted that a critical factor in diverting the materials from disposal was the ability to control the flow of the MSW through "designation." In other words, in 1992, all waste materials generated in the County were required to be delivered to County-designated facilities under the County's waste designation ordinance (flow control).

Figure 1
Managed Municipal Solid Waste

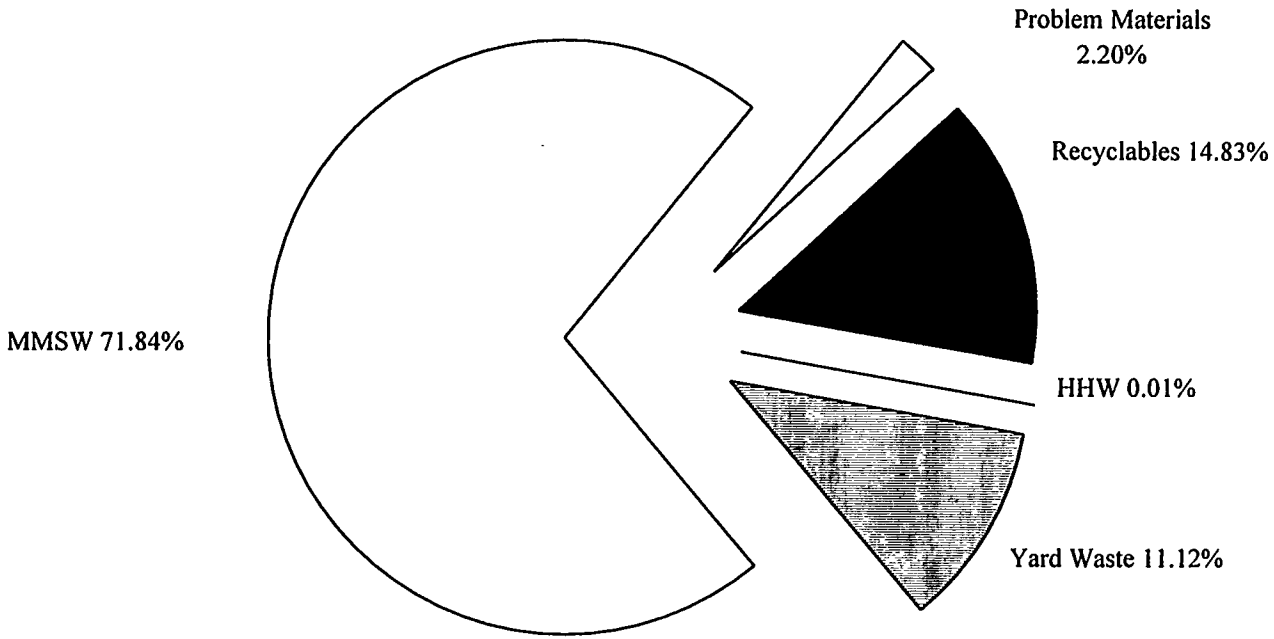
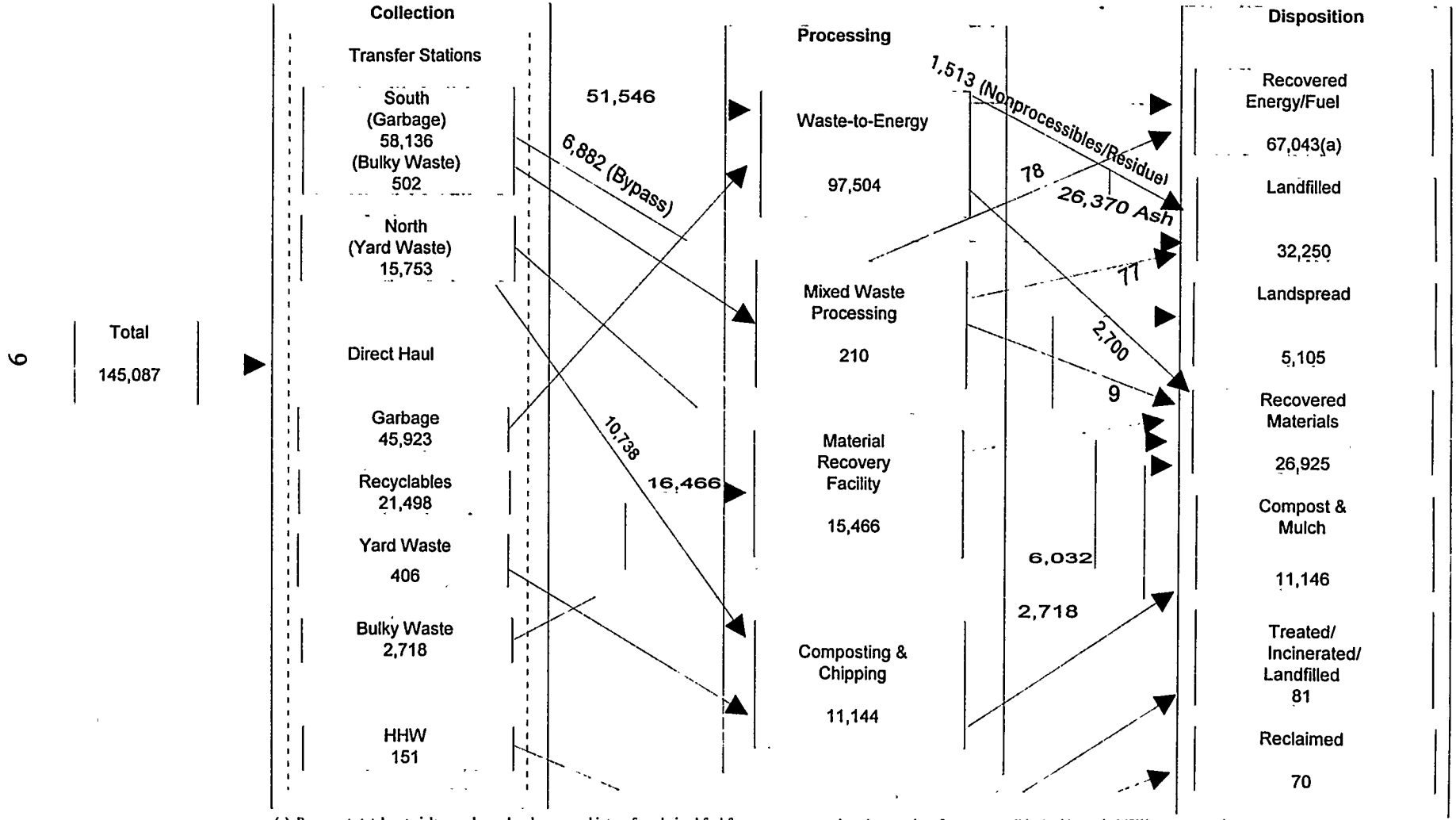


Figure 2
Municipal Solid Waste Flow & Resource Recovery FY 1992



(a) Represents total materials mass burned and processed into refuse derived feul for energy recovery less the quantity of non-processibles/residue, ash, MSW compost, and recovered materials from mass burn RDF production and mixed waste processing.

(b) Does not account for 30% to 50% loss by weight which occurs during the composting process. Extent of loss based on actual materials composted and process used.

Collection

A total of 145,087 tons of MSW were self-hauled or collected through City-sponsored programs in 1992.

The total materials received at the City's South Transfer Station in 1992 was 58,638 tons of MSW and bulky waste. This represented approximately 56 percent of the total materials collected through City-sponsored programs. The remaining 45,923 tons of MSW collected were directly hauled to a processing facility. Approximately 21,498 tons of recyclable materials were collected curbside through a City-sponsored program. These materials were either hauled to a materials processor or directly to an end user for recovery. Approximately 16,159 tons of yard waste were collected through City-sponsored programs. Of this amount, approximately 15,753 tons of yard waste were collected and taken to the City's North Transfer Station for consolidation and transfer to private processing facilities. The remaining 406 tons were directly hauled to a yard waste processor. An additional 2 tons of fines from the Eden Prairie facility were brought in as "compost" thus making the total amount of material composted, mulched, or landspread 16,161 in 1992.

The City collected a total of 3,220 tons of bulky waste in 1992. The bulky waste (characterized as Problem Materials by the City) were separated into two groups - items with less than 50 percent metal and appliances and large items with more than 50 percent metal. The items with less than 50 percent metal were considered combustible and composed a total of 502 tons in 1992. These materials were transported to the South Transfer Station prior to being transferred to HERC for combustion. The remaining 2,718 tons of materials, which included appliances and items with more than 50 percent metal, were processed. A total of 408 tons of residuals from processing were transported to HERC for combustion.

It is estimated that 151 tons of HHW were collected at two HHW collection events and through drop-off at the permanent collection facility at the Brooklyn Park Transfer Station.

Processing

Of the 145,087 tons of MSW collected in 1992, approximately 124,378 tons were processed, or approximately 85 percent of the total collected. These materials were processed at RDF resource recovery facilities, a mass burn facility, a mixed waste processing facility, MMFs, and yard waste composting and chipping facilities.

A total of 97,504 tons of MSW and problem materials/bulky waste were processed for energy recovery at the HERC, Elk River, and Newport facilities, and an additional 210 tons were processed at the EPR facility. Therefore, a total of 97,714 tons of MSW and Problem Materials were processed in 1992. The 90,148 tons processed at the HERC facility were mass-burned for energy recovery. The 7,356 tons of materials processed at Elk River and Newport were used to produce RDF.

Of the 16,159 tons of yard waste collected, approximately 11,144 tons of yard waste and Christmas trees were transported to several private processors for composting and chipping.

Of the 2,718 tons of bulky waste collected that were identified as recoverable, it is estimated that 2,310 tons were recovered through processing, including recovery of metals, plastics, and other materials suitable for recycling.

Source separated recyclable materials were collected through the City-sponsored curbside collection program. The breakdown by material type of the materials collected is provided in the Table 4.

Table 4
Materials Recovered From the Curbside Program FY 1992

Material Collected	Tons	Percent
Newsprint	12,914	60.1
Magazines, Boxboard, and Mixed Office Paper [a]	57	0.3
Old Corrugated Cardboard	315	1.5
Plastic	646	3.0
Glass	5,911	27.5
Aluminum	512	2.4
Food Cans	1,143	5.3
Total	21,498	100.0

[a] These materials were collected in a pilot program conducted by the city in FY 1992.
Source: City of Minneapolis, "Breakdown of Recyclable Materials 1992."

Table 5
MSW Processing and Disposing Comparision of Hennepin County and City of Minneapolis FY 1992

	Hennepin County [a]	Minneapolis
Process		
Mass Burn[b]	361,417	90,148
RDF Resource Recovery[c]	227,983	7,356
Mixed Waste Processing	105,597	210
Total Processed	694,997	97,714
Disposition		
Nonprocessibles/Residue[d]	78,846	1,590
Ash[e]	149,269	26,370
Recovered Materials	22,408	2,709
Compost	1,219	2

[a] Includes quantities generated by the City of Minneapolis.
[b] Equals total waste delivered to HERC less the nonprocessibles from Elk River to preclude double counting.
[c] Includes 701 tons of materials delivered to Elk River in 1991 but processed in 1992.
[d] Equals the sum of HERC nonprocessibles, EPR rejects and residue, and Elk River and Newport nonprocessibles and residue.
[e] Weight of ash includes moisture content.

Disposition

Of the 97,714 tons of materials received at these processing facilities from the City, almost 70,000 were diverted from landfill disposal. Specifically, 2,709 tons of the City's MSW were recovered through recycling before and after combustion, and approximately 67,000 tons were converted into fuel for energy recovery. The remaining non-processibles, bypass, residue, and ash were landfilled. The ash was disposed of at a monofill, and the non-processibles, bypass, and residue were disposed at a number of different landfills in the region. In total, 35,250 tons of materials, including bypass, non-processibles, residue, and ash were disposed of at landfills.

A total of 26,517 tons of materials were recovered (26,571 tons minus 54 tons of HHW recycled for reuse as liquid fuels) through recycling. These materials included those collected through the source-separated curbside recycling program, bulky waste recovery of non-combustible materials, materials directly hauled to end users, materials recovered through mixed waste processing, and materials recovered pre- and post-combustion. The 26,517 tons represent approximately 18 percent of the total materials collected. In other words, approximately 18 percent of the total materials collected through the City's IMSWM system were recycled.

Mixed waste processing and yard waste composting and chipping resulted in the production of large quantities of compost and mulch. Of the 16,159 tons of yard waste collected, 5,015 tons, or approximately 31 percent, were landspread.

Cost of Municipal Solid Waste Management

Apportionment of Waste Stream

Only a portion of the total solid waste stream described in Section 3, Municipal Solid Waste Quantities, is included in the economic analyses presented in this section. The reason for limiting the tonnage included in the analysis is to include only that portion of the waste stream considered to be MSW and for which the total cost of collection, transfer, hauling, processing, combusting, composting, mulching, landspreading, marketing, and disposal is known. The portion of the waste stream meeting these two criteria is hereinafter referred to as "Analyzed MSW." Failure to limit the economic analysis to the tonnage and costs associated with Analyzed MSW would bias the results and could therefore lead to misleading conclusions.

Generally speaking, Analyzed MSW is all the MSW that was collected by or on behalf of the City in FY 1992, with the exception of small quantities of self-hauled garbage and HHW, which are excluded since the costs of collecting these portions of the waste stream are not known and cannot be estimated in a manner consistent with the scope of this study. Therefore, both the costs and quantities (i.e., 2,027 tons of garbage and 151 tons of HHW) are excluded from the economic analysis.

When a portion of the MSW stream is excluded from an analysis performed in this section because its collection costs are unknown, the associated transport, hauling, processing and disposal costs are also excluded from the analysis. Consequently, the cost comparisons among types of MSW are valid and include all the costs required to manage the Analyzed MSW stream from the time it was placed at the curb until it was sold, reused, or disposed of in a landfill. Although HHW is not included in the definition of Analyzed MSW, a separate analysis of the costs incurred for the HHW program, exclusive of the costs incurred by individuals to transport HHW to the collection site, is provided.

Table 6 shows the FY 1992 tonnages of the components of both the total MSW and Analyzed MSW.

Table 6
City of Minneapolis Total MSW and Analyzed MSW Tonnages by Component FY1992

MSW Component	Total MSW (tons)	Analyzed MSW (tons)
Garbage		
City and MRI Collected	99,058	99,058
Self Hauled/Other City Agencies	2,027	0
Neighborhood Cleanup		2,972
Subtotal - Garbage	104,059	102,030
Yard Waste		
City Collected	7,823	7,823
MRI Collected	8,336	8,336
Subtotal - Yard Waste	16,159	16,159
Recyclables		
City Collected	10,834	10,834
MRI Collected	10,665	10,665
Subtotal - Recyclables	21,498	21,498
Problem Materials/Bulky Wastes		
White Goods	782	782
Problem Materials (Recycled)	1,936	1,936
Problem Materials (Not Recycled)	502	502
Subtotal - Problem Materials/Bulky Wastes	3,220	3,220
Household Hazardous Waste	151	0
Total	145,087	142907

Total Net Costs of Waste Management

The methodology, assumptions, and data used to calculate total net costs for managing MSW in the City are presented in this section. The costs calculated in this section represent the total net costs of the IMSWMS in FY 1992 and do not represent the costs attributed solely to Analyzed MSW.

The methodology used to calculate the total net costs consists of 14 steps, as follows:

1. Determine the City's Solid Waste and Recycling Division's reported and adjusted costs
2. Determine annualized capital costs for vehicle and equipment capital expenses
3. Allocate vehicle and equipment annualized capital costs
4. Determine transfer (handling) and haul annualized capital and operation and maintenance (O&M) costs
5. Determine the City's allocation of HERC and Elk River facility costs
6. Determine the costs of waste sharing at the Newport and Eden Prairie facilities
7. Determine the costs of Christmas tree processing
8. Determine the costs of MSW landfill disposal at the Anoka and Woodlake landfills
9. Determine HHW collection and processing costs
10. Determine the costs of bins, cans, and bags
11. Determine the County's G&A annualized capital costs and O&M expenses for managing the City's waste
12. Determine the City's indirect G&A expenses attributed to the City's Solid Waste and Recycling Division (Sanitation)
13. Determine the Solid Waste and Recycling Division's G&A annualized capital costs
14. Summarize total net costs.

Each of the 14 steps are summarized in the Report.

Total Net Costs of Analyzed Municipal Solid Waste and Costs by Functional Area

In order to allocate the net costs shown in Table 7, which are attributable to managing the 142,907 tons of Analyzed MSW, costs were first allocated into the following functional areas:

- General and Administrative
- Collection
- Transfer and Haul
- Facilities (Processing)
- Landfill
- Promotion, Education, and Public Relations
- Other.

All of the types of costs incurred were reviewed and allocated to one of the specific functional areas listed above. Then it was determined whether each cost could be classified as being either "applicable" or "not applicable" to Analyzed MSW. Typically, tonnage figures were used when necessary to determine the portion of total costs that should be allocated to Analyzed MSW.

Table 7 summarizes the net costs of managing Analyzed MSW by functional area. As shown in Table 7, the City's net costs associated with handling 142,907 tons of Analyzed MSW in FY 1992 was $23,798,129, or an average cost of $167 per ton.

Table 7
Net Costs of Managing Analyzed MSW by Functional Area FY 1992

Functional Area	Applicable Tons of Analyzed MSW	Net Costs	Dollars per Ton	Percent of Net Costs
G&A		$4,494,097		19
Collection		11,668,536		49
Transfer and Haul		1,549,064		6
Facilities (Processing)		4,892,468		21
Landfill		1,044,687		6
Promotion, Education, and Public Relations		137,546		<1
Other		11,731		<1
Total	142,907	$23,798,129	$167	100

Allocation of Analyzed Municipal Solid Waste Management Costs by Type of Waste

Now that the net costs of managing Analyzed MSW have been determined, the costs can be allocated to various types of waste by using the following procedure. The procedure to allocate the $23,798,129 total net cost of managing the 142,907 tons of Analyzed MSW to the cost of managing garbage, yard waste, recyclables, and problem materials/bulky wastes was similar to the procedure used to determine which costs or proportion of costs were "applicable" or "not applicable" to Analyzed MSW. Specific costs that were 100

percent associated with the various types of MSW were identified and allocated accordingly. Generally, the data available were sufficient to allocate most costs using this approach. However, some costs were allocated to more than one type of waste. Table 8 shows the results of this allocation. G&A expenses were allocated in direct proportion to the allocation of other costs.

Program Incremental Costs (Savings)

In this section, the estimated Program Incremental Costs (Savings) of the WTE facilities, curbside recycling, yard waste composting, mulching and landspreading programs, and bulky waste recycling programs are presented. A Program Incremental Cost (or Savings) is defined in these SWANA case studies as "the difference between the cost of managing MSW with and without the inclusion of a particular program." For purposes of the Case Studies, landfilling was considered the basic program that was not considered optional.

Therefore, an incremental cost was calculated for each program by assuming that the program had never been implemented and determining what the cost impact on the system would have been if the program had never been implemented. It should be noted that in some instances, legislative plans precluded the "actual" ability to eliminate all management programs except landfilling. For instance, landfilling or incinerating yard waste is banned in many states. In cases such as these, the incremental cost methodology can be interpreted as reflecting the cost of the ban. Each Program Incremental Cost (Savings) presented below reflects FY 1992 price levels and, unless otherwise specified, FY 1992 contractual relationships, and can be interpreted as the FY 1992 cost or savings caused by a particular program.

Table 8
Total Net Costs Allocated by Type of Waste FY 1992

Description	Total Costs	Not Applicable Costs	Total Costs For Analyzed MSW	Waste Type				Total Costs
				Garbage	Recyclables	Yard Waste	Bulky Waste	
General Administrative								
Operating & Maintenance:								
City Indirect	$1,543,846	$58,551	$1,485,295	$1,032,293	$229,192	$176,795	$47,015	$1,485,295
County Indirect	$443,947	$16,837	$427,110	$296,845	$65,906	$50,839	$13,519	$427,110
Solid Waste & Recycling Division	$2,289,612	$86,835	$2,202,777	$1,630,950	$439,905	$104,211	$27,712	$2,202,777
Subtotal	$4,277,405	$162,223	$4,115,182	$2,960,089	$735,003	$331,845	$88,246	$4,115,182
Capital Costs:								
City Indirect	$154,385	$5,855	$148,529	$103,229	$22,919	$17,680	$4,701	$148,529
County Indirect	$44,395	$1,684	$42,711	$29,685	$6,591	$5,084	$1,352	$42,711
Solid Waste & Recycling	$195,073	$7,398	$187,674	$130,435	$28,960	$22,339	$5,941	$187,674
Subtotal	$393,852	$14,937	$378,915	$263,349	$58,469	$45,102	$11,994	$378,915
General Administrative Total	**$4,671,257**	**$177,160**	**$4,494,097**	**$3,223,438**	**$793,472**	**$376,947**	**$100,240**	**$4,494,097**
Collection								
City Collection (c), (d)	$3,520,504	$0	$3,520,504	$1,701,531	$1,286,244	$399,881	$132,847	$3,520,504
Contract Collection (e)	$5,851,471	$0	$5,851,471	$3,666,358	$1,283,439	$593,071	$308,603	$5,851,471
Equipment Shop (f)	$771,922	$0	$771,922	$501,417	$1,500	$164,922	$104,083	$771,922
90-Gallon Refuse Cart O&M	$89,019	$0	$89,019	$89,019		$0	$0	$89,019
Plastic & Kraft Bags	$85,800	$0	$85,800	$0	$0	$85,800	$0	$85,800
Subtotal	$10,318,716	$0	$10,318,716	$5,958,325	$2,571,183	$1,243,675	$545,533	$10,318,716
Capital Costs:								
Maintenance Shop Equipment	$7,841	$0	$7,841	$5,093	$15	$1,675	$1,057	$7,841
Recycling Bins	$155,300	$0	$155,300	$0	$155,300	$0	$0	$155,300
Garbage Cans	$8,100	$0	$8,100	$0	$0	$8,100	$0	$8,100
90-Gallon Garbage Carts	$942,500	$0	$942,500	$942,500	$0	$0	$0	$942,500
Litter & Corner Cans	$0	$0	$0	$0	$0	$0	$0	$0
Garbage/Yard Waste Collection Vehicles & Equipment	$239,263	$0	$239,263	$194,711	$0	$44,552	$0	$239,263
Bulky Waste Collection Vehicles & Equipment	$2,865	$0	$2,865	$0	$0	$0	$2,865	$2,865
Recyclables Collection Vehicles & Equipment	$20,762	$0	$20,762	$0	$20,762	$0	$0	$20,762
Subtotal	$1,376,631	$0	$1,376,631	$1,142,305	$176,077	$54,327	$3,922	$1,376,631
Revenues								
Bulky Waste Revenues	$26,811	$0	$26,811	$0	$0	$0	$26,811	$26,811
Subtotal	$26,811	$0	$26,811	$0	$0	$0	$26,811	$26,811
Collection Total	**$11,668,536**	**$0**	**$11,668,536**	**$7,100,630**	**$2,747,260**	**$1,298,002**	**$522,644**	**$11,668,536**

Table 8
Total Net Costs Allocated by Type of Waste FY 1992
(continued)

Description	Total Costs	Not Applicable Costs	Total Costs for Analyzed MSW	Waste Type				Total Costs
				Garbage	Recyclables	Yard Waste	Bulky Waste	
Transfer & Haul (i)								
South Transfer Station (j)	$63,729	$1,933	$61,796	$61,267	$0	$0	$529	$61,796
North Transfer Station	$35,023	$0	$35,023	$0	$0	$35,023	$0	$35,023
Operating Fee Paid to HTI (South TS)	$540,491	$16,391	$524,100	$519,613	$0	$0	$4,487	$524,100
BFI Contract North TFS O&M	$135,359	$0	$135,359	$0	$0	$135,359	$0	$135,359
Haul to HERC	$167,864	$5,091	$162,773	$161,380	$0	$0	$1,394	$162,773
Haul to Elk River	$160,069	$4,854	$155,214	$155,214	$0	$0	$0	$155,214
Haul to Newport	$1,595	$48	$1,547	$1,547	$0	$0	$0	$1,547
Haul to Eden Prairie	$2,130	$65	$2,066	$2,066	$0	$0	$0	$2,066
Haul to Anoka	$114,868	$3,484	$111,384	$111,384	$0	$0	$0	$111,384
Haul to Woodlake	$3,623	$110	$3,513	$3,513	$0	$0	$0	$3,513
Haul to Lynde & McLeod	$48,597	$0	$48,597	$0	$0	$48,597	$0	$48,597
Haul to Kraimer/Burnsville	$36,870	$0	$36,870	$0	$0	$36,870	$0	$36,870
Haul to Pine Bend	$30,158	$0	$30,158	$0	$0	$30,158	$0	$30,158
Haul to Hiawatha	$618	$0	$618	$0	$0	$618	$0	$618
Haul to Empire Organic	$92,345	$0	$92,345	$0	$0	$92,345	$0	$92,345
Haul Chistmas Tree	$1,275	$0	$1,275	$0	$0	$1,275	$0	$1,275
Subtotal	$1,434,615	$31,976	$1,402,639	$1,015,985	$0	$380,245	$6,409	$1,402,639
Capital Costs:								
South Transfer Station	$77,140	$2,339	$74,801	$74,801	$0	$0	$0	$74,801
North Transfer Station	$71,624	$0	$71,624	$0	$0	$61,085	$10,539	$71,624
Subtotal	$148,764	$2,339	$146,425	$74,801	$0	$61,085	$10,539	$146,425
Transfer & Haul Total	**$1,583,379**	**$34,315**	**$1,549,064**	**$1,090,786**	**$0**	**$441,330**	**$16,948**	**$1,549,064**
Facilities (k)								
Lynde & McLeod	$95,287	$0	$95,287	$0	$0	$95,287	$0	$95,287
Kraemer/Burnsville	$67,448	$0	$67,448	$0	$0	$67,448	$0	$67,448
Pine Bend	$41,111	$0	$41,111	$0	$0	$41,111	$0	$41,111
Mics. Yard Waste Processing	$4,221	$0	$4,221	$0	$0	$4,221	$0	$4,221
Empire Organic	$208,600	$0	$208,600	$0	$0	$208,600	$0	$208,600
Christmas Trees	$2,759	$0	$2,759	$0	$0	$2,759	$0	$2,759
Compost Site Rental	$30,000	$30,000	$0	$0	$0	$0	$0	$0
HHW Processing & Disposal	$516,671	$516,671	$0	$0	$0	$0	$0	$0

Table 8
Total Net Costs Allocated by Type of Waste FY 1992
(continued)

Description	Total Costs	Not Applicable Costs	Total Costs for Analyzed MSW	Waste Type				Total Costs
				Garbage	Recyclables	Yard Waste	Bulky Waste	
HERC WTE O&M	$2,928,765	$51,723	$2,877,042	$2,861,046	$0	$0	$15,996	$2,877,042
NSP Elk River	$257,707	$7,815	$249,892	$249,892	$0	$0	$0	$249,892
NSP Newport	$30,246	$917	$29,329	$29,329	$0	$0	$0	$29,329
Eden Prairie	$17,010	$516	$16,494	$16,494	$0	$0	$0	$16,494
Material Recovery Facility (RMR)	$36,898	$0	$36,898	$0	$36,898	$0	$0	$36,898
Subtotal	$4,236,725	$607,643	$3,629,082	$3,156,761	$36,898	$419,427	$15,996	$3,629,082
Capital Costs:								
HERC Facility (l)	$3,023,155	$53,390	$2,969,764	$2,953,253	$0	$0	$16,511	$2,969,764
Elk River Facility	$90,298	$2,738	$87,560	$87,560	$0	$0	$0	$87,560
HHW Collection Center (Brooklin Park Transfer Station)	$13,294	$13,294	$0	$0	$0	$0	$0	$0
MRF	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal	$3,126,747	$69,423	$3,057,324	$3,040,813	$0	$0	$16,511	$3,057,324
Revenues								
HERC Electricity (m)	$1,778,403	$31,407	$1,746,996	$1,737,283	$0	$0	$9,713	$1,746,996
HERC Ferrous (m)	$8,594	$261	$8,334	$8,287		$0	$46	$8,334
Elk River Electricity	$39,816	$1,207	$38,609	$38,609	$0	$0	$0	$38,609
Subtotal	$1,826,813	$32,876	$1,793,938	$1,784,179	$0	$0	$9,759	$1,793,938
Facilities Total	**$5,536,658**	**$644,190**	**$4,892,468**	**$4,413,395**	**$36,898**	**$419,427**	**$22,748**	**$4,892,468**
Landfill								
HERC Non-Processibles (m)	$5,736	$101	$5,635	$5,603	$0	$0	$31	$5,635
HERC Ash Disposal (m)	$743,935	$13,138	$730,797	$726,734	$0	$0	$4,063	$730,797
Elk River Non-processibles & Residue	$43,777	$1,328	$42,449	$42,449	$0	$0	$0	$42,449
Elk River Ash Disposal	$48,955	$1,485	$47,470	$47,470	$0	$0	$0	$47,470
Anoka Landfill	$216,318	$6,560	$209,758	$209,758	$0	$0	$0	$209,758
Woodlake Landfill	$8,846	$268	$8,577	$8,577	$0	$0	$0	$8,577
Landfill Total	$1,067,567	$22,880	$1,044,687	$1,040,593	$0	$0	$4,094	$1,044,687
Promotion/Education/PR								
Publication & Printing Recycle	$14,387	$0	$14,387	$0	$14,387	$0	$0	$14,387
Publication & Printing General	$74,270	$2,817	$71,453	$49,661	$11,026	$8,505	$2,262	$71,453
County Educ. & Promo.	$0	$0	$0	$0	$0	$0	$0	$0
Recycling	$37,125	$0	$37,125	$0	$37,125	$0	$0	$37,125
Waste Reduction & Reuse	$14,097	$14,097	$0	$0	$0	$0	$0	$0
HHW	$2,514	$2,514	$0	$0	$0	$0	$0	$0
Yard Waste	$8,456	$0	$8,456	$0	$0	$8,456	$0	$8,456

Table 8
Total Net Costs Allocated by Type of Waste FY 1992
(continued)

Description	Total Costs	Not Applicable Costs	Total Costs for Analyzed MSW	Waste Type				Total Costs
				Garbage	Recyclables	Yard Waste	Bulky Waste	
Multi-Housing	$6,884	$6,884	$0	$0	$0	$0	$0	$0
Agriculture Education	$44	$44	$0	$0	$0	$0	$0	$0
Printing, postage, & supplies	$9,289	$3,163	$6,125	$0	$4,989	$1,136	$0	$6,125
Promotion/Education/PR Total	**$167,065**	**$29,519**	**$137,546**	**$49,661**	**$67,526**	**$18,097**	**$2,262**	**$137,546**
Other Costs								
Waste Disposal - Tires	$12,650	$12,650	$0	$0	$0	$0	$0	$0
Hazardous Waste	$11,731		$11,731	$0	$0	$0	$11,731	$11,731
Other Costs Total	**$24,381**	**$12,650**	**$11,731**	**$0**	**$0**	**$0**	**$11,731**	**$11,731**
NET COST	**$24,718,843**	**$920,714**	**$23,798,129**	**$16,918,502**	**$3,645,157**	**$2,553,803**	**$680,668**	**$23,798,129**
NET COST PER TON ($/TON)				**$166**	**$170**	**$158**	**$211**	

Notes:

a The procedure for the allocation of costs is as follows:
Step 1 Classifying each expenditure or revenue by function (i.e. G&A, Collection; Transfer Station and Haul; Facilities; Landfill; Promotion, Education and Public Relations; and Other).
Step 2 Determining expenditures that are totally or partially "applicable" or "not applicable" to the 142,907 tons of Analyzed MSW. Approximately 3.7% of the $28.3 million net cost was deemed "not applicable." This "not applicable" portion can be attributed to management of "not applicable" waste (i.e. self hauled waste and HHW).
Step 3 Allocating expenditures related to the Analyzed MSW to the management of Garbage, Recyclables, Yard Waste, and Bulky Waste. The allocations by facility were done in proportion to the waste delivery quantities to the facility. For example, Since the HERC receives 502 tons (or 0.56%) Bulky Waste, 0.56% of the total cost to process material at the HERC is allocated to Bulky Waste. The allocation of collection costs was based upon the City's reported hours spent to collect each waste.

b SOURCES:
1. City of Minneapolis, "Annual Report - Solid Waste & Recycling 1992 with Comparative Data for 1991," Department of Public Works.
2. City of Minneapolis, "Asset Inventories," Solid Waste & Recycling Division.
3. City of Minneapolis, "Annual Financial Report for the Year Ending December 31, 1992."
4. City of Minneapolis, "Monthly Invoices for MRI and HTI."
5. Summary of Monthly Recycling Material Fees Between Recycle Minnesota Resources and the City of Minneapolis," January 7, 1993.
6. Hennepin County, "Solid Waste Management Master Plan," 1993.
7. Hennepin County, "1992 NSP ERRRF Binnings by Month."
8. Hennepin County, "1992 HERC Billings by Month."
9. Conversations with various City and County officials

c Allocation of City collection costs is based upon the percentage of labor hours as reported by the City, spent to collect each type of waste.
d Allocation between garbage and yard waste is based on the percentage of truck hours devoted to each activity.
e Allocation of Contract Collection based on actual billings as reported by the City.
f Allocation of Maintenance Shop costs is based on allocation of these costs as reported by the City.
g Maintenance Shop Equipment capital cost is allocated based on O&M cost allocation.
h Garbage/Yard Waste collection vehicles and equipment capital cost is allocated based on hours of operation for each activity.
i The allocation of costs to "Not Applicable" is based on the percentage of tons that were self-hauled.
j The allocation of costs between Garbage and Bulky Waste is based on the percentage of tonnage delivered to the South Transfer Station that was Garbage and Bulky Waste respectively.
k The allocation of the Garbage between "Not Applicable" and "analyzed" is based on the fraction of tonnage that is self-hauled.
l Allocation of costs for the HERC facility is based on percentage of tonnage that is Garbage and Bulky Waste.
m Allocation of HERC costs/revenues between Garbage and Bulky Waste is based on tonnage.

The results of the Program Incremental Costs analysis are provided in Tables 9 through 12. Each table shows in the first column the costs incurred by the City in FY 1992, which includes the costs of all of the Programs (i.e., "With Program"). The second column of each table (i.e., "Without Program") shows an estimate of the costs (or savings) that would have occurred if a given Program had never been implemented. The difference between the first two columns is shown in the third column and represents the Program Incremental Cost (or Savings).

It should be noted that all of the Program Incremental Costs (Savings) presented below are highly dependent on the assumed landfill(s) location and average tip fees. The results presented assume that there would be sufficient capacity at a local landfill and that the prevailing tip fees would be similar to the FY 1992 tip fees. However, because there is limited landfill capacity in the Minneapolis area, this may not be a reasonable assumption. For example, it is likely that without the WTE programs, the demand for landfill space would increase significantly and the distance travelled and tip fees paid would be higher than those that existed in FY 1992. Thus, the WTE Program Incremental Cost is probably overstated. Similarly, the other Program Incremental Costs (Savings) would be significantly affected if these assumptions are not valid.

Summary of Results

Of the approximately 145,087 tons of waste managed by the City, about 142,907 tons, or about 99 percent, were analyzed to determine the cost of the City's IMSWM system. The total FY 1992 net cost to manage the Analyzed MSW was $23,798,129 or about $167 per ton.

The net cost was broken down by functional area in Table 8. The results are as follows:

- G&A: 19 percent
- Collection: 49 percent
- Transfer and Haul: 6 percent
- Facilities (Processing): 21 percent
- Landfill: 6 percent
- Promotion, Education, and Public Relations: <1 percent
- Other: <1 percent.

This net cost was also broken down in Table 8 by the type of analyzed MSW as follows:

- Garbage: 71 percent ($166 per ton of garbage in Analyzed MSW)
- Recyclables: 15 percent ($170 per ton of garbage in Analyzed MSW)
- Yard Waste: 11 percent ($158 per ton of garbage in Analyzed MSW)
- Bulky Waste: 3 percent ($211 per ton of old corrugated cardboard in Analyzed MSW).

The Program Incremental Costs analysis resulted in the following incremental costs per ton by program:

- WTE Program: $6 per ton
- Curbside Recycling Program: $53 - $95 per ton
- Yard Waste Programs: $35 - $73 per ton
- Bulky Waste/Problem Waste Programs: $69 per ton.

Table 9
Incremental Cost (Savings) of the Waste-to-Energy Program

Cost Categories & Revenues	With Program	Without Program	Incremental Cost (Savings)
General & Administrative	$4,494,097[a]	$4,276,597	$217,500
Collection	11,695,347[b]	11,695,347	0
Transfer & Haul	1,549,064[c]	3,283,961	(1,734,897)
Materials Recovery Facility	36,898[d]	36,898	0
Waste-to-Energy Facility	6,213,586[e]	0	6,213,586
Composting Operations	324,139[f]	324,139	0
Landspreading Operation	95,287[g]	95,287	0
Landfill	1,044,687[h]	3,334,067	(2,289,380)
Other	165,771[i]	165,771	0
Revenues	(1,820,749)[j]	(26,811)	(1,793,938)
Total	$23,798,129[k]	$23,185,258	$612,871
Tons Managed			95,692
Incremental Cost (Savings) per ton			$6.40 k

[a] Total G&A from Table 8.
[b] Total Collection (excluding revenues) from Table 8.
[c] Total transfer & Haul form Table 8.
[d] Facilities (Table 8) RMR MRF.
[e] Facilities (Table 8) HERC, Elk River, Newport - O&M; HERC, Elk River - Capital.
[f] Facilities (Table 8) Kraemer/Burnsville, Pine Bend, Empire Organics, Miscellaneous Yard Waste Processing, Christmas Tree Processing.
[g] Facilities (Table 8) Lynde & McLeod.
[h] Total Landfill (Table 8).
[i] Total Other, Total Public Relations, and Eden Prairie Facility (Table 8).
[j] Revenues for Bulky Waste Collection, HERC Electricity & Ferrous recovery, and Elk River Electricity (Table 8).
[k] This value may beoverstated because the demand for local landfill space is likely to have increased significantly, without the WTE program, resulting in greater average hauling distances.

Table 10
Incremental Cost (Savings) of the Curbside Recycling Program

Cost Categories & Revenues	Assuming 0% Increase in Collection Costs			Assuming 15% Increase in Collection Costs	
	With Program	Without Program	Incremental Cost (Savings)	Without Program	Increment al Cost (Savings)
General & Administrative	$4,494,097[a]	$4,225,887	$268,210	$4,225,887	$268,210
Collection	11,695,347[b]	8,948,102	2,747,245[c]	9,857,705	1,837,210
Transfer & Haul	1,549,064[c]	2,175,258	(626,194)	2,175,258	(626,194)
Materials Recovery Facility	36,898[d]	0	36,898	0	36,898
Waste-to-Energy Facility	6213,586[e]	6,312,369	(98,783)[g]	6,312,369	(98,783)
Composting Operations	324,139[f]	324,139	0	324,139	0
Landspreading Operation	95,287[g]	95,287	0	95,287	0
Landfill	1,044,687[h]	1,393,922	(349,235)[k]	1,393,922	(349,235)
Other	165,771[i]	98,245	67,526[m]	98,407	67,364
Revenues	(1,820,749)[j]	(1,820,749)	0	(1,820,749)	0
Total	$23,798,129[k]	$23,185,258	$612,871	$22,662,227	$1,135,902
Tons Managed			95692		21,498
Incremental Cost (Savings) per ton			$6.40		$52.84

[a] Total G&A from Table 8.
[b] Total Collection (excluding revenues) from Table 8.
[c] Reference Table 8 (Recyclables" column in Collection section) equals sum of following:
City Collection $1,286,244
MRI Collection $1,283,439
Equipment Shop $1,500
Capital Costs - Bins $155,300
Capital Costs - Recyclables $20,762
[d] Total Transfer & Haul form Table 8.
[e] Facilities (Table 8) RMR MRF.
[f] Facilities (Table 8) HERC, Elk River, Newport - O&M; HERC, Elk River - Capital.
[g] Equals $9.19 per ton times half of 21,498 tons.
[h] Facilities (Table 8) Kraemer/Burnsville, Pine Bend, Empire Organics, Miscellaneous Yard Waste Processing, Christmas Tree Processing.
[i] Facilities (Table 8) Lynde & McLeod.
[j] Total Landfill (Table 8).
[k] Equals $32.49 per ton times half of 21,498 tons.
[l] Total Other, Total Public Relations, and Eden Prairie Facility (Table 8).
[m] Reference Table 8 "Recyclables" column for the facilities section - Promotion & Education.
[n] Revenues for Bulky Waste Collection, HERC Electricity & Ferrous recovery, and Elk River Electricity (Table 8).

Table 11
Incremental Cost (Savings) of the Yard Waste Program

Cost Categories & Revenues	Assuming 0% Increase in Collection Costs			Assuming 15% Increase in Collection Costs	
	With Program	Without Program	Incremental Cost (Savings)	Without Program	Increment al Cost (Savings)
General & Administrative	$4,494,097[a]	$4,494,097	$0	**$4,494,097**	$0
Collection	11,695,347[b]	10,492,921	2,202,426[c]	11,099,323	596,024
Transfer & Haul	1,549,064[d]	1,674,443	(125,379)	1,674,443	(123,379)
Materials Recovery Facility	36,898[e]	36,898	0	36,898	0
Waste-to-Energy Facility	6213,586[f]	6,287,841	(74,255)[g]	6,287,841	(74,255)
Composting Operations	324,139[h]	0	324,139i	0	324,139
Landspreading Operation	95,287[j]	0	95,287 k	0	95,287
Landfill	1,044,687[l]	1,307,206	(262,519)[m]	1,307,206	(262,519)
Other	165,771[n]	147,674	18,097[o]	147,674	18,097
Revenues	(1,820,749)[p]	(1,820,749)	0	(1,820,749)	0
Total	$23,798,129[k]	$22,620,333	$1,177,796	$22,662,227	$571,394
Tons Managed			16,159		16,159
Incremental Cost (Savings) per ton			$72.89		$35.36

[a] Total G&A from Table 8.
[b] Total Collection (excluding revenues) from Table 8.
[c] Equals the sum of avoided yard waste collection costs of $399,881 (City) and $593,071 (MRI) Equipment costs of $164,922 allocated to yard waste and annualized capital costs of yard waste collection vehicles of $44,552 (Reference table 8)
[d] Total Transfer & Haul form Table 8.
[e] Facilities (Table 8) RMR MRF.
[f] Facilities (Table 8) HERC, Elk River, Newport - O&M; HERC, Elk River - Capital.
[g] Equals $9.19 per ton times half of 16,159 tons.
[h] Facilities (Table 8) Kraemer/Burnsville, Pine Bend, Empire Organics, Miscellaneous Yard Waste Processing, Christmas Tree Processing.
[i] Payments made to raemer/Burnsvill, Pine Bend, Empire Organics, etc.
[j] Facilities (Table 8) Lynde & McLeod.
[k] Payments made to Lynde & McLeod.
[l] Total Landfill (Table 8).
[m] Equals average FY 1992 Anoka Landfill tip fee of $32.49 per ton times half of 16,159 tons.
[n] Total Other, Total Public Relations, and Eden Prairie Facility (Table 8).
[o] Reference Table 8 "Recyclables" column for the facilities section - Promotion & Education.
[p] Revenues for Bulky Waste Collection, HERC Electricity & Ferrous recovery, and Elk River Electricity (Table 8).

Table 12
Incremental Cost (Savings) of the Bulky Waste/Problem Waste Recycling Program (FY 1992 $)

Cost Categories and Revenues	With Program		Without Program	Incremental Cost (Savings)	
General & Administrative	$4,494,097	[a]	$4,494,097	$0	
Collection	11,695,347	[b]	11,695,347	0	
Transfer & Haul	1,549,064	[c]	1,620,504	(71,440)	[d]
Materials Recovery Facility	36,898	[e]	36,898	0	
Waste-to-Energy Facilities	6,213,586	[f]	6,213,586	0	
Composting Operations	324,139	[g]	324,139	0	
Landspreading Operation	95,287	[h]	95,287	0	
Landfill	1,044,687	[i]	1,132,995	(88,308)	[j]
Other	165,771	[k]	165,771	0	
Revenues	(1,820,749)	[l]	(1,793,938)	(26,811)	[m]
TOTAL	$23,798,129		$23,984,688	($186,559)	
Tons Managed				2,718	[n]
Incremental Cost (Savings) per Ton ($/ton)				($68.64)	

Notes:

[a] Total G&A from Table 4-10.

[b] Total Collection (excluding Revenues) from Table 4-10.

[c] Total Transfer and Haul from Table 4-10.

[d] Sum of avoided transfer (handling) cost which equals $25,060 ($9.22 times 2,718 tons) and avoided haul cost which is equal to $46,380 (i.e. 27 miles times 2,718 tons times $0.632 per ton-mile).
FY 92 average transfer (handling cost) milage to Anoka landfill and average haul cost are $9.22/ton, 27 miles, and $0.632 per ton-mile.

[e] Facilities (Table 4-10), RMR MRF.

[f] Facilities (Table 4-10): HERC, Elk River, Newport - O&M
HERC, Elk River - Capital

[g] Facilities: Kraemer/Burnsville, Pine Bend, Empire Organics, Miscellaneous Yard Waste Processing, and Christmas Tree Processing.

[h] Facilities (Table 4-10): Lynde & McLeod

[i] Total Landfill from Table 4-10.

[j] Avoided landfill tip fee assumed to be average FY 92 Anoka Landfill tip fee of $32.49 per ton (32.49 times 2,718 tons equals $88,308).

[k] Total Other, Total Public Relations, and Eden Prairie Facility.

[l] Revenues for Bulky Waste Collection, HERC Electrcity & Ferrous recovery, and Elk River Electricity from Table 4-10.

[m] Equals revenues from Bulky Wastes that are recovered.

[n] Sum of Bulky/Problem Wastes exclusive of tons not recovered.

Energy Usage Analysis

The energy consumed to manage the City's MSW during FY 1992 is discussed in this section. Due to the complexity of the management programs, much of the information presented in this section is limited by the availability of data.

The types of management programs which the Report covers include:

- Collection
- Transfer and hauling
- Transfer and hauling of RDF, residue, and ash generated from MSW
- MSW processing and disposal facilities
- Transport of recovered materials to remanufacturers/end markets.

Energy consumed in the remanufacturing process for recovered materials is excluded from the analysis herein because it is beyond the scope of this study. Since many remanufacturing processes utilizing recovered material use less energy than processes utilizing virgin material this exclusion, may understate the overall energy efficiency of recycling. Conversely, for example, energy consumption for processing yard waste into compost or mulch is included in this study. The distinction is that yard waste, unlike recyclables, is not a remanufactured consumable with an alternate virgin material substitute. Thus, the energy consumed by the processing of yard waste is considered in this analysis to the extent that data is available. Energy consumption for management of HHW is excluded due to a lack of data.

Collection Vehicle Energy Consumption

Energy in the form of diesel fuel and gasoline is consumed in the IMSWM system for the collection of garbage, yard waste, bulky waste, and recyclables. Truck hour data provided by the City were used to allocate the fuel consumption data for sanitation vehicles among garbage, yard waste, and bulky waste collection. The results of this allocation are provided in Table 13. These estimates include the fuel consumed by administration vehicles.

The City also purchased 16,841 gallons of unleaded gasoline and 13,681 gallons of diesel fuel for "recycling" activities (e.g., curbside collection and administrative vehicles). This is equal to 28,370 equivalent gallons of diesel fuel. MRI's cost for diesel and gasoline related to recyclables collection was converted to gallons based on average prices of gasoline and diesel fuel estimated by MRI. Equivalent gallons of diesel were then calculated. As shown in Table 13, an estimated total of 59,070 equivalent gallons of diesel were consumed by MRI and the City to collect recyclables.

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Table 13
Energy Consumption to Collect Garbage, Yard Waste, Bulky Waste, and Recyclables
FY 1992

Variables	Garbage	Bulky Waste	Yard Waste	Recyclables
City Truck Hours	41,089	6,247	9,402	
Percent of Truck Hours	72.42	11.01	16.57	
Tons Collected	48,355	3,220	7,823	21,499
Millions of Btus	10,689	1,625	2,446	8,648
Diesel Fuel (Equivalent Gallons)	73,020	11,100	16,710	59,070
Gallons Per Ton	1.5	3.4	2.1	2.7

Data for garbage, yard waste, and bulky waste are from the City only.
Data for Recyclables are for both the City and MRI.
MRI fuel consumption assumes average price of gasoline and diesel fuel were $1.10 and $1.25 per gallon, respectively. (Telephone conversation with Mr. D. Kruell, MRI, October 29, 1994).
Conversion to millions of Btus for diesel fuel assumes 146,390 Btus per gallon.
Conversion to millions of Btus for gasoline assumes 127,650 Btus per gallon.
Sources:
1. City of Minneapolis, "Fuel Use Data," Computer Printouts.
2. Minneapolis Refuse, Inc., "Monthly Invoices," December 30, 1991 through December 31, 1992.

Energy Consumption for Transfer and Hauling of MSW

No data were available to determine the energy consumed to operate the North and South Transfer Stations. However, the operator of the transfer stations did provide data on energy consumed to transport garbage, bulky waste, and yard waste from the transfer stations to their subsequent destinations.

Based on data provided by HTI, the operator of both transfer stations, an average of 0.024 gallons per ton-mile was consumed to haul garbage/bulky waste or yard waste in transfer trailers. Because the average loads of either garbage/bulky waste or yard waste were about 18.6 tons, there was little or no difference in the fuel consumed to haul either garbage/bulky waste or yard waste. Table 14 shows that an estimated 17,110 gallons of diesel fuel were consumed in FY 1992 to transport 58,136 tons of garbage and 502 tons of bulky waste from the South Transfer Station. Similarly, an estimated 9,480 gallons of diesel fuel were consumed in FY 1992 to transport 15,753 tons of yard waste from the North Transfer Station to various composting or landspreading sites.

Table 14
Energy Consumption to Transport MSW from North and South Transfer Stations FY 1992

South Transfer Station				North Transfer Station			
Delivered To	**Tons**	**Distance (Miles)**	**Gallons**	**Delivered To**	**Tons**	**Distance (Miles)**	**Gallons**
HERC	44,189	6.0	6,363	Christmas Trees	248	19.0	113
Elk River	6,868	36.0	5,934	Lynde & McLeod	5,015	19.0	2,287
Newport	488	15.0	176	Kraemer/ Burnsville	3,109	21.0	1,567
Eden Prairie	210	16.3	82	Pine Bend	1,136	27.0	736
Anoka Landfill	6,658	27.6	4,410	Hiawatha	73	18.5	32
Woodlake Landfill	224	26.0	140	Empire Organic	6,172	32.0	4,740
Total	58,638		17,106	**Total**	15,753		9,476

Based upon average energy consumption of 0.024 gallons per ton-mile.
Source: BFI Waste System Invoices, January 1992 through December 1992.

Energy Consumption to Transport RDF, Residue, and Ash

RDF, residue, and ash are hauled among the various WTE facilities, mixed waste processing facilities, and landfills that comprise the IMSWM system. Some examples are: (1) the RDF produced at the Elk River facility was hauled in transfer trailers to either the UPA or Wilmarth power plants; (2) the ash generated at the UPA power plant was hauled about 18 miles in open top dump trucks to the Becker Landfill; (3) the ash generated at the HERC facility was hauled in open top dump trucks about 460 miles to the Laraway Landfill in Illinois; (4) rejects and heavies from the Eden Prairie facility and non-processible waste from Elk River were hauled to the HERC facility; and (5) residues from the Elk River and Eden Prairie facilities were hauled to landfills.

The average amount of fuel consumed in FY 1992 to haul ash in open top dump trucks was about 0.026 and 0.017 gallons per ton-mile to the Becker and Laraway Landfills, respectively. The estimated total gallons of fuel consumed to haul this ash is shown in Table 15.

Table 15
Energy Consumption to Transport RDF, Residue, and Ash Generated from MSW FY 1992

Material	Delivered To	Tons	Distance (Miles)	Gallons
Ash from HERC	Laraway Landfill	24,798	460	193,920
Ash from UPA	NSP Becker Landfill	1,164	18	545
Ash from Wilmarth	Ponderosa Landfill	301	11	86
Ash from Red Wing	NSP Red Wing Landfill	3	10	1
Total				632

Energy Consumption at the Municipal Solid Waste Processing and Disposal Facilities

Table 16 shows the energy consumed in FY 1992 at the WTE and mixed waste processing facilities, yard waste composting, mulching and landspreading operations, and Woodlake, Becker, and Laraway Landfills.

Table 16
Energy Consumption by Function FY 1992

Function	Total Tons Processed at Facility	Diesel Fuel (Gallons)	No. 2 Oil (Gallons)	Natural Gas (Kcuft)	Electricity (Mwh)	Total Energy Consumed at Facility (MBtus)	Total Energy/Ton (Gal./Ton)
Combustion and Processing							
HERC	364,996	Unknown		31,260		31,260	0.59
Elk River Processing	402,835	48,000		2,700	1,270	14,060	0.24
UPA Combustion (Tons of RDF)	254,362	24,025	40,700	87,315		96,790	2.60
Eden Prairie	105,597	Unknown		2,381	5,439	20,940	1.35
Yard Waste Processing							
Kraemer Composting	11,573	17,005				2,490	1.47
Lynde & McLeod landspreading	23,330	11,243				1,650	0.48
Landfill							
Woodlake Landfill (MSW)	124,400	37,288				5,460	0.30
Becker Landfill (Ash)	13,830	2,302				340	0.17
Laraway Landfill (Ash)	213,167	24,863				3,640	0.12

Tons processed and total energy data are for waste handled at the facility, not just the city's waste.
Diesel fuel consumed at the combustion and yard waste processing facilities and the landfills is for rolling stock, including pickup trucks.
Energy consumption data at each combustion and yard waste processing facilities and the landfills were provided by the respective company officials.
No data were available on energy consumption from the MRF.
Data from Becker Landfill are for July and December 1993.
1993 electricity consumption data for the Eden Prairie facility were converted to 1992 by assuming the average consumption per ton in 1993 is applicable to 1992.
Energy consumption at the Elk River and HERC facilities exclude in-plant power.
Conversion factors used to determine Total Energy Consumed at facility (MBtus) are as follows: diesel + 146,390 Btus per gallon; natural gas + 1,000 Btus per cubit foot; No. 2 oil + 146,390 Btus per gallon; electricity + 3,413 Btu per kilowatt hour. These conversion factors were used to be consistent with other case studies developed by CSI.

Energy Consumption to Transport Recovered Material to Remanufacturers/End Markets

No information was available to determine the energy consumed to haul compost or recyclables to market. However, data on selected quantities of recyclables and distances to markets were obtained, as shown in Table 17. The compost facility operators indicated that the majority of the compost was sold locally.

Table 17 reflects approximate ton-miles for hauling recyclables from the Recyclable Minnesota Resource MRF and resource recovery facility to market.

Table 17
Ton-Mile Equivalents for Transporting Recyclables FY 1992

Recyclables	Tons	Miles	Ton-Miles
Curbside Recycling (sent from RMR MRF)			
Glass	5,912	15	88,680
Aluminum	512	450	230,400
Steel	1,143	10	11,430
Plastic	645	300	193,500
Newspaper	6,882	10	68,820
Corrugated	315	1,300	409,500
Total	15,409		1,002,330
Resource Recovery			
Metals from HERC	2,443	2	4886
Metals from Elk River	243	48	11,664
Total	2,686		16,550

Of the 12,914 tons of newspaper collected, 6,032 tons were sent directly to the end user. The energy consumed in the transportation of the 6,032 tons is assumed to be covered by collection energy consumption. The energy consumed by the remaining 6,882 tons is the result of transporting this material from the RMR MRF to the market.

Transportation data for 57 tons of curbside collected magazines was not obtained and is excluded from this analysis.

Transportation data for the ferrous materials recovered at the Newport facility was not available and is excluded from this analysis.

Data for the recyclables recovered at the Eden Prairie facility was not available and is excluded from this analysis.

Energy Consumption to Manage Garbage, Bulky Waste, Yard Waste, and Curbside Recyclables

Tables 18 through 21 show the equivalent gallons of diesel fuel per ton to manage (i.e. collect, transport, process, and deliver to end users) garbage, bulky waste, yard waste, and curbside recyclables, respectively. Much of the data needed to determine the total gallons of diesel fuel per ton for managing MSW are missing. Due to this lack of relevant data, a reasonable calculation of total equivalent gallons of diesel fuel used to manage waste cannot be performed. Tables 18 through 21 are intended to show exactly where data is missing.

Table 18
Energy Consumption to Manage Garbage FY 1992

	Tons	Equivalent Gallons of Diesel	Equivalent Gallons of Diesel Per Ton
Collection			
City Collection	48,355	73,020	1.5
MRI Collection	50,703	--	--
Self-Haul	2,027	--	--
Special Collections	2,972	--	--
South Transfer Station			
Facility	58,136	--	--
Transportation of Garbage to:			
HERC	43,687	6,363	0.1
Elk River	6,868	5,934	0.9
Newport	488	8,176	0.4
Eden Prairie	210	82	0.4
Anoka Landfill	6,658	4,078	0.6
Woodlake Landfill	224	140	0.6
HERC			
Facility	90,293	53,273	0.59
Transportation of:			
Recovered Ferrous to Market	2,444	--	--
Non-processibles to Landfill Disposal Sites	217	--	--
Ash to Landfill Disposal Site	24,798	193,920	7.8
Elk River Processing/combustion			
Processing Facility	6,868	1,648	0.2
Transportation of RDF to:			
UPA Power Plant	4,074	--	--
Wilmath Power Plant	1,052	--	--
Red Wing Power Plant	10	--	--
Transportation of Non-Processibles/Residue to:			--
Landfill Disposal Sites	1,182	--	--
HERC	144	--	

Table 18
Energy Consumption to Manage Garbage FY 1992
(continued)

	Tons	Equivalent Gallons of Diesel	Equivalent Gallons of Diesel Per Ton
Transportation of Recovered Ferrous to Market	243	--	--
Power Generation Facilities:			
UPA	4,074	10,592	2.6
Wilmath	1,052	--	--
Red Wing	10	--	--
Transportation of Wet Ash to:			
Becker Monofill	1,164	545	0.5
Wilmath Monofill	301	141	0.5
Red Wing Monofill	3	1	0.3
Newport Processing/Combustion			
Processing Facility	488	--	--
Transportation of RDF to:			
UPA Power Plant	1	--	--
Wilmath Power Plant	124	--	--
Red Wing Power Plant	239	--	--
Transportation of Non-Processibles/Residue to:			
Landfill Disposal Sites	111	--	--
HERC	144	--	--
Transportation of Recovered Ferrous to Market	13	--	--
Power Generation Facilities:			
UPA	1	3	3
Wilmath	124	--	--
Red Wing	239	--	--
Transportation of Wet Ash to:			
Becker Monofill	0	--	--
Wilmath Monofill	35	--	--
Red Wing Monofill	68	--	--
Eden Prairie Processing/Combustion			
Processing Facility	210	284	1.35
Transportation of RDF to Market	78	--	--
Transportation of Non-Processibles/Residue to:			
Landfill Disposal Sites	77	--	--
HERC	37	--	--
Compost Facility	2	--	--
Transportation of Recovered Materials to Market	9	--	--
Power Generation Facilities	78	--	--
Transportation of Wet Ash to Disposal Sites	--	--	--

Table 18
Energy Consumption to Manage Garbage FY 1992
(continued)

	Tons	Equivalent Gallons of Diesel	Equivalent Gallons of Diesel Per Ton
Landfills/Monofills			
Anoka	--	--	--
Woodlake	--	--	0.3
Elk River	--	--	--
Becker	1,164	198	0.2
Wilmath	336	--	--
Red Wing	71	--	--
Laraway	24,798	2,976	0.1

The energy consumption of HERC excludes diesel and electricity usage, but includes natural gas usage. In-house electrical consumption at all power generation facilities is excluded.

Table 19
Energy Consumption to Manage Bulky Waste FY 1992

	Tons	FY 1992 Equivalent Gallons of Diesel	Equivalent Gallons of Diesel Per Ton
Collection	3,220	11,100	3.4
North Transfer Station			
Facility	2,718	--	--
Transportation of Recovered Ferrous to Market	2,310	--	--
Transportation to Landfill Disposal Site	408	--	--
South Transfer Station			
Facility	502	--	--
Transportation to HERC	502	72	0.1
Landfill	910	--	--

Table 20
Energy Consumption to Manage Yard Waste FY 1992

	Tons	FY 1992 Equivalent Gallons of Diesel	Equivalent Gallons per Ton of Diesel
Collection			
City Collection	7,823	16,710	2.1
MRI Collection	8,336	--	--
North Transfer Station			
Facility	15,753	--	--
Transportation of Yard Waste to:			
Ceres	248	113	0.5
L&M	5,015	2,287	0.5
Pine Bend	1,136	736	0.6
Hiawatha	73	32	0.4
Empire Organic	6,172	4,740	0.8
Burnsville	3,109	1,567	0.5
Processing Facilities			
Ceres	248	--	--
L&M	5,015	2,407	0.5
Pine Bend	1,136	--	--
Hiawatha	73	--	--
Empire Organic	6,172	--	--
Burnsville	3,109	4,570	1.5

Approximately 406 tons of yard waste bypass the North Transfer station and go directly to a processor. No data were acquired on where this material was ultimately processed. The tonnages for processing facilities shown above assume the yard waste bypassing the North Transfer Station did not go to any of these facilities.

Table 21
Energy Consumption to Manage Curbside Recyclables

	Tons	FY 1992 Equivalent Gallons of Diesel	Equivalent Gallons of Diesel per Ton
Collection			
City Collection	10,834	28,370	2.6
MRI Collection	10,665	30,700	2.9
MRF			
Facility	15,466	--	--
Transportation of Recyclables to Market:			
Glass	5,912	--	--
Aluminum	512	--	--
Steel	1,143	--	--
Plastics	646	--	--
ONP	6,882	--	--
Old corrugated cardboard (OCC)	315	--	--
Magazines	57	--	--

Of the total ONP collected, 6,032 tons were hauled directly to an end-user and 6,882 tons were taken to the RMR MRF. Energy consumption related to hauling the ONP directly to the end-user is included in the City's collection consumption.

Energy Production at the HERC and UPA Power Plant

Energy production data were only available from the HERC facility and the UPA power plant. Data were not available from the Wilmath and Red Wing power plants nor the RDF market for the Eden Prairie facility.

The UPA power plant generated a total of 192,476 Mwh of electricity during FY 1992 and sold 168,188 Mwh. Based on the total tonnage processed during that time of 254,362 tons, the gross electrical generation rate was 757 Kwh per ton and the net generation rate exclusive of in-plant usage was 661 Kwh per ton. In-plant usage was approximately 13 percent of the total electricity generated.

Of the total tonnage combusted at the UPA power plant, approximately 4,075 tons, or 2 percent, was from the City's MSW. Therefore, the gross and net amount of electricity generated from the City's MSW during FY 1992 was 3,084 Mwh and 2,694 MWH, respectively, based on the average per ton electrical generation rates for the UPA power plant.

The HERC facility generated a total of 261,781 Mwh of electricity during FY 1992 and sold 227,488 Mwh. Based on the total tonnage processed during that time of 364,996 tons, the gross electrical generation rate was 717 kWh per ton, and the net generation rate exclusive of in-plant usage was 623 kWh per ton. In-plant usage was approximately 13 percent of the total electricity generated.

Of the total tonnage combusted at the HERC facility, approximately 90,293 tons, or 25 percent was from the City's MSW. Therefore, the gross and net amount of electricity generated from the City's MSW during FY 1992 were 64,760 MWh and 56,276 MWh, respectively, based on the average per ton electrical generation rates for the HERC facility.

Environmental Regulations and Permit Requirements

The compliance with the environmental regulations and permit requirements discussed in this section are reflected in the costs and energy consumption levels reported in this Case Study. In FY 1992, the operation of all of the facilities comprising the Hennepin County IMSWM System were in general compliance with all of the environmental and safety regulations.

Overview of Federal Environmental Regulations

The potential environmental impacts of solid waste management facilities have led to the development of an extensive network of federal and state regulations. Embodied in many federal environmental laws is an implicit federal-state partnership whereby the federal government sets the agenda and standards for pollution abatement while the states carry out the day-to-day activities of implementation and enforcement.

The Clean Air Act, most recently amended in 1990, established programs for protecting public health and the environment from exposure to gaseous emissions, including toxic air pollutants.[2] The Clean Water Act, most recently amended in 1987, is the principal federal law protecting the nation's waterways from pollution.[3] The Safe Drinking Water Act, most recently amended in 1988, established programs for protecting public drinking water systems from harmful contaminants.[4] The Solid Waste Disposal Act and Resource Conservation and Recovery Act (RCRA) of 1976, most recently amended in 1992, is the main piece of federal legislation addressing landfill disposal regulation.[5] A brief summary of these four federal Acts as they apply to solid waste management facilities is given below.

In February 1991, the U.S. Environmental Protection Agency (EPA) issued final rules for municipal waste combustors in response to the Clean Air Act. These rules, commonly referred to as the New Source Performance Standards (NSPS), apply to municipal waste combustors with capacities of 250 tons per day or greater, and whose construction, reconstruction, or modification commenced after December 20, 1989.[6] The NSPS establish maximum emission levels for new or extensively modified major stationary sources. These emission levels were determined by "best adequately demonstrated" continuous control technology analysis and are presented in Table 22.[7] In addition to the NSPS, the EPA also proposed emissions limitations for existing (i.e., constructed, reconstructed, or modified prior to December 20, 1989) municipal waste combustors.

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[2] The Clean Air Act and Major Amendments are codified as 42 U.S.C. 7401-7671, 1990

[3] The Clean Water Act and Major Amendments are codified as 33 U.S.C. 1251-1387, 1987.

[4] The Safe Drinking Water Act and Amendments are codified as 42 U.S.C. 300f-300j-11, 1988.

[5] The Solid Waste Disposal/Resource Conservation and Recovery Act and Major Amendments are codified as 42 U.S.C. 6901-6991k, 1992.

[6] Federal Register, "Standards of Performance for New Stationary Sources: Municipal Waste Combustors," Vol. 56, No. 28, pages 5488-5527, 1991.

[7] Congressional Research Service, "Summary of Environmental Laws Administered by the Environmental Protection Agency," The Library of Congress, January 1993.

Table 22
New Source Performance Standards

Pollutant	Emission Limit[a]	Technology Basis[d]	Monitoring
Dioxins and Furans	30 ng/dscm	GCP, SD/FF	Annual Stack Test[b]
Particulate Matter	34 mg/dscm	FF	Annual Stack Test[b]
Opacity	10%	FF	CEMS, 6-min. avg.
Sulfur Dioxide	30 ppm or 80% reduction	SD/FF	CEMS, 24-hr. avg.
Hydrogen Chloride	25 ppm or 95% reduction	SD/FF	Annual Stack Test[2]
Nitrogen Oxides	Nitrogen Oxides180 ppmv[c]	SNCR	CEMS, 24-hr. avg.
Carbon Monoxide			
Modular	50 ppmv	GCP	CEMS, 4-hr. avg.
Massburn	100 ppmv	GCP	CEMS, 4-hr. avg.
Massburn/Rotary	100 ppmv	GCP	CEMS, 24-hr. avg.
Fluidized Bed	100 ppmv	GCP	CEMS, 4-hr. avg.
RDF/Full-Dedicated	150 ppmv	GCP	CEMS, 24-hr. avg.
RDF/Co-Fired	150 ppmv	GCP	CEMS, 4-hr. avg.

[a] All emission limits are dry basis corrected to 7% O_2.
[b] In the case of small plants (less than 250 TPD), if compliance is demonstrated for two consecutive years, the facility need only conduct testing every third year. If a non-compliant result occurs, another two years of consecutive testing must be done before the facility can switch back to the three-year cycle.
[c] The NO_x standard applies to large plants only; small plants are exempt.
[d] Good Combustion Practice (GCP); Spray Dryer (SD); Fabric Filter (FF); Selective Non-Catalytic Converter (SNCR).
Source: Federal Register, "Standards of Performance for New Stationary Sources: Municipal Waste Combustors," Vol. 56, No. 28, 1991.

The owner/operator of a proposed municipal waste combustor must apply for a Prevention of Significant Deterioration (PSD) permit and conduct a Best Available Control Technology (BACT) analysis to determine the applicable level of emissions control. BACT analysis evaluates the energy, environmental, and economic impacts of various alternative control technologies. The PSD permit requirements reflect the principle which holds that areas where the air quality is better than required by the national ambient air quality standards (NAAQS) established for six criteria pollutants (ozone, sulfur, dioxide, NO_x, carbon monoxide, lead, and particulates) should be protected from significant new air pollution, even if the NAAQS would not be violated by a proposed new source. Areas not meeting NAAQS are called nonattainment areas and are subject to more stringent control requirements determined by "reasonable available control technology".

Emissions from municipal waste combustors, in addition to meeting allowable limits, must also be monitored by the facility owner/operator. Monitoring requirements for existing facilities include continuous emissions monitoring for carbon monoxide and sulfur dioxide. Annual stack testing must be conducted for particulate matter, dioxin/furans, hydrogen chloride, and opacity.

The 1991 EPA regulations also required that chief facility operators and shift supervisors be certified in accordance with operating standards established by the American Society of Mechanical Engineers (ASME). While the states must develop certification programs with standards meeting those of ASME, no formal training requirement is included in the regulations.

Pursuant to the Clean Water Act, a solid waste management facility cannot cause a discharge of pollutants that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES) into United States waters. The states are responsible for establishing water quality standards and are authorized to issue discharge permits. The NPDES permit requires the source to attain technology-based effluent limits, "best practicable control technology" (BPT), and "best available technology" (BAT). The initial BPT limitations focus on regulating discharges of conventional pollutants such as bacteria and oxygen-consuming materials. The BAT limitations emphasize controlling toxic pollutants such as heavy metals, pesticides, and other organic chemicals. Table 23 provides a listing of the pollutants regulated under the NPDES.

Pursuant to the Safe Drinking Water Act, a facility or practice cannot contaminate an underground drinking water source beyond the solid waste management facility boundary or beyond an alternate boundary. Table 24 provides the maximum contaminant levels as promulgated under this Act. The primary enforcement responsibility lies with the states, provided they adopt regulations as stringent as the federal requirements, develop adequate procedures for enforcement, maintain records, and create plans providing emergency water supplies.

Pursuant to RCRA, criteria were established to determine which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on public health or the environment.[8] The objective of these criteria is to mitigate adverse effects through the protection of floodplains, endangered species, surface water, and groundwater. These criteria also provide guidelines for sludge utilization and disposal under the Clean Water Act.

Subtitle D of RCRA primarily addresses non-hazardous waste, whereas Subtitle C of RCRA addresses hazardous waste disposal. In October 1991, the EPA promulgated revised Subtitle D regulations applicable

[8] 40 CFR, EPA, Part 257--"Criteria For Classification of Solid Waste Disposal Facilities and Practices."

to MSW landfills, with an effective date of October 1993. In general, the new regulations require liners, leachate collection, groundwater monitoring, and corrective action at municipal landfills.[9]

The management of ash from municipal waste combustors is also governed by regulations established pursuant to RCRA. Much controversy surrounds the toxicity of incinerator ash and whether it should be classified as a hazardous waste under Subtitle C of RCRA, as a non-hazardous waste under Subtitle D of RCRA, or as a special waste. In 1991, the EPA began requiring the use of the Toxic Characteristic Leaching Procedure (TCLP) to determine the toxicity of ash. Currently, municipal waste combustor ash is regulated under Subtitle D as a "special waste" that requires special handling regardless of the TCLP results concerning toxicity. In the absence of sufficient federal guidance on municipal waste combustor ash disposal, some states have taken the lead in developing requirements and rules.[10]

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[9] On October 1, 1993, the Federal criteria for MSW landfills under subtitle D of RCRA were amended to extend the date of compliance for small landfills to April 9, 1994, and by delaying the effective date of subpart G, Financial Assurance, to April 9, 1995, for all MSW landfills. In addition, the MSW landfill criteria were amended by removing the exemption from the groundwater monitoring requirements and by delaying the date for compliance with all requirements of the MSW landfill criteria for two years for owners and operators of MSW landfill units in arid and remote areas that meet the qualifications of the small landfill exception in the MSW landfill criteria. (Federal Register, "Solid Waste Disposal Facility Criteria; Delay of Compliance and Effective Dates," Vol. 58, No. 189, pages 51536-51548, 1993.)

[10] On May 2, 1994, the U.S. Supreme Court ruled that ash from municipal waste combustors is not exempt from the Subtitle C requirements of RCRA as is MSW. Under RCRA, regular testing of ash, principally for toxic metals, lead, and cadmium, will be required. Ash deemed to be hazardous must be disposed of in licensed facilities that protect groundwater.

Table 23
Pollutants Regulated by the NPDES Permit Program

Oxygen Demand: Biochemical Oxygen Demand Chemical Oxygen Demand Total Oxygen Demands Total Organic Carbon Other	**Metals:** Aluminum Cobalt Iron Vanadium
Solids: Total Suspended Solids (Residues) Total Dissolved Solids (Residues) Other	**Metals (All Forms):** Other metals not specifically listed under Group 1
Nutrients: Inorganic Phosphorus Compounds Inorganic Nitrogen Compounds Other	**Inorganic** Cyanide Total Residual Chlorine
Detergents and Oils: MBAS NTA Oil and Grease Other Detergents or Algicides	**Minerals:** Calcium Chloride Fluoride Magnesium Sodium Potassium Sulfur Sulfate Total Alkalinity Total Hardness Other Minerals

Source: 40 CFR, EPA; Part 123-"Appendix A - Criteria for Reporting in the NPDES Programs."

Table 24
Maximum Contaminant Levels Promulgated Under the Safe Drinking Water Act

Chemical	MCL (mg/l)
Arsenic	0.05
Barium	1.0
Benzene	0.005
Cadmium	0.01
Carbon Tetrachloride	0.005
Chromium (Hexavalent)	0.05
2,4-Dichlorophenoxy Acetic Acid	0.1
1,4-Dichlorobenzene	0.075
1,2-Dichloroethabe	0.005
1,1-Cichloroethylene	0.007
Endrin	0.0002
Fluoride	4.0
Lindane	0.004
Lead	0.05
Mercury	0.002
Methoxyclor	0.1
Nitrate	10.0
Selenium	0.01
Silver	0.05
Toxaphene	0.005
1,1,1-Trichloroethane	0.2
Trichloroethylene	0.005
2,4,5-Trichlorophenoxy Acetic Acid	0.01
Vinyl Chloride	0.002

Source: 40 CFR, EPA, Part 257 - "Criteria for Classification of Solid Waste Disposal Facilities and Practices."

Overview of State and Local Environmental Regulations

At a minimum, state regulations are required to adopt and enforce the federal environmental protection requirements. However, states may choose to impose more stringent or more extensive requirements. A brief summary of the State of Minnesota's regulations for solid waste management follows. Specific requirements for the facilities are then discussed as they apply to the individual components of the IMSWM System.

The goal of the Minnesota Waste Management Act of 1980[11] (the "Act") is to foster integrated waste management system in a manner appropriate to the characteristics of the waste streams managed. The following waste management practices are in order of preference:

- Waste reduction and reuse
- Waste recycling
- Composting of yard waste and food waste
- Resource recovery through mixed MSW composting or incineration
- Land disposal.

The Act prohibits the disposal of unprocessed MSW and bans certain items such as appliances, batteries, HHW, and yard waste from landfills or processing facilities. To comply with the Minnesota Rules promulgated pursuant to the Act, additional separate collections of yard waste, batteries, and bulky items were implemented.

Pursuant to the Act, each county within the seven-county Minneapolis/St. Paul metropolitan area was required to recycle a minimum of 35 percent by weight of total solid waste generation by December 31, 1993. In addition, each county will have a goal to recycle 45 percent by weight of total solid waste generation by December 31, 1996. Counties must ensure that residents have an opportunity to recycle. Opportunity to recycle means availability of recycling and curbside pickup or collection centers for recyclable materials at sites that are convenient for persons to use. Counties must also provide for the collection and processing of household hazardous waste and major appliances.

Counties must ensure that their residents have the opportunity to recycle used major appliances. Recycling includes: (1) the removal of capacitors that may contain PCBs; (2) the removal of ballasts that may contain PCBs; 3) the removal of chlorofluorocarbon refrigerant gas; and (4) the recycling or reuse of the metals, including mercury.

The Minnesota Pollution Control Agency (MPCA) is responsible for the execution and enforcement of the provisions of the Act as contained in Minnesota Rules, Chapter 7035-MPCA, Solid Waste Rules (referred to as the Solid Waste Rules, unless otherwise noted).[12] In accordance with the Solid Waste Rules, the Metropolitan Council is the governmental unit responsible for the environmental oversight of solid waste management policy in Minneapolis and the seven-county metropolitan area surrounding the City. This oversight includes the review of MSW disposal, transfer, energy recovery, and compost facilities (new or expansion projects).

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[11] Minnesota Statutes, Volume 9, Environmental Protection, Chapter 115A-Waste Management, Enacted 1980, most recently amended 1992.

[12] Minnesota Rules, Chapter 7035-MPCA, Groundwater and Solid Waste Division-Solid Waste Rules; Adopted January 12, 1970; most recently amended March 18, 1991.

The Solid Waste Designation Ordinance (Number Twelve), adopted on December 10, 1985, and amended on April 24, 1990[13], requires DEM licensing of solid waste haulers and regulates all designated waste generated, collected, transported, or disposed of in Hennepin County. Designated waste is defined as "mixed MSW generated in the County and destined for in-state and out-of-state disposal, excluding hazardous waste, infectious waste, and undesignatable waste."[14] Exclusions from designation have been granted to solid waste facilities for the purpose of resource recovery, recycling, or composting. This ordinance requires that all MSW be delivered to one of the County's designated facilities; however, materials which are not recyclable and have no resource recovery value may be granted a DEM exception. The Solid Waste Source Separation and Recycling Ordinance (Number Thirteen) regulates the separation of materials which must be separated from MSW by generators, before collection of such materials.

Permit Requirements for Selected Integrated Municipal Solid Waste Management Facilities

This section briefly summarizes the permit requirements applicable to selected facilities included in the Hennepin County IMSWM System. This includes the two transfer stations in Minneapolis, the MRFs, the HERC facility, the Elk River/UPA facility, the yard waste landspread and composting facilities, and the Laraway, Becker, Anoka, and Woodlake landfills.

A solid waste management facility permit or permit modification is required by the MPCA to: (1) treat, store, process, or dispose of solid waste; (2) establish, construct, or operate a solid waste management facility; or (3) change, add, or expand a permitted solid waste management facility. A permit is effective for a fixed term not to exceed five years.[15]

In accordance with the General Technical Requirements,[16] solid waste management facility personnel must successfully complete a program of classroom instruction or on-the-job training. In addition, the owner or operator of a solid waste management facility must submit an annual report covering all activities during the previous calendar year to the MPCA.

Transfer Stations

Minneapolis' North and South transfer stations operate under a permit from the MPCA, with the City and HTI as co-permittees. In accordance with the Specific Technical Requirements[17], the transfer stations provide the operational appurtenances necessary to maintain a clean and orderly operation. They are staffed at all times the facilities are open with employees trained in the safe operation of equipment. The transfer stations must have effective barriers (e.g., fences) and procedures to prevent unauthorized entry and dumping.

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[13] Most recently, amended December 21, 1993 subsequent to the study period of FY 1992.

[14] Hennepin County Board of Commissioners, Bureau of Public Service, Ordinance Number Twelve Solid Waste Designation for Hennepin County, Adopted on December 10, 1985, amended on April 24, 1990 (subsequently amended December 21, 1993).

[15] Minnesota Rules, Chapter 7001-MPCA. Permits-Solid Waste Management Facility Permits; Adopted November 7, 1988; Amended March 18, 1991.

[16] Minnesota Rules, Chapter 7035-MPCA. Groundwater and Solid Waste Division, Solid Waste-Solid Waste Management Facility General Technical Requirements; Adopted November 7, 1988; Amended March 18, 1991.

[17] Minnesota Rules, Chapter 7035-MPCA, Solid and Hazardous Waste Division, Solid Waste Management Facility Specific Technical Requirements, Adopted November 7, 1988.

In 1992, the transfer stations were issued renewal licenses for the 1992-1993 year from the DEM. DEM inspections of these facilities verified continued compliance with licensing conditions.

Hennepin Energy Resource Company Waste-to-Energy Facility

HERC operates under a MPCA Combined Air and Solid Waste permit which was issued in 1987 and renewed in 1992. The PSD determination was received in October 1989 from MPCA. The HERC facility performed well within all emission limits during environmental testing conducted in 1992 as shown in Table 25.

HERC is permitted to discharge wastewater into public sewers that feed into the Metropolitan Wastewater Treatment Plant in accordance with the Municipal Waste Control Commission's Waste Discharge Rules and allowable discharge limitations listed on Table 26. Pursuant to HERC's NPDES permit conditions, effluent limitations and monitoring requirements are listed on Table 27.

Elk River Resource Recovery Facility

In 1992, Elk River applied to MPCA for the reissuance of the facility permit. In November, 1992 UPA conducted emission tests for particulate matter, hydrogen chloride, sulfur dioxide, and mercury. The permit limits and the results of the November test are provided in Table 28. The UPA facility met all FY 1992 MPCA standards.

Table 25
1992 HERC Emission Limits and Test Results

Emission	Permit Maximum Limit	Emission as Percent of Limit
Dioxins	1.0 ug/dscm	1.22
Hydrocarbons	3.0 lb/hr	18.67
Particulate	0.02 gr/dscf	7
Lead	0.007 lb/ton	0.08
Hydrogen Chloride	50.0 ppm	8
Mercury	0.002 lb/ton	40.33
Sulphur Dioxide	20.83 ppm	14.89
Nitrous Oxide	250.0 ppm	62.3
Carbon Monoxide	100.0 ppm	15.5
Opacity	10%	17.20

Units:
ug/dscm = microgramper dry standard cubic meter
lb/h = pounds per hour
gr/dscf = grains per dry standard cubic foot
lb/ton = pounds per ton
ppm = parts per million

Table 26
HERC Wastewater Discharge Limitations

Parameter	Standard (mg/l)
Cadmium	2
Chromium - total	8
Cyanide - total	6
Lead	1
Mercury	0.1
Nickel	6
Zinc	8
pH - Maximum	11
pH - Minimum	5

Source: Industrial Discharge Permit

Table 27
HERC Effluent Discharge Limitations

Parameter	Standard (mg/l)
Temperature	50°C (122°F)
Total Residual Chlorine	0.038 mg/l
pH - Maximum	9.0
pH - Minimum	6.0
Floating Solids	None
Visible Foam	Trace amounts only
Oil or Other Substances	No visible color film

For the purpose of this permit, the above discharges are limited solely to noncontact cooling waste free from process and other wastewater discharges.
Source: NPDES/State Disposal System Permit

Table 28
1992 UPA Emission Limits and Test Results

Emission	Permit Maximum Limit	Emissions (Nov. 92)
Dioxins (PCDD & PCDF)	125.0 ng/dscm	0.793
@ 12% CO_2 as 2378, TE	3 ng/dscm	0.014
Particulate	0.02 gr/dscf	0.007
Hydrogen Chloride	50 ppm	11.8
Carbon Monoxide	400 ppm	120[a]
Opacity	20%	0.35
Sulfur Dioxide	N/A ppm @ 7% O_2	28[a]
Mercury	N/A ug/dscm @ 7% O_2	3.71[a]
Nitrous Oxide	N/A ppm @ 7% O_2	249[b]

[a]Test results for February 1994
[b]Test results for June 1994
Units:
ng/dscm = nanograms per dry standard cubic meter

Materials Recovery Facility

Pursuant to the provisions of "permits-by-rule," of the Minnesota Rules, Chapter 7001-MPCA, Permits,[18] the owner or operator of a recycling facility is deemed to have obtained a solid waste management facility permit. No application for a permit is required, simply a letter to the MPCA notifying them of the existence of the facility.

Landspreading and Composting Facilities

Pursuant to the provisions of "permits-by-rule," of the Minnesota Rules, Chapter 7001-MPCA, Permits,[19] the owner or operator of a compost or landspreading facility (receiving yard waste only), is deemed to have obtained a solid waste management facility permit. No application for a permit is required, simply a letter to the MPCA notifying them of the existence of the facility. Furthermore, there are no regulations governing the quality of the compost generated from yard waste, although site set-up and operations are regulated.

Municipal Solid Waste and Ash Landfills

Ash from the HERC facility was disposed of at the Laraway landfill located in Elwood, Illinois. In general, this landfill is in compliance with Subtitle D requirements of RCRA.

Ash from the UPA power plant (i.e., the Elk River/UPA waste-to-energy facility) was disposed of at the Becker ash monofill. This landfill also complies with Subtitle D requirements of RCRA.

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[18] Minnesota Rules, Chapter 7001-Minnesota Pollution Control Agency, Permits-Solid Waste Management Facility Permits; Adopted November 7, 1988; Amended March 18, 1991.

[19] Minnesota Rules, Chapter 7001-MPCA, Permits-Solid Waste Management Facility Permits; Adopted November 7, 1988; Amended March 18, 1991.

Overview of Occupational Health and Safety Regulations

Federal Regulations

The Occupational Safety and Health Act of 1970[20] imposes two basic duties on private employers. State and local governments in their roles as employers are not required to comply with these duties, which are:

- To comply with occupational safety and health standards developed by the Occupational Safety and Health Administration (OSHA) pursuant to the Occupational Safety and Health Act

- To comply with the General Duty Clause, Section 5(a)(1), which requires that employers protect their employees from recognized hazards not regulated by an OSHA standard.

Pursuant to the Occupational Safety and Health Act, OSHA, created within the Department of Labor, is responsible for promulgating legally enforceable standards. These OSHA standards require conditions, or the adoption or use of one or more practices, means, methods, or processes, reasonably necessary and appropriate to protect workers on the job. These standards include the General Industry Standards, 29 CFR Part 1910, which apply to all workplaces unless more specific OSHA standards apply. The General Industry Standards are applicable to solid waste processing facilities and are listed in Table 29.

State and Local Safety Requirements

OSHA provisions, as previously mentioned, do not apply to state and local governments in their role as employers. The Act does provide that any state desiring to gain OSHA approval for its private sector occupational safety and health program must provide a program that covers its state and local government workers and that is at least as effective as its program for private employees. State plans may also cover only public sector employees.

As previously discussed, all private employers are required to comply with the General Industry Standards developed by OSHA. Thus, the privately owned and operated IMSWM System facilities must comply with OSHA standards. The State of Minnesota does have an OSHA approved state plan. In addition, the MPCA, in cooperation with the Office of Waste Management and the Metropolitan Council, has prepared and distributed a guide for the operation of a recycling or yard waste composting facility to protect the environment and public health.

[20] Occupational Safety and Health Act of 1970, 5 USC 5108, 1970, most recently amended October 1992.

Table 29
OSHA Standards and Rules

OSHA Standards and Rules	Requirement
Cadmium Standard	29 CFR 1910.1027
Chemical Safety and Handling	29 CFR 1910.120
Confined Space	29 CFR 1910.146
CPR/First Aid	29 CFR 1910.151
Crane Operation	29 CFR 1910.179
Electrical Policy	29 CFR 1910.300
Emergency Response Drill	29 CFR 1910.157
Eye Protection	29 CFR 1910.133
Fire Extinguishers and 1.5" Hose	29 CFR 1910.157(g)
Flammable Materials	29 CFR 1910.120h (1&2)
Hazard Communication	29 CFR 1910.120h (1&2)
HazMat Emergency Response Team	29 CFR 1910.1201(2)i
Lead Standard	29 CFR 1910.1025
Lock Out/Tag Out	29 CFR 1910.147
Machine Operating and Guarding	29 CFR 1910.212
Noise (Hearing Protection)	29 CFR 1910.95(k)
Powered Industrial Truck	29 CFR 1910.178(1)
Respirator Training	29 CFR 1910.134(b)(3)
Nuclear	10 CFR Part 31 & 32
Scaffolding	29 CFR 1926.451

Source: 29 CFR, OSHA, Part 1901-"Occupational Safety and Health Standards.

Appendix A - References

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Appendix B - Glossary of Terms

Allocated Cost (Dollars per year):	That portion of the Total Cost that is expended or apportioned to a specific activity such as the management of garbage, trash, recyclables, yard waste, or household hazardous waste.
Analyzed MSW:	Portion of the MSW stream for which the cost of items such as collecting, hauling, processing, marketing, and/or disposing of such waste is known or can be reasonably estimated.
Average Cost (Dollers per ton):	Total of Allocated Cost divided by the tons of MSW, garbage, trash, recyclables, or yard waste, as appropriate.
Average Program Incremental Cost (Savings) (Dollars per ton):	The Program Incremental Cost divided by the number of tons of materials diverted from the landfill by the program.
Bulky Waste:	Oversized items, including white goods and furniture, that have been separated from the MSW stream for separate collection.
Commercial MSW:	Municipal solid waste that is generated by sources other than households, including businesses (e.g., offices, restaurants, retail stores, and industry); institutions (e.g., schools and government establishments; and public areas (e.g., train stations, airports, and litter from roadside).
Demolition Waste:	Materials resulting from the construction, remodeling, repair or demolition of buildings, bridges, pavements and other structures as well as bulky wastes, wood wastes, brush and tires.
Garbage:	Garbage is all MSW exclusive of source-separated trash, recyclables, yard waste, household hazardous waste, and bulky waste.
Hazardous Waste:	Waste which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed and is defined as such in accordance with federal and state laws. Does not include Household Hazardous Waste.
Household Hazardous Wastes (HHW):	Materials that are separated from Residential MSW as household hazardous wastes for separate collection and treatment. Such materials may include paints and solvents, pesticides, herbicides, and propane tanks.
Integrated Municipal Solid Waste Management (IMSWM):	A practice of using several (i.e., two or more) alternative waste management techniques to treat, process, and/or dispose of the Municipal Solid Waste stream. Alternative waste management techniques include source reduction, recycling, composting, combusting, and landfilling.

Allocated Cost (Dollars per year):	That portion of the Total Cost that is expended or apportioned to a specific activity such as the management of garbage, trash, recyclables, yard waste, or household hazardous waste.
Materials Recovery:	A term describing the extraction and utilization of materials from a waste stream.
Municipal Solid Waste (MSW):	Non-hazardous solid wastes generated by households, commercial and business establishments, institutions, and light industry; it excludes industrial process wastes, agricultural wastes, mining wastes, construction and demolition debris, offal, sludges, and ashes, except ashes derived from the combustion of MSW. In practice, specific definitions vary across jurisdictions.
Non-Processible Waste	Solid waste that a processing facility receives but cannot process due to the physical nature of the waste. Non-processibles are either sent to a landfill or another waste processing facility.
Program Incremental Costs (Savings) (Dollars per year):	The difference between the cost of managing MSW with or without a particular program (e.g., curbside collection, processing, and marketing of recyclables).
Recovered Materials:	Recyclable or reusable materials that are recovered from MSW and may also include some contamination.
Recyclable Materials or Recyclables:	Materials that still have useful physical or chemical properties after serving their usefulness for a given individual or firm and can, therefore, be reused or recycled for the same or other purposes.
Recycle:	To convert discarded materials into useful products through reuse and remanufacturing.
Residential MSW:	Municipal solid waste that is generated by households.
Residue:	That portion of processed MSW that is ultimately disposed of in a landfill.
Resource Recovery:	A term describing the extraction and utilization of energy or materials from a waste stream.
Secondary Material:	A material that is used in place of a primary or raw material in manufacturing a product; often handled by dealers and brokers in "secondary markets."
Self-Haul:	The delivery of MSW or other wastes to an integrated municipal solid waste management system by a private firm or individual that is not under contract to a municipality, authority, utility, or other public entity responsible for municipal solid waste management to make such deliveries.

Allocated Cost (Dollars per year):	That portion of the Total Cost that is expended or apportioned to a specific activity such as the management of garbage, trash, recyclables, yard waste, or household hazardous waste.
Total Net Cost of Total Cost (Dollars per year):	The aggregate of all expenditures incurred to manage municipal solid waste, inclusive of general and administrative, planning, capital, collection, processing, transfer and haul, marketing, promotion and education, and disposal costs, less any revenues derived from resource recovery activities.
White Goods:	That portion of bulky waste which consists of large appliances, such as refrigerators, stoves, washing machines, and dryers.

Contents

Contents (Continued)

Contents (Continued)

List of Tables

List of Tables (Continued)

List of Figures

1. Introduction

1.1 Twin City Metropolitan Area

The seven-county Twin City Metropolitan Area (Metropolitan Area) had an estimated population of 2.38 million in 1992. Minneapolis and St. Paul, the "Twin Cities," are the two largest cities in the Metropolitan Area. The Metropolitan Area is located approximately 250 miles north of Des Moines, Iowa and 350 northwest of Chicago in the southeast part of the State of Minnesota.

The region has a relatively diverse economy. In 1992, three industry types – manufacturing, wholesale and retail trade, and services accounted for nearly 70 percent of the jobs in the Metropolitan Area. This is comparable to the current mix of such industries on a national basis, which account for approximately 67 percent of the jobs nationally. In FY 1992, in the Metropolitan Area, the percentage of total employment for each of these sectors was 18 percent for manufacturing, 24 percent for wholesale and retail trade, and 28 percent for the services sector. Also in FY 1992, 17 manufacturing companies' corporate headquarters listed in the Fortune 500 Manufacturers' list were located in the Metropolitan Area, and an additional 14 firms located in the region were on the Fortune 500 Service list. The region had three publicly owned Fortune firms ranked in the top 100: Minnesota Mining and Manufacturing (3M), General Mills, and Honeywell. Other well known privately owned firms located in the region included Cargill, Northwest Airlines and Carlson Companies.

1.2 Minneapolis and Hennepin County

Of the approximately 2.3 million residents in the Metropolitan Area in FY 1992, more than 1 million of those residents lived in Hennepin County, Minnesota (the County). Approximately 368,000 residents, or 37 percent of the County's residents lived in the City of Minneapolis (the City). The City had an estimated 161,000 households; approximately 80,000 of these households were single family units; 30,000 multifamily dwellings with two to four units; and the remainder were multifamily dwellings with five or more units.

The City currently encompasses an area of approximately 58.7 square miles with a population density of about 6,270. In 1990, the City bolstered more than 22 percent of all the available jobs within the Metropolitan Area. In addition, the City ranked eighth among major U.S. cities with more than six Fortune 500 companies headquartered within their jurisdiction.

1.3 Minnesota Waste Management Act

The Minnesota Waste Management Act (WMA) was passed by the Minnesota legislature in 1980. The legislative purpose of the WMA is to "protect the State's land, air, water and other natural resources and the public health by improving waste management in the State." Moreover, the goal of the WMA is to foster an ISWMS through the following waste management practices in order of preference:

- Waste reduction and reuse;
- Waste recycling;
- Composting of yard waste and food waste;

- Resource recovery through municipal solid waste (MSW) composting or incineration; and
- Land disposal.

Since it became effective in 1980, the WMA has been amended frequently to promote land disposal abatement through integrated waste management activities. Under WMA, Section 473.803, each of the seven Metropolitan Area counties is required to develop a solid waste master plan. Each county master plan must describe the solid waste activities, facilities and programs including those implemented to achieve the recycling goals established in the WMA. By December 31, 1993, each Metropolitan Area county had to meet a recycling goal of a minimum of 35 percent by weight of the total solid waste generated. By December 31, 1996, each county within the Metropolitan Area must recycle a minimum of 45 percent by weight of the total solid waste generated. These recycling goals, along with the statewide policy goal MSW should be "processed" prior to disposal, serve as the basis for development of an ISWMS in the County and other counties throughout the State of Minnesota.

In the Metropolitan Area, Minnesota cities and counties have shared responsibilities for implementing an ISWMS consistent with the WMA. Specifically, Minnesota Statute Section 115A.941 requires cities with a population of 5,000 or more ensure that every residential household and business has solid waste collection service. One rationale for this requirement is to minimize illegal disposal of MSW. Furthermore, Minnesota Statute Section 478.813 requires that any solid waste contracts entered into by cities for the processing and disposal of MSW must be consistent with its county's and the Metropolitan Area's solid waste master plans.

The County's solid waste management master plan was approved by the County Board of Commissioners in November of 1992, and by the Metropolitan Council in February of 1993. The County's master plan identifies a comprehensive set of activities and programs composing its ISWMS. A key mechanism used to enhance the ability of the County's system to maximize the quantity of materials processed is the use of its waste designation authority under Minnesota Statute 158.83. Specifically, the County required that all MSW be delivered to designated facilities to control the flow of the waste materials within its jurisdiction. Certain materials are exempt from this ordinance, including materials that are separated for recovery and reuse. Consequently, in 1992, the City, located within the County, was subject to this County ordinance. As a result, the City and County have planned and implemented an IMSWMS that is consistent with the County's solid waste master plan.

2. Integrated Municipal Solid Waste Management System

2.1 System Overview

In FY 1992, the IMSWMS utilized by the City was composed of collection, transfer, processing, and disposal components, and included both City- and County-sponsored solid waste management services and facilities. Detailed definitions of the terms used to describe these components, as well as other terms used in this document are provided in Appendix A, Glossary of Terms.

Table 2-1 summarizes the various components of the IMSWMS utilized by the City, and identifies the collection, transfer, processing, and disposal components for the various segments of the MSW stream that were managed by the City. Please note that the industrial, commercial, and institutional wastes were managed exclusively by the private sector, and therefore, this analysis does not focus upon these generator types.

2.2 System Component Descriptions

The individual system components form the various "building blocks" of a complex, ISWMS. As shown in Table 2-1, the collection of various solid waste materials was primarily a City-sponsored service and the processing and disposal of MSW was primarily a County-sponsored service.

A detailed description of each of the four system components of collection, transfer, processing, and disposal is provided below.

2.2.1 Collection

The City sponsored separate collection of each of the following — MSW, recyclables, yard waste, household batteries, bulky wastes, tires, used oil, and paving and construction materials. Household hazardous waste (HHW) collection was a cooperative effort between the City and the County. Specifically, HHW could be dropped off at the County's permanent collection facility and HHW collection events were periodically co-sponsored by the City and County with the City providing the promotional resources and the County funding reclamation and disposal. Moreover, consumer electronics and fluorescent lamps also could be dropped off at a County-owned transfer station or at a collection event.

Municipal crews and Minneapolis Refuse Incorporated (MRI), a consortium of private haulers contracting with the City, provided curbside collection of MSW, recyclables, yard waste, and bulky wastes/problem materials. In 1992, approximately 116,500 households were provided collection. Those households provided collection were predominantly single family residences and multi-family dwellings of five units or less. Multi-family dwellings with five or more units could request collection service from the City, and a small number of these households were provided collection in 1992. Of the total 116,500 households provided collection service, approximately 80 percent received alley collection service.

Municipal crews and MRI collected recyclable materials every other week on the same day each individual household received MSW collection. In 1992, the City provided each household with a 23-gallon recycling bin for the collection of metal, glass, plastic bottles and containers,

Table 2-1. INTEGRATED SOLID WASTE MANAGEMENT SYSTEM COMPONENTS — FY 1992

	MSW	Recyclables	Yard Waste	Bulky Wastes/Problem Wastes	HHW, Consumer Electronics, Fluorescent Lamps, and HH Batteries	Other Materials (Tires, Used Oil, and C&D Debris)
Collection[a]	■ City-sponsored curbside/alley collection of residential household wastes ■ Commercial hauler collection of ICI wastes[b]	■ City-sponsored curbside/ alley collection of residential recyclables ■ Commercial hauler collection of ICI recyclables[b]	■ City-sponsored curbside/alley collection of residential materials ■ Commercial hauler collection of ICI materials[b]	■ City-sponsored collection of residential materials	■ City-sponsored curbside/alley collection of household batteries ■ Drop-off collection at County's permanent collection facility ■ HHW collection days	■ Drop-off at transfer stations (tires, C&D) ■ Drop-off at City garages (used oil)
Transfer	■ Two City-owned and privately operated transfer stations (North and South)[c] ■ One County-owned and privately operated transfer station (Brooklyn Park) ■ One privately-owned and operated transfer station (Freeway) utilizing a County contract	N/A	■ One City-owned transfer station used to consolidate materials prior to transport to private processing facilities	■ Non-combustibles were hauled to a transfer station for processing ■ Combustibles were transferred to privately owned WTE facilities	■ HH batteries are transferred to Hennepin County Vocational Services for sorting and consolidation ■ HHW collected at the permanent collection facility is consolidated and prepared at the Brooklyn Park Transfer Station for transport ■ HHW collected at "events" was transported directly off-site for reuse or disposal	N/A
Processing	■ Three privately-owned and operated waste processing facilities (Elk River, Newport, EPR) with County-sponsored processing ■ One privately-owned and operated mass burn WTE facility (HERC) with County-sponsored processing ■ County waste designation/flow control	■ City-sponsored source-separated materials processing through contract with RMR, a private processor ■ ICI recyclables processed at a series of private materials processing facilities	■ Residential materials collected were processed via contracts with a set of private processors ■ ICI materials processed by private processors	■ Metals from the non-combustible materials were recovered ■ Mercury switches were recovered ■ Freon was recovered and reused by City	■ Reclaimable materials were transported to designated facilities for fuel blending and solidification	■ Tires were recovered for fuel ■ Recoverable C&D materials were crushed and used in road projects ■ Used oil was recovered as fuel
Disposal	■ County contracts with regional landfills for disposal of residue, non-processibles, and bypass ■ County waste sharing agreements with other metropolitan counties ■ County contracts for out-of-state landfill disposal of ash	N/A	N/A	■ PCB-laden capacitors and fluorescent light ballasts were removed and disposed at an out-of-state waste disposal facility	■ Non-recoverable or non-reusable items were transported to a hazardous waste incinerator or landfill for disposal	N/A

Notes:

(a) City-sponsored collection is equivalent to collection by municipal crews or collection by private vendors through contract with the City.
(b) ICI refers to industrial, commercial and institutional segments of the overall waste stream.
(c) In 1992, the City used only the South Transfer Station for the consolidation and transfer of MSW to HERC. Significant quantities of solid waste also were hauled directly to HERC for processing.

corrugated cardboard, newspaper, and household batteries. Pilot programs for the collection of mixed paper, magazines, and boxboard were implemented in 1992. As of April of 1995, the City has added magazines, phone books, milk cartons, and drink boxes to its recyclable materials collection program.

City-sponsored curbside collection of recyclables was initiated in 1992. The collection vehicles used included 20 to 25 cubic yard packers for the newspaper and recycling trucks pulling 8 to 11 cubic yard trailers. The metal cans and plastic containers were placed in the trailers and the glass, corrugated, and household batteries were placed in compartments in the recycling trucks. These vehicles were leased by the City in 1992. At the end of the year, the City purchased 14 new recycling trucks and trailers that were designed for alley collection of materials.

Yard waste was collected weekly from approximately April 15 through November 30 through City-sponsored collection. Residents were asked to set out their yard waste in plastic bags on garbage collection day for collection by 20 cubic yard packers. Christmas trees were collected for two weeks in January.

Bulky oversized items not appropriate to place in individual carts were collected curbside through a City-sponsored program. Bulky oversized items, which are defined as being composed of 50 percent or more of metal, such as appliances, aluminum doors, swing sets, etc., were collected on recyclable materials collection day. Those items that were less than 50 percent metal such as chairs, carpeting, wooden tables, etc., were collected separately on garbage collection day with 16 cubic yard flat bed trucks. These two sets of items were characterized as "Problem Materials" by the City. The first set of materials were considered recyclable and non-combustible, and the second set was considered combustible and non-recyclable.

The City sponsored collection of other specific materials, which included tires, used oil, and paving and construction materials. Tires and paving and construction materials could be dropped off at the City's South Transfer Station. In 1992, the City offered drop-off collection of tires at no charge. However, there was a minimal charge for the drop-off of paving and construction materials. Used oil could be dropped off at City garages or several service stations around the City.

Overall, the City sponsored separate collection of a comprehensive set of residentially generated materials. Most uniquely, these collection services were provided in 1992 with minimal additional costs to each resident beyond their flat monthly fees.

2.2.2 Transfer

Once the various materials were collected, they were either directly hauled to processing or disposal facilities or to transfer facilities for additional handling. In 1992, the City owned two transfer stations — the North and South Transfer Stations, which were privately operated by Hennepin Transfer Inc. (HTI), a subsidiary of Browning-Ferris Industries Inc. The County reimbursed the City for expenses related to the management of MSW at the South Transfer Station. In addition, two other transfer stations were considered a part of the ISWMS. The Brooklyn Park Transfer Station was a County-owned facility located in northeastern Hennepin County and was operated by HTI. The Freeway Transfer Station, located in northern Dakota County, was privately owned and operated by HTI and managed solid waste via County contract.

The North Transfer Station served primarily to receive much of the yard waste collected through the City-sponsored yard waste collection program. A small quantity of yard waste was hauled directly to processing sites. In 1992, a site owned by the City adjacent to the North Transfer Station served as a processing area for recovering bulky materials. The North Transfer Station was not used for the transfer and haul of MSW.

The South Transfer Station served primarily to receive MSW not directly hauled to a processing or disposal facility. As highlighted in the subsection above, this transfer station served as drop-off for tires and paving and construction materials. Moreover, the non-recoverable, bulky oversized materials were delivered to this transfer station before being hauled to designated facilities for combustion.

In 1992, the City did not utilize the Brooklyn Park Transfer Station or Freeway Transfer Station for the direct management of its solid waste stream. However, the HHW dropped off at the permanent HHW collection facility at the Brooklyn Park Transfer Station by County residents was consolidated for transport for final management. The household batteries collected curbside through City-sponsored collection were delivered to Hennepin County Vocational Services for sorting and preparation for transport to final management facilities.

2.2.3 Processing

2.2.3.1 MSW and Non-Recoverable Bulky Wastes

The MSW and non-recoverable bulky wastes collected in 1992 through the City- sponsored program were primarily transferred to a mass burn waste-to-energy (WTE) facility in the City or one of three waste processing facilities in the region. The materials transferred to the waste processing facilities were primarily processed into refuse-derived fuels (RDF) and combusted for energy recovery after processing. The facilities receiving the City's MSW and non-recoverable bulky wastes were:

- Hennepin Energy Resource Company Waste-to-Energy Facility (HERC);
- Northern States Power Elk River Resource Recovery Facility (Elk River);
- EPR Refuse Derived-Fuel Facility (EPR); and
- Northern States Power Newport Resource Recovery Facility (Newport).

2.2.3.1a HERC

In FY 1992, the HERC was a 365,000 ton per year, mass-burn waste-to-energy facility located in downtown Minneapolis, which began operation in October 1989. HERC was privately owned and operated by Ogden Projects, Inc. (Ogden) and sponsored by the County. It received MSW seven days a week. It had two water-wall mass combustion units where MSW was burned. Under an existing contract between the County and Ogden, the County is required to provide 365,000 tons per year of acceptable waste through the year 2018. If the County does not meet this annual guarantee of waste, then it must compensate Ogden for the lack of acceptable waste delivered to the Ogden municipal waste combustor (MWC).

In FY 1992, the County shared the revenues from the sale of the electricity generated from the combustion process. The electricity produced was sold to Northern States Power (NSP). The County also shared in the revenues from the sale of ferrous metals, which were removed from the ash using a mechanical magnetic system. Moreover, large sources of metals were separated out at the tipping floor prior to combustion.

2.2.3.1b Elk River

In FY 1992, Elk River was a privately owned and operated facility that processed MSW into RDF. The Elk River facility was jointly owned by NSP and United Power Associates (UPA). The Elk River facility became operational in 1989 and accepted MSW from Anoka, Benton, Sherburne, Stearns, and Hennepin Counties pursuant to contracts with each of these counties. The Elk River facility accepted MSW six days per week and processed waste 307 days per year. The waste was shredded and separated through a series of screens, air classifiers, and magnets into a non-processible fraction, a ferrous metal fraction, a residue fraction, and an RDF burnable fraction.

The County may deliver up to 234,548 tons of MSW per year to the Elk River facility through the year 2009 to meet its financial obligations as related to the facility's fixed costs associated with processing capacity. Under this contractual agreement, NSP may divert up to 11,052 tons per year of County MSW. In 1992, the County delivered a total 225,517 tons to the facility.

In 1992, about 80 percent of the RDF produced at the Elk River facility was hauled by transfer trailers approximately three miles to the UPA's retrofitted coal-fired plant that combusts RDF. Most of the other 20 percent of the RDF produced was hauled to NSP's Wilmarth Power Plant located in Mankato, Minnesota, which was also retrofitted to combust RDF.

2.2.3.1c Newport

In addition to the two waste processing facilities described above, the County currently has waste sharing agreements with the Newport facility. If HERC or Elk River receive more waste than they have the capacity to process, the County can transfer waste materials to Newport under existing waste sharing agreements. This is consistent with Minnesota Statute 473.8480, which establishes limitations on the disposal of "unprocessed" waste.

In FY 1992, the Newport facility was also owned and operated by NSP and was similar in design to the Elk River facility. Much of the RDF produced at the Newport facility was combusted at the Wilmarth or Red Wing Power Plants. The Red Wing facility, similar to the Wilmarth facility, was retrofitted by NSP to combust RDF.

2.2.3.1d EPR

The County passed an ordinance in 1985 requiring that MSW be delivered to designated facilities. This ordinance granted exclusions for certain facilities, which were already receiving and processing the County's MSW. The intent of these exclusions from the County's designation authority was to allow for the development of private sector initiatives that promote landfill abatement.

One of the facilities granted an exclusion under the designation ordinance was EPR. The EPR facility is located in the City of Eden Prairie and is authorized to received up to 146,000 tons per year of MSW from the County. In 1992, the facility was operated to produce RDF. Materials were deposited on the tipping floor and processed both manually and mechanically to separate out the recyclable materials. The remaining materials were then shredded to make either fluff RDF or densified RDF. This fuel was produced and marketed to various power plants. The rejects and non-processible materials were transported to HERC for combustion.

Tables depicting the quantities of materials managed by the County and City are included in Appendix B.

2.2.3.2 Recyclables and Recoverable Bulky Wastes

The recyclable materials collected curbside through the City-sponsored programs in 1992 were processed at the Recyclable Minnesota Resource (RMR) Materials Recovery Facility (MRF). Residents source-separated their recyclables, which were collected curbside/alley by municipal crews. Only minimal processing was necessary at the RMR MRF. Primarily, the collected materials were stored and baled in preparation for shipping to a facility for use/remanufacture. However, automated processing was necessary for the separation of bi-metal aluminum cans. The materials received at the RMR MRF included metal, glass, plastic food and beverage containers, along with corrugated cardboard and newspaper.

Major appliances and bulky items with more than 50 percent metal were also recovered. These materials were processed at a site adjacent to the North Transfer Station. Specifically, PCB laden compactors, fluorescent lights, and mercury switches were removed from the appliances and properly managed. Moreover, freon was removed, filtered and reused in City air conditioning equipment.

2.2.3.3 Yard Waste

In 1992, upon collecting the yard waste in packer trucks, the materials were off loaded at the North Transfer Station. The materials were then consolidated and transferred to one of five different processing sites. These five sites included the following:

- Yard Waste Composting Facility at the Burnsville Landfill;
- Yard Waste Composting Facility at the Pine Bend Landfill;
- Empire Organic Composting Facility;
- Lynde and McLeod's Land Spreading Site; and
- Ceres Tree Company Processing Site.

At the three yard waste composting facilities, the composting method utilized was either static pile or windrow. Yard waste was frequently turned to promote aerobic decomposition. At the Lynde and McLeod County Land Spreading operation in Maple Grove, yard waste was spread on farmland and tilled into the soil. The Ceres Tree Company, also in Maple Grove, accepted Christmas trees under a contract with the County and processed them into mulch using a tub grinder.

2.2.3.4 Household Hazardous Waste and Household Batteries

The recoverable/reclaimable HHW and household batteries were transported out-of-County to designated facilities for reclamation when feasible.

2.2.3.5 Other Materials

The tires collected at the South Transfer Station drop-off were combined with those collected in the neighborhood cleanup programs for processing. The City contracted for the processing of these tires with HTI. The used oil dropped off at City garages or service stations was processed for the reuse as fuel at local and regional asphalt plants. In 1992, a small portion of this material was being re-refined into new oil for reuse. Paving and construction materials that were dropped off at the South Transfer Station were also processed. Concrete was eventually crushed and reused as road bed materials, and the asphalt was also crushed and used for new roadway projects.

2.2.4 Disposal

2.2.4.1 MSW

The MSW processed at the various waste processing facilities generates residue, non-processible waste, by-passed waste, and ash. In 1992, all of the ash generated from the HERC facility was disposed at the Laraway Recycling and Disposal facility (Laraway Facility) in Elwood, Illinois. The County contracted for the transportation and disposal of the ash via contracts with HERC and the Laraway Facility. The ash resulting from the combustion of RDF at Elk River-UPA WTE facility was disposed of at the NSP monofill located adjacent to its Sherco power plant in the City of Becker.

In FY 1992, the Laraway Facility was owned and operated by Waste Management of Illinois, a subsidiary of WMX, Inc. It was designed with a double composite liner and an extensive leachate collection and management system. This landfill currently accepts ash from multiple MSW combustion facilities. The Becker Ash Monofill had a composite liner of HDPE over two feet of clay. The leachate was collected and pumped to a wet scrubber solid settling pond on NSP property for management.

Some of the non-processibles from the Elk River facility were transported to HERC for processing. The process residues and non-processibles from the Elk River and HERC facilities were landfilled in the Anoka, Woodlake, and Elk River landfills in 1992 pursuant to contracts with the County. The Woodlake and Anoka landfills were subsequently closed. In addition to those landfills, the County had contractual agreements for the disposal of MSW when necessary with the Burnsville Landfill, Forest City Road Landfill, and Pine Bend Landfill. These landfills were used primarily for by-pass waste when a processing facility was unable to manage the waste received.

2.2.4.2 Household Hazardous Waste

The household batteries that could not be recycled in 1992, such as the lithium, alkaline and carbon zinc batteries, were either incinerated at a hazardous waste facility or disposed at a

hazardous waste landfill. Moreover, other HHW that could not be reused or recycled was managed in a similar manner.

2.2.4.3 Recoverable Bulky Materials

The PCB laden compactors and fluorescent light ballasts removed from the bulky oversized waste materials were disposed of at out-of-state hazardous waste management facilities. Any mercury switches removed from the items collected were transported to the Mercury Refining Company in New York for recovery.

3. Municipal Solid Waste Quantities

3.1 Management Overview

The City managed a total of 145,087 tons of MSW in FY 1992. As identified in Section 2.2.1, this total tonnage represented approximately 116,500 households within the City. MSW is defined in this study to include waste materials generated by residential households serviced by the City. For purposes of analyzing waste quantities, MSW excludes the industrial, commercial, and institutional waste composing the City's solid waste stream. These materials are excluded because they are not directly managed by the City and data related to their management are limited.

Of the 145,087 tons of materials managed by the City in 1992, the different types of materials and their quantities were as follows:

•	Mixed Municipal Solid Waste:	104,059
•	Recyclables:	21,498
•	Yard Waste:	16,159
•	Problem Materials/Bulky Waste:	3,220
•	Household Hazardous Waste:	151
•	Other Material:	Negligible

Figure 3-1 depicts the quantity of materials in percent by weight for each material type managed in the IMSWMS.

3.2 MSW Waste Quantities and Flow

As described in Section 2, the IMSWMS included the components of collection, transfer, processing, and disposal. For purposes of characterizing the waste quantities and flow for the IMSWMS, this section is divided into discussions addressing the collection, processing, and disposition of the materials. Table 3-1 depicts the quantities for each of the material types managed by the City from collection through processing to disposition. The information in Table 3-1 is used as the basis for depicting the IMSWMS waste flow shown in Figure 3-2.

The estimated total quantity of materials diverted from disposal in 1992 was approximately 110,000 tons, which represented approximately 75 percent of the total waste stream by weight. The diversion of these materials resulted from the use of mass combustion, RDF production, mixed waste processing, composting and chipping, and recyclable materials recovery. The resulting disposition of the use of these processes was as follows:

•	Materials Recovered for Energy:	67,043
•	Materials Composted, Mulched and Landspread:	16,161
•	Materials Recovered Through Recycling:	26,571

The above represents the use of energy recovery, composting, and recycling to divert approximately 46 percent, 11 percent and 18 percent, respectively, of the total MSW managed by the City in FY 1992. It should be noted that a critical factor in diverting the materials from

Figure 3-1. Managed Municipal Solid Waste - City of Minneapolis

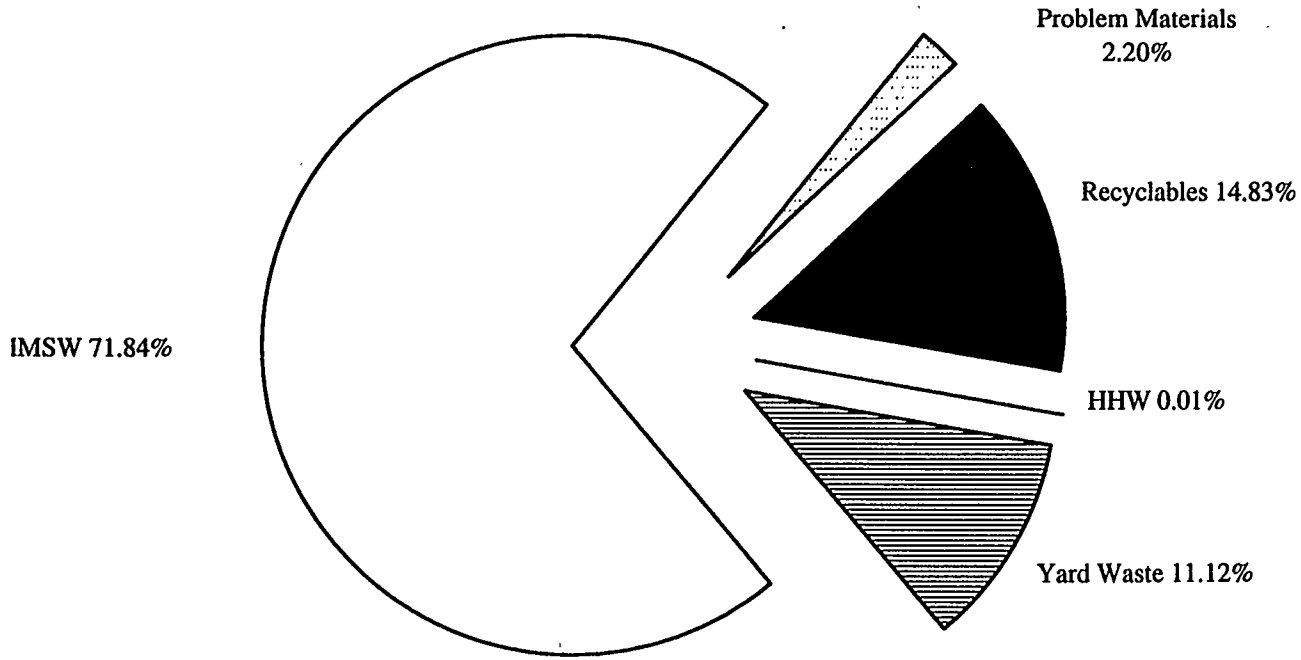


Table 3-1. City of Minneapolis Waste Quantities (FY 1992 Tons)

System Component	TPY Subtotal	TPY
Collection		
MSW		104,059 [a]
City Collected	48,355	
MRI Collected	50,703	
Self-Hauled	2,027	
Neighborhood Cleanup Events	2,972	
Recyclables		21,498
City Collected	10,834	
MRI Collected	10,664	
Yard Waste		16,159
City Collected	7,823	
MRI Collected	8,336	
Problem Materials/Bulky Wastes[b]		3,220
Recoverable	2,718	
Non-Recoverable	502	
HHW		151
Collection Events/Drop-off	151[c]	
Other Materials[d]	Negligible	
Total Materials Collected		145,087
Processing		
MSW and Problem Materials/Bulky Wastes		97,714
Mass Burn	90,148[e]	
RDF Resource Recovery[f]	7,356	
Mixed Waste Processing[g]	210	
Recyclable Materials Recovery		15,466[h]
Yard Waste		11,144
Composting	10,896	
Wood Waste Mulching	248[i]	
HHW		54
Fuels Mixing	70[j]	
Other Materials	Negligible	
Total Materials Processed		124,394[k]
Disposition		
Recovered Energy/Fuel		67,043[l]
Compost and Mulch		11,146[m]
Landspread		5,015
Mixed Municipal Waste Landfill		8,472
Non-Processibles/Residue[n]	1,590	
Bypass[o]	6,882	
Monofill		26,370

Table 3-1. City of Minneapolis Waste Quantities (FY 1992 Tons)

System Component	TPY Subtotal	TPY
Ash from Mass Burn	24,798	
Ash from RDF	1,572	
Recovered Materials		26,571
Pre-combustion at Mass Burn	76	
Ferrous at RDF	256	
Post-Combustion at Mass Burn	2,368	
Mixed Waste Processing	9	
Source Separated Materials Recovery	21,498	
Problem Materials/Bulky Waste Recovery	2,310	
Liquid Fuels	54	
Non-Reclaimable HHW[p]		81
Total Disposition		144,752[q]

Notes:

[a] Includes only the MSW collected through the City-sponsored curbside program and materials self-hauled by residential households to the South Transfer Station.

[b] These materials are generally characterized as oversized, bulky wastes, but the City considers these as Problem Materials and manages these materials based upon their combustibility and recyclability.

[c] Materials collected at events and dropped off at the permanent collection facility were combined based upon data availability.

[d] Represents household batteries, tires, used oil, and paving and construction materials dropped off at the South Transfer Station or collected at Neighborhood Cleanup events.

[e] Equals total waste delivered to HERC less 144 tons of Elk River non-processibles.

[f] Represents materials processed at the Elk River and Newport facilities.

[g] Represents materials processed at the EPR facility.

[h] Excludes 6,032 tons of old newspapers hauled directly to end-user.

[i] Includes processing of the Christmas trees collected through a City-sponsored collection program.

[j] Represents materials collected that were ultimately reused as fuel such as flammable liquids and waste oil and solidification and reuse of latex paint. Only consolidation was conducted within the IMSWMS.

[k] Does not equal total materials collected because materials processed excludes materials that were landfilled, landspread, and hauled directly to market.

[l] Recovered energy/fuel is represented by the total materials mass burned and processed into RDF for energy recovery less the quantity of non-processibles/residue, ash, MSW compost and recovered materials from mass burn, RDF production, and mixed waste processing.

[m] Does not account for the 30 to 50 percent loss by weight, which occurs during the composting process. The extent of loss is based on actual materials composted and process used.

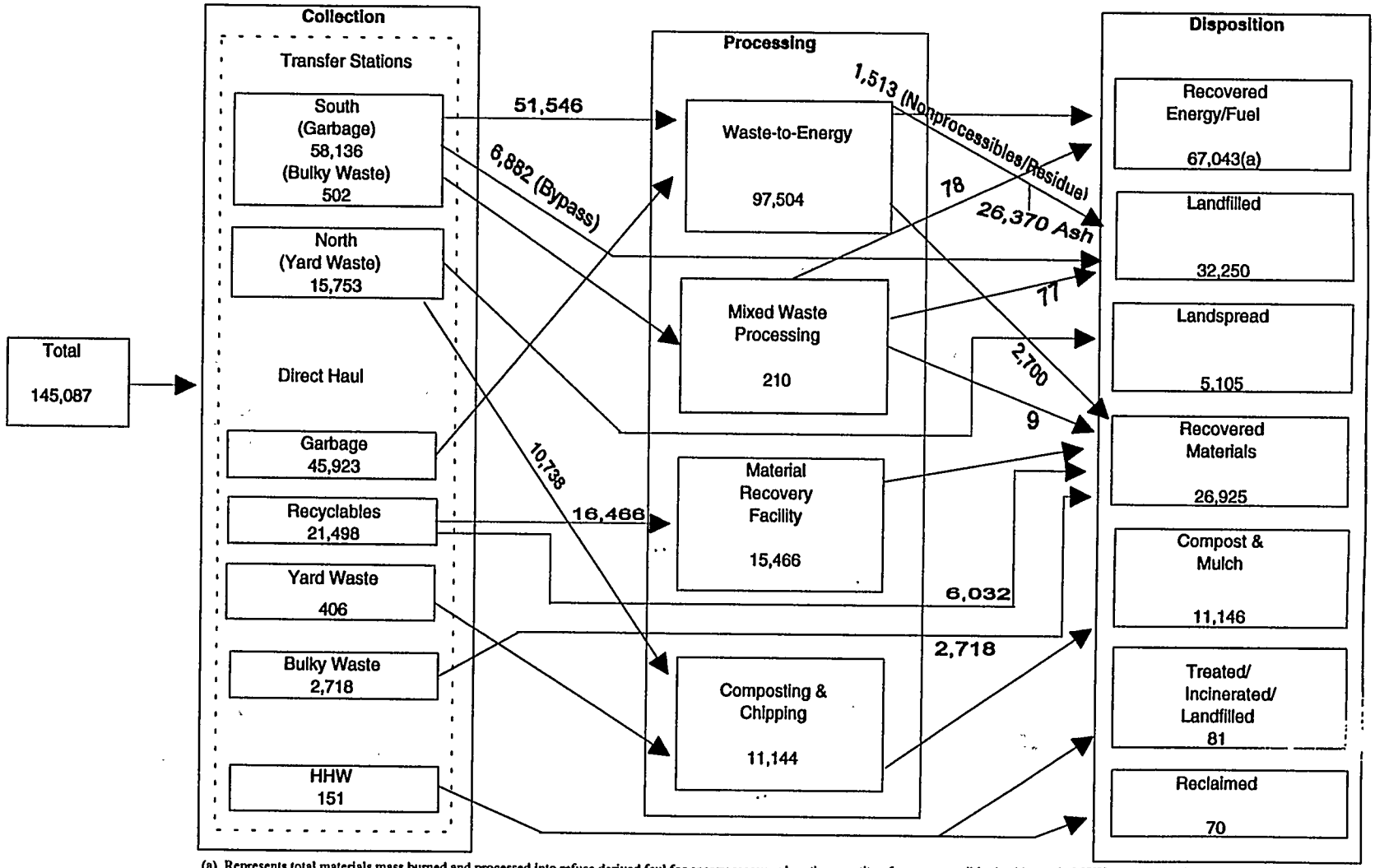
[n] Includes non-processibles, residue, and rejects landfilled as a result of the processing of City wastes at the four processing facilities of HERC, Elk River, Newport and EPR.

[o] Represents waste delivered to the South Transfer Station, which was transported directly to a landfill for disposal because the waste was not compatible with processing methods.

[p] Treated, landfilled, or incinerated as hazardous wastes.

[q] Total does not equal total materials collected because it does not account for shrinkage of materials during processing.

Figure 3-2. MSW Waste Flow & Resource Recovery - Minneapolis, MN (FY 1992)



(a) Represents total materials mass burned and processed into refuse derived feul for energy recovery less the quantity of non-processibles/residue, ash, MSW compost, and recovered materials from mass burn RDF production and mixed waste processing

(b) Does not account for 30% to 50% loss by weight which occurs during the composting process. Extent of loss based on actual materials composted and process used.

disposal was the ability to control the flow of the MSW through "designation." In other words, in 1992, all waste materials generated in the County were required to be delivered to County-designated facilities under the County's waste designation ordinance (flow control).

3.2.1 Collection

A total of 145,087 tons of MSW were self-hauled or collected through City-sponsored programs in 1992. As outlined in Section 2.2.1, the materials collected included MSW, recyclable materials, yard waste, problem materials/bulky waste, HHW, tires, used oil, and paving and construction materials.

The total materials received at the City's South Transfer Station in 1992 was 58,638 tons of MSW and bulky waste. This represented approximately 56 percent of the total materials collected through City-sponsored programs. The remaining 45,923 tons of MSW collected were directly hauled to a processing facility. Approximately 21,498 tons of recyclable materials were collected curbside through a City-sponsored program. These materials were either hauled to a materials processor or directly to an end user for recovery.

Approximately 16,159 tons of yard waste were collected through City-sponsored programs. Of this amount, approximately 15,753 tons of yard waste were collected and taken to the City's North Transfer Station for consolidation and transfer to private processing facilities. The remaining 406 tons were directly hauled to a yard waste processor. An additional 2 tons of fines from the Eden Prairie facility were brought in as "compost" thus making the total amount of material composted, mulched, or landspread 16,161 in 1992.

The City collected a total of 3,220 tons of bulky waste in 1992. The bulky waste (characterized as Problem Materials by the City) were separated into two groups — items with less than 50 percent metal and appliances and large items with more than 50 percent metal. The items with less than 50 percent metal were considered combustible and composed a total of 502 tons in 1992. These materials were transported to the South Transfer Station prior to being transferred to HERC for combustion. The remaining 2,718 tons of materials, which included appliances and items with more than 50 percent metal, were processed. A total of 408 tons of residuals from processing were transported to HERC for combustion.

It is estimated that 151 tons of HHW were collected at two HHW collection events and through drop-off at the permanent collection facility at the Brooklyn Park Transfer Station. No data were available concerning the quantity of batteries collected. The "Other Materials" collected included used oil, tires, and paving and construction materials. The total quantity of each of these materials collected through the City-sponsored drop-off program was negligible for purposes of this study.

3.2.2 Processing

Of the 145,087 tons of MSW collected in 1992, approximately 124,378 tons were processed, or approximately 85 percent of the total collected. These materials were processed at RDF resource recovery facilities, a mass burn facility, a mixed waste processing facility, material recovery facilities, and yard waste composting and chipping facilities.

A total of 97,504 tons of MSW and Problem Materials/bulky waste were processed for energy recovery at the HERC, Elk River, and Newport facilities, and an additional 210 tons were

processed at the EPR facility. Therefore, a total of 97,714 tons of MSW and Problem Materials were processed in 1992. The 90,148 tons processed at the HERC facility were mass-burned for energy recovery. The 7,356 tons of materials processed at Elk River and Newport were used to produce RDF. The RDF produced was then burned for energy recovery at several retrofitted power plants within the region as identified in Section 2.2.3.1.

Of the 16,159 tons of yard waste collected, approximately 11,144 tons of yard waste and Christmas trees were transported to several private processors for composting and chipping. These processors are identified in Section 2.2.3.3.

Of the 2,718 tons of bulky waste collected that were identified as recoverable, it is estimated that 2,310 tons were recovered through processing, including recovery of metals, plastics, and other materials suitable for recycling.

Source separated recyclable materials were collected through the City-sponsored curbside collection program. The breakdown by material type of the materials collected is provided in the Table 3-2.

Table 3-2. Materials Recovered From the Curbside Program - FY 1992

Material Collected	Tons	Percent
Newsprint	12,914	60.1
Magazines, Boxboard, and Mixed Office Paper [a]	57	0.3
Old Corrugated Cardboard	315	1.5
Plastic	646	3.0
Glass	5,911	27.5
Aluminum	512	2.4
Food Cans	1,143	5.3
TOTAL	**21,498**	**100.0**

Note:

[a] These materials were collected in a pilot program conducted by the City in FY 1992.

Source: City of Minneapolis, "Breakdown of Recyclable Materials 1992."

As can be seen in Table 3-2, the largest quantities by weight of materials collected were newsprint and glass. Of the materials collected, 15,466 tons were delivered to RMR for processing and preparation for market.

3.2.3 Disposition

As identified in the previous section, more than 97,000 tons of materials collected were processed for energy recovery. These materials were processed at the four facilities identified in Section 2.2.3.1. Table 3-3 depicts the quantity of materials processed at these facilities from both the County and the City.

Table 3-3. MSW Processing and Disposition Comparison of Hennepin County and City of Minneapolis (FY 1992 Tons)

Process	Hennepin County [a]	Minneapolis
Mass Burn[b]	361,417	90,148
RDF Resource Recovery[c]	227,983	7,356
Mixed Waste Processing	105,597	210
Total Processed	**694,997**	**97,714**
Disposition		
Nonprocessibles/Residue[d]	78,846	1,590
Ash[e]	149,269	26,370
Recovered Materials	22,408	2,709
Compost	1,219	2

Notes:

[a] Includes quantities generated by the City of Minneapolis.

[b] Equals total waste delivered to HERC less the nonprocessibles from Elk River to preclude double counting.

[c] Includes 701 tons of materials delivered to Elk River in 1991 but processed in 1992.

[d] Equals the sum of HERC nonprocessibles, EPR rejects and residue, and Elk River and Newport nonprocessibles and residue.

[e] Weight of ash includes moisture content.

These estimates were derived from County data provided by the County's Public Works Environmental Management Staff. As is reflected in the above table, the quantity of materials received at the HERC facility from the City represented almost 25 percent of that received from the entire County. Contrastingly, the quantity of materials received from the City at the RDF resource recovery and mixed waste processing facilities represented less than 3 percent of the total materials received at these facilities from the County.

Of the 97,714 tons of materials received at these processing facilities from the City, almost 70,000 were diverted from landfill disposal. Specifically, 2,709 tons of the City's MSW were recovered through recycling before and after combustion, and approximately 67,000 tons were converted into fuel for energy recovery. The remaining non-processibles, bypass, residue, and ash were landfilled. The ash was disposed of at a monofill, and the non-processibles, bypass, and residue were disposed at a number of different landfills in the region. In total, 35,250 tons of materials, including bypass, non-processibles, residue, and ash were disposed of at landfills.

A total of 26,517 tons of materials were recovered (26,571 tons minus 54 tons of HHW recycled for reuse as liquid fuels) through recycling. These materials included those collected through the source-separated curbside recycling program, bulky waste recovery of non-combustible materials, materials directly hauled to end users, materials recovered through mixed waste processing, and materials recovered pre- and post-combustion. The 26,517 tons represent approximately 18 percent of the total materials collected. In other words, approximately 18 percent of the total materials collected through the City's IMSWMS were recycled.

Mixed waste processing and yard waste composting and chipping resulted in the production of large quantities of compost and mulch. The actual quantities generated were not available and, furthermore, an estimate was not made because the composting process can reduce the materials composted by 30 percent to 50 percent by weight. The extent of this reduction is based upon the type of materials composted and the specific method of composting used. Of the 16,159 tons of yard waste collected, 5,015 tons, or approximately 31 percent, were landspread.

Of the 151 tons of HHW collected through two collection events and through drop-off at the permanent collection facility, 81 tons were managed as hazardous waste and transported to an out-of-state hazardous waste landfill or incinerator. Fifty-four tons of HHW were recycled for reuse as liquid fuels and 16 tons were solidified for reuse. The types and amounts of materials collected, along with their conversion to quantities by weight, are provided in Table 3-4. This information was provided by the County with the quantity estimates based on the estimated percentage of participants from the City at the collection events. No specific data concerning the quantities of consumer electronics and fluorescent lamps dropped off at the Brooklyn Park Transfer Station was available.

Table 3-5 identifies the end users of the recovered materials based upon discussions with RMR. As can be seen from the table, the end users were located throughout the Midwest and the materials were reused for a variety of purposes.

Table 3-4. Collection of HHW in FY 1992

Type of HHW	Brooklyn Park Transfer Station				Event Collections				Total Tons
	Gallons	Factor (lbs/gal)	Pounds	Tons	Gallons	Factor (lbs/gal)	Pounds	Tons	
Hennepin County Total									
Mixed Lab Packs (a)	24,849	4.0	99,396	49.7	23,407	4.0	93,628	46.8	96.5
Latex Paint (b)	32,785	7.5	245,888	122.9	25,650	7.5	192,375	96.2	219.1
Oil-Based Paint	17,185	7.5	128,888	64.4	10,725	7.5	80,438	40.2	104.7
Flammable Liquids	7,095	8.0	56,760	28.4	1,815	8.0	14,520	7.3	35.6
Waste Oil	19,643	7.5	147,323	73.7	(c)	7.5	0	0.0	73.7
Total	101,557			339.1	61,597			190.5	529.6
Minneapolis' Share (d),(e)									
Mixed Lab Packs	4,967	4.0	19,866	9.9	10,284	4.0	41,138	20.6	30.5
Latex Paint	6,553	7.5	49,146	24.6	11,270	7.5	84,524	42.3	66.8
Oil-Based Paint	3,435	7.5	25,761	12.9	4,712	7.5	35,342	17.7	30.6
Flammable Liquids	1,418	8.0	11,345	5.7	797	8.0	6,380	3.2	8.9
Waste Oil	3,926	7.5	29,445	14.9	0	7.5	0	0.0	14.7
Total	20,298			67.8	27,064			83.7	151
Number of Participants									
Hennepin County	12,383								
Minneapolis (f)	2,475								

Source: Hennepin County, "Household Hazardous Waste Program - 1992 Actual Breakdown."

Notes:

a. Mixed Lab Packs gallons shown are the total amount of containers used. Actual volume of chemicals is 25-50 percent.
b. About 14,195 one gallon cans (or 43 percent) of the latex paint were packaged in one cubic yard Gaylord for processing by the contractor. The balance was bulked.
c. Quantity of used oil collected at event days was not measured.
d. Gallons collected at the Brooklyn Park Transfer Station from Minneapolis residents was estimated using the percentage of participants from the City that delivered HHW to the facility in 1991.
e. City participants at the Brooklyn Park Transfer Station were estimated using the actual percentage of participants from the City that used the facility in 1991. The number of participants using the Brooklyn Park Transfer Station from the City was obtained from the participants' drivers licenses.
f. The total "event" gallons of HHW collected from the City were actual quantities collected during events held in North Minneapolis and South Minneapolis during FY 1992. The distribution of HHW by type of waste was based on percent distribution of "event" collected HHW for the entire County.

Table 3-5. Intermediate and End-Users of Source Separated Recyclables (FY 1992)

Recovered Materials	Vendor/Location	Approximate Distance to Market	Remanufacture Use
Aluminum	American National Can (Chicago, IL)	450 miles	Can Sheet
Paper			
Corrugated	Stone Corporation (Missoula, MT)	1,300 miles	Liner Board
Newspaper Office Paper Magazines	Waldorf Corporation (St. Paul, MN)	10 miles	Newsprint
Glass	Anchor Glass (Shakopee, MN)	15 miles	Bottles/Jars
Plastic	Phoenix Plastics (Roseville, MN)	300 miles	Bark Benches, Toys
Metal			
Ferrous	AMG (St. Paul, MN)	10 miles	Can Sheet
Bulky	American Iron (Minneapolis, MN)	0.5 miles	

Source: Recycle Minnesota Resources.

4. Cost of Municipal Solid Waste Management

The cost of MSW management (i.e., collection, transfer, haul, processing, combustion, mulching, composting, landspreading, marketing of recovered materials, and disposal) in the City is presented in this section.

4.1 Apportionment of Waste Stream

Only a portion of the total solid waste stream described in Section 3, Municipal Solid Waste Quantities, is included in the economic analyses presented in this section. The reason for limiting the tonnage included in the analysis is to include only that portion of the waste stream considered to be MSW and for which the total cost of collection, transfer, hauling, processing, combusting, composting, mulching, landspreading, marketing, and disposal is known. The portion of the waste stream meeting these two criteria is hereinafter referred to as "Analyzed MSW." Failure to limit the economic analysis to the tonnage and costs associated with Analyzed MSW would bias the results and could therefore lead to misleading conclusions.

Generally speaking, Analyzed MSW is all the MSW that was collected by or on behalf of the City in FY 1992 with the exception of small quantities of self-hauled garbage and HHW, which are excluded, since the costs of collecting these portions of the waste stream are not known and cannot be estimated in a manner consistent with the scope of this study. Therefore, both the costs and quantities (i.e., 2,027 tons of garbage and 151 tons of HHW) are excluded from the economic analysis.

When a portion of the MSW stream is excluded from an analysis performed in this section because its collection costs are unknown, the associated transport, hauling, processing and disposal costs are also excluded from the analysis. Consequently, the cost comparisons among types of MSW are valid and include all the costs required to manage the Analyzed MSW stream from the time it was placed at the curb until it was sold, reused, or disposed of in a landfill. Although HHW is not included in the definition of Analyzed MSW, a separate analysis of the costs incurred for the HHW program, exclusive of the costs incurred by individuals to transport HHW to the collection site, is provided.

Table 4-1 shows the FY 1992 tonnages of the components of both the total MSW and Analyzed MSW.

4.2 Total Net Costs of Waste Management

The methodology, assumptions, and data used to calculate total net costs for managing MSW in the City are presented in this section. The costs calculated in this section represent the *total* net costs of the IMSWMS in FY 1992 and do not represent the costs attributed solely to Analyzed MSW.

In FY 1992, the City's Solid Waste and Recycling Division was primarily responsible for the day-to-day collection of MSW and other related activities within the City. However, many services such as vehicle equipment and facilities maintenance, legal services, and procurement services were performed by other City departments, and other services, such as the operation of the transfer

Table 4-1. City of Minneapolis FY 1992 Total MSW and Analyzed MSW Tonnages by Component

MSW Component	Total MSW (tons)	Analyzed MSW (tons)
Garbage		
City and MRI Collected	99,058	99,058
Self Hauled/Other City Agencies	2,027	0
Neighborhood Cleanup		2,972
Subtotal – Garbage	**104,059**	**102,030**
Yard Waste		
City Collected	7,823	7,823
MRI Collected	8,336	8,336
Subtotal – Yard Waste	**16,159**	**16,159**
Recyclables		
City Collected	10,834	10,834
MRI Collected	10,665	10,665
Subtotal – Recyclables	**21,498**	**21,498**
Problem Materials/Bulky Wastes		
White Goods	782	782
Problem Materials (Recycled)	1,936	1,936
Problem Materials (Not Recycled)	502	502
Subtotal – Problem Materials/Bulky Wastes	3,220	3,220
Household Hazardous Waste	151	0
Total	**145,087**	**142,907**

stations and the collection of a portion of the garbage and recyclables, were provided by the City and/or County through private contractors. The County's Department of Public Works was primarily responsible for the processing and disposal of all the MSW collected in the County. Finally, residents were responsible for purchasing kraft paper bags, plastic garbage bags and/or cans for yard waste collection. Since MSW collection and other related activities in the City were paid for from general fund revenues and were not treated as an enterprise system, a consolidated accounting of the costs was not available. Instead, for purposes of this study, the total costs were determined by compiling information provided by the City, the County, and other sources, and making estimates and assumptions when needed.

Please note that during FY 1992, the County provided a range of processing and disposal services to the City for a fee of $95 per ton. To maintain consistency of data, the cost allocation methodology used in this study does not use the actual fee paid by the City to the County, but rather uses the "real" costs incurred by the County to provide each of the specific services studied. Determining each component of the costs incurred by the County to manage the City's waste is one of the key focuses of this section. It is *not* the intent of this study to determine if the $95 per ton fee charged to the City is more or less than the cost of providing the services.

The methodology used to calculate the total net costs consists of 14 steps, as follows:

1. Determine the City's Solid Waste and Recycling Division's reported and adjusted costs;
2. Determine annualized capital costs for vehicle and equipment capital expenses;
3. Allocate vehicle and equipment annualized capital costs;
4. Determine transfer (handling) and haul annualized capital and operation and maintenance (O&M) costs;
5. Determine the City's allocation of HERC and Elk River facility costs;
6. Determine the costs of waste sharing at the Newport and Eden Prairie facilities;
7. Determine the costs of Christmas tree processing;
8. Determine the costs of MSW landfill disposal at the Anoka and Woodlake landfills;
9. Determine HHW collection and processing costs;
10. Determine the costs of bins, cans, and bags;
11. Determine the County's general and administrative (G&A) annualized capital costs and O&M expenses for managing the City's waste;
12. Determine the City's indirect G&A expenses attributed to the City's Solid Waste and Recycling Division (Sanitation);
13. Determine the Solid Waste and Recycling Division's G&A annualized capital costs; and
14. Summarize total net costs.

Each of these steps are described in the following subsections and are summarized in Table 4-11 at the end of Section 4.2.

4.2.1 Step 1: Determine the City's Solid Waste and Recycling Division's Reported and Adjusted Costs

Table 4-2 presents the City's Solid Waste and Recycling Division's reported costs and the adjustments made to those costs for purposes of this study. Reported costs were $23,850,379

Table 4-2. Solid Waste and Recycling Division's Reported and Adjusted Costs (FY 1992)

	Total Reported Cost [a]	Adjustments: Capital Outlays Adjustments	Adjustments: Other Adjustments	Total Adjusted Cost
Administrative				
Administration	$1,083,538	$115,807	$81,271 [b]	$886,460
Contract Administration	121,140	0	1,216 [b]	119,924
Recycling Administration	737,156	3,586	35,506 [b]	698,064
Disposal Administration	311,914	64,895	740 [b]	246,279
Worker's Compensation	427,542	0	0	427,542
Subtotal: Administrative Costs	**$2,681,290**	**$184,288**	**$118,733** [b]	**$2,378,269** [c]
Collection				
City Collection	$3,606,987	$86,483	$0	$3,520,504
Contract Collection	5,851,471	0	0	5,851,471
Equipment Shop	923,381	151,459	0	771,922
90-Gallon Refuse Cart O&M	135,075	46,056	0	89,019
Subtotal: Collection Costs	**$10,516,914**	**$283,998**	**$0**	**$10,232,916**
Transfer Stations				
North Transfer Station	$35,023	$0	$0	$35,023
South Transfer Station	63,729	0	0	$63,729
Subtotal: Transfer Stations Costs	**$98,752**	**$0**	**$0**	**$98,752**
Processing/Disposal Contracts				
Municipal Solid Waste (Garbage)	$9,753,743	$0	($9,753,743)	$0
Bulky Waste Revenues	0	0	[d]	(26,811)
Materials Recovery Facility	0	0	26,811 [e]	36,898
Waste Disposal — Tires	12,650	0	(36,898) [f]	12,650
Hazardous Waste	11,731	0	0	11,731
Compost Site Rental	30,000	0	0	30,000
Yard Waste Disposal/Hauling	745,299	0	0	761,964
			(16,665) [f]	
Subtotal: Disposal Costs	**$10,553,423**	**$0**	**($9,726,991)**	**$826,432**
Total Costs	**$23,850,379**	**$468,286**	**($9,845,724)**	**$13,536,369**

Notes:

[a] City of Minneapolis, "Annual Report — Solid Waste & Recycling 1992 with Comparative Data for 1991," Department of Public Works.

[b] City indirect costs, such as "rents" and overhead charges, for use of various City facilities and services.

[c] Approximately $88,657 included in administrative costs is for promotion, public education, and public relations.

[d] Paid by City to County.

[e] Adjustment for revenues not reported in FY 1992 but attributed to FY 1992.

[f] Adjustments for costs incurred, but not reported.

from which a capital outlay adjustment and other adjustments were subtracted to yield an adjusted cost of $13,536,369. Each adjustment is discussed in the following subsections.

4.2.1.1 Capital Outlays Adjustment

A capital expense is the cost of purchasing an asset or service with a useful life of greater than one year. The City reports capital expenses as capital outlays (i.e., the actual payment made during the year). For example, in FY 1992, the City purchased new 90-gallon carts. The reported FY 1992 costs include the total cost of the cart purchases even though the carts will be used for many years. On the other hand, the FY 1992 reported costs do not reflect the value of the carts purchased in prior years. While the treatment of capital outlays in this manner is appropriate for accounting purposes, it does not properly reflect the annual economic costs of capital assets, as required for this study and explained in Appendix C. For this reason, capital assets with a cost of more than $500 (cart/recycling bin costs were considered in aggregate for the total year) were subtracted from the reported costs as shown in Table 4-2. However, the capital costs of assets have been accounted for separately and added back into the total costs as discussed in a subsequent subsection.

4.2.1.2 Other Adjustments

The reported costs from the City's Solid Waste and Recycling Division include costs for indirect expenses incurred by other City departments such as "Building and Ground Rent" and "Overhead" expenses. However, such expenses are accounted for separately in this study and are therefore subtracted from the reported costs to avoid double counting of these expenses.

The reported costs from the City's Solid Waste and Recycling Division included $9,753,743 paid to the County primarily for processing and disposal services. However, as discussed previously, the County's costs associated with the City's solid waste are accounted for separately in this study, and therefore, the $9,753,743 is subtracted from the reported costs to avoid double counting of these expenses.

In FY 1992, the City received $26,811 from the sale of recyclable bulky waste (recovered City Problem Wastes), which were not accounted for in the reported costs. Therefore, this revenue is subtracted from the reported costs.

In FY 1992, RMR operated a material recovery facility for the processing of the City's recyclables and also marketed the recovered materials. Because the revenues from the sale of recyclables were expected to be greater than RMR's processing fee, the City did not pay RMR for its services in FY 1992. However, in FY 1993, it was determined that the actual revenues from the FY 1992 material sales were less than the FY 1992 processing fee, and therefore, the City paid RMR $36,898 in FY 1993. Although paid in FY 1993, this cost is attributed to services provided in FY 1992, and therefore, this cost is added to the FY 1992 reported costs.

Two component costs of yard waste disposal were either incorrectly recorded or not accounted for in the FY 1992 reported costs. The first component cost, a January (FY 1993) payment of $3,559 made to R.D. Pecar for the marketing of compost, was included in the $745,299 "Yard Waste Disposal" reported costs. Since this was actually a FY 1993 payment, it was subtracted from the FY 1992 reported costs. The second component cost was a payment made by the City to BFI Waste Systems for $20,224 for the operation of the North Transfer Station and the hauling

of Christmas trees during January and February, 1992. These costs were not reported, and therefore, must be added to the reported costs. Combining these two adjustments results in additional costs of $16,665 (i.e., $20,224 minus $3,559).

4.2.2 Step 2: Determine Annualized Capital Costs for Vehicle and Equipment Capital Expenses

The capital expenses for the fleet vehicles and related equipment used by the City's Solid Waste and Recycling Division in FY 1992 are provided in Table 4-3. The information in Table 4-3 was generated primarily from the Solid Waste and Recycling Division's asset account, which was first developed in 1989. The purchase dates of assets acquired prior to 1989 are generally unknown. The annualized capital costs presented in Table 4-3 were calculated using the methodology described in Appendix C.

4.2.3 Step 3: Allocate Vehicle and Equipment Annualized Capital Costs

Based on the calculations presented in Table 4-3, the total "Vehicle and Equipment Annualized Capital Costs" were $270,731, as summarized below. This total does not include the annualized capital costs shown in Table 4-3 associated with general and administrative or transfer station expenses, which are accounted for separately.

Vehicle and Equipment Annualized Capital Costs

Activity	Total Net Costs ($)
Garbage Collection Vehicles and Equipment [a]	$239,263
Bulky Waste Collection Vehicles and Equipment [a]	2,865
Maintenance Shop Equipment [a]	7,841
Recyclables Collection Vehicles and Equipment [a]	12,262
Recyclables Collection Garaging and Maintenance [b]	8,500 [c]
Total Vehicle and Equipment Annualized Capital Costs	**$270,731**

Notes:

[a] Reference Table 4-3.

[b] Represents an allocation of the North Transfer Station capital expense, since a portion of the North Transfer Station is used as a garage and maintenance facility for recyclables collection vehicles.

[c] City of Minneapolis, "Annual Report — Solid Waste and Recycling 1992 with Comparative Data for 1991," page 3.

4.2.4 Step 4: Determine Transfer (Handling) and Haul Annualized Capital and Operation and Maintenance Costs

The City contracted with HTI for the operation of the South and North Transfer Stations. Garbage and combustible bulky wastes were delivered to the South Transfer Station, while yard waste and non-combustible bulky wastes were delivered to the North Transfer Station. HTI was paid an operating (handling) fee and haul fee based on the tonnage delivered to each facility and the distance travelled to each processing or disposal site.

Table 4-3. Assets - Solid Waste and Recycling Division (As of December 31, 1992)[a]

Function	Description	Date of Purchase	Age (years)	Purchase Price ($)	Assumed Useful Life (years)	Annualized Capital Cost [b][c][d] FY 1992 $)
SOLID WASTE ASSETS WITH VALUE OVER $500 (5)						
General & Administrative						
Furnishings and Equipment	Office Furniture & Equipment	1987	5	9,052	8	1,516
Furnishings and Equipment	SIS System Costs	1987	5	149,586	5	0
Furnishings and Equipment	SIS Micro Computer System	1988	4	21,009	8	3,518
Furnishings and Equipment	SIS System Costs	1988	4	57,155	5	13,940
Furnishings and Equipment	Office Furniture & Equipment	1988	4	2,611	8	437
Furnishings and Equipment	Office Furniture & Equipment	1989	3	4,633	8	776
Furnishings and Equipment	SIS Micro Computer System	1990	2	3,070	8	514
Furnishings and Equipment	Office Furniture & Equipment	1990	2	17,170	8	2,875
Furnishings and Equipment	Office Furniture & Equipment	1991	1	20,961	8	3,510
Furnishings and Equipment	Office Furniture & Equipment	1992	0	12,723	8	2,131
Subtotal				297,970		29,217
Vehicles	2 Jeep Scrambler Trucks	1984	8	18,240	6	0
Vehicles	3 Pickup Trucks #416-418	1992	0	28,154	6	0
Subtotal				46,394		0
Collection Vehicles						
Garbage Collection	9 Packers #146-154 Chassis	1980	12	189,758	6	0
Garbage Collection	Ottawa Cab/Chassis #155	1987	5	38,000	6	6,644
Garbage Collection	25 Zoeller Lifting & Tipping Dev.	1988	4	264,840	6	55,562
Garbage Collection	9 Packers #146-154 20 yd. Packer	1989	3	251,605	4	61,901
Garbage Collection	3 Pickup Trucks #001-003	1989	3	41,880	6	8,786
Garbage Collection	3 Hydraulic Dump Boxes	1989	3	7,185	6	1,507
Garbage Collection	Dual Steering Controls #145 (old)	1989	3	7,298	4	1,795
Garbage Collection	9 Packers #146-154 Cabs	1989	3	149,932	4	36,887
Garbage Collection	2 Zoeller Lifting & Tipping Dev.	1990	2	24,370	6	5,113
Garbage Collection	3 Zoeller Lifting & Tipping Dev.	1991	1	39,170	6	8,218
Garbage Collection	2 Hydraulic Dump Boxes	1992	0	4,518	6	0
Garbage Collection	1 Peerless 12 yd. Packer	1992	0	87,290	6	0
Garbage Collection	2 Zoeller Lifting & Tipping Dev.	1992	0	30,800	6	1,077
Garbage Collection	13 Garbage Packers #010-022	1992	0	1,402,356	6	49,035
Garbage Collection	One-time Vehicle Excise Tax	1992	0	78,320	6	2,739
Subtotal				2,617,322		239,263
Bulky Waste Collection	Bulky Trailer 5' x 12'	1990	2	2,483	6	521
Bulky Waste Collection	Tandem Dump Truck #158	1991	1	5,000	6	1,049
Bulky Waste Collection	Truck Bed for Bulky	1991	1	2,696	6	566
Bulky Waste Collection	2 Truck Beds #141 & 142	1991	1	3,479	6	730
Bulky Waste Collection	4 Bulky Trucks #141-144	1992	0	274,809	6	0
Subtotal				288,467		2,865
Miscellaneous Vehicle	2 SWAP Loaders #139 & 140	1992	0	142,232	6	0
Subtotal				142,232		0
Transfer Stations						
North Transfer Station	Scale House Equipment	1987	6	24,426	8	4,091
North Transfer Station	Scale House Equipment	1990	2	5,478	8	917
North Transfer Station	Scale House Equipment	1992	0	695	8	116
Subtotal				30,599		5,124
South Transfer Station	Office Furniture & Equipment	1986	6	1,000	8	167
South Transfer Station	Office Furniture & Equipment	1987	5	8,560	8	1,434
South Transfer Station	Office Furniture & Equipment	1992	0	3,216	8	539
Subtotal				12,776		2,140
Maintenance Shop	Sweeper #278	1992	0	5,000	6	0
Maintenance Shop	Shop Equipment/Tools	1987	5	10,973	8	1,838
Maintenance Shop	Shop Equipment/Tools	1988	4	502	8	84
Maintenance Shop	Shop Equipment/Tools	1989	3	1,759	8	295
Maintenance Shop	Shop Equipment/Tools	1990	2	11,947	8	2,001
Maintenance Shop	Shop Equipment/Tools	1991	1	13,474	8	2,256
Maintenance Shop	Shop Equipment/Tools	1992	0	8,168	8	1,368
Subtotal				51,823		7,841
TOTAL SOLID WASTE				$ 3,487,583		$ 286,451

Table 4-3. Assets - Solid Waste and Recycling Division (As of December 31, 1992)[a]
(Continued)

Function	Description	Date of Purchase	Age (years)	Purchase Price ($)	Assumed Useful Life (years)	Annualized Capital Cost [b][c][d] (FY 1992 $)
RECYCLING ASSETS WITH VALUE OVER $500 [f]						
General & Administrative	Office Equipment	1984	8	1,000	8	0
General & Administrative	Office Equipment	1987	5	2,378	8	398
General & Administrative	Feasibility & Consulting Services	1989	3	88,440	5	21,570
General & Administrative	Office Equipment	1989	3	41,446	8	6,941
General & Administrative	Office Equipment	1990	2	48,434	8	8,111
General & Administrative	Office Equipment	1991	1	10,232	8	1,713
General & Administrative	Office Equipment	1992	0	11,551	8	1,934
Subtotal				203,481		40,667
Recycling Collection	5 Trailers, Falcon	1989	3	6,829	4	2,016
Recycling Collection	4 Trailers, Blacksmith	1989	3	7,180	4	2,120
Recycling Collection	1 Trailer, Tandem Dump	1989	3	7,000	4	2,067
Recycling Collection	2 Isuzu Rental - AC	1990	2	2,050	3	781
Recycling Collection	1 Trailer, Plastics	1990	2	4,961	3	1,890
Recycling Collection	4 Isuzu Rental - Lift Gates	1990	2	6,065	3	2,311
Recycling Collection	1 Mod on Trailer	1990	2	2,826	3	1,077
Recycling Collection	14 Recycling Trucks	1992	0	1,242,493	6	0
Recycling Collection	14 Recycling Trailers	1992	0	162,025	6	0
Recycling Collection	4 15 cubic yd. Dumpsters	1992	0	9,321	8	0
Recycling Collection	One-time Vehicle Excise Tax	1992	0	50,179	6	0
Subtotal				1,500,929		12,262
TOTAL RECYCLING				$ 1,704,410		$ 52,929
TOTAL ASSETS - SOLID WASTE & RECYCLING DIVISION AS OF DECEMBE				$ 5,191,993		$ 339,380

NOTES:

[a] Does not include leased vehicles that were included in Table 4-2.

[b] Vehicles placed into service in fiscal year 1992 were assumed to be placed into service November 1, 1992 and the capital cost reflects only two months of service. However, those vehicles retired in fiscal year 1992 reflect only ten months of service. Vehicles purchased in fiscal year 1992 and placed into service in fiscal year 1993, were not assigned any capital cost for fiscal year 1992.

[c] Cost of capital assumed to be 7 percent.

[d] Useful life of the collection vehicles and related equipment was assumed to be 6 years. Some vehicles that were purchased, or had major modification after 1986 and were replaced in 1992, were assigned a shorter useful life.

[e] Source: "Sanitation Inventory - Year End 12-31-92," Computer printout.

[f] Source: "Recycling Inventory - Year End 12-31-92," Computer printout.

4.2.4.1 South Transfer Station

In FY 1992, the total operating fee paid to HTI for the operation of the South Transfer Station was $540,491 and the total haul fee was $450,146, for a total payment of $990,637. This cost was a part of the $9,753,743 excluded from Table 4-2, and therefore, must be separately accounted for.

The City does not have records documenting the original date of construction, original cost, or costs of modifications to the South Transfer Station, and therefore, the actual annualized capital cost cannot be determined. In addition to reimbursing the City for operation expenses paid to HTI, in FY 1992, the County paid the City an annual rent of $75,000 for use of this transfer station. Therefore, it will be assumed for purposes of this study that the annual rent plus the annualized capital cost of the equipment and furnishings (determined in Table 4-3) will equate to the total annualized capital cost of the facility. Table 4-4 summarizes the total South Transfer Station annualized capital and O&M costs.

Table 4-4. South Transfer Station Annualized Capital and O&M Costs (FY 1992 $)

	Total Net Costs ($)
Operating Fee Paid to HTI	$540,491 [a]
Haul Fee Paid to HTI	450,146 [a]
Subtotal	**$990,637** [a]
Annual Rent	$75,000
Equipment and Furnishings	2,140
Subtotal	**$77,140**
Total	**$1,067,780**

Note:

[a] Hennepin County, "Minneapolis South Transfer Station Costs 1992," and Hennepin Transfer Inc., "City Billing," January through December 1992.

4.2.4.2 North Transfer Station

In FY 1992, the total operating (handling) and haul fee paid to HTI for the North Transfer Station was $324,978. Unlike the fee paid for the South Transfer Station, this fee was included in the City's costs reported in Table 4-2, and therefore, has already been accounted for.

The City does not have records documenting the original date of construction, original cost, or costs of modifications to the North Transfer Station, and therefore, the actual annualized capital costs cannot be determined. Therefore, it will be assumed for purposes of this study that the annual rent paid for the South Transfer Station is representative of the North Transfer Station's cost. This rent, plus the annualized capital costs of the equipment and furnishings (determined in Table 4-3), less $8,500, which represents an allocation to the North Transfer Station for storage and maintenance of recyclables collection vehicles, is assumed to equate to the total annualized

capital cost of the facility. Table 4-5 summarizes the total North Transfer Station annualized capital and O&M cost.

Table 4-5. North Transfer Station Annualized Capital and O&M Costs (FY 1992 $)

	Total Net Costs ($)
Annual Rent	$75,000
Equipment and Furnishings	5,124
Subtotal	**$80,124**
Less Recyclables Collection Vehicle Allocation	(8,500)
Total	**$71,624**

4.2.5 Step 5: Determine the City's Allocation of HERC and Elk River Facility Costs

The portion of the County's expenses attributed to the City for the waste processing and disposal services provided at the HERC and Elk River facilities are provided in Tables 4-6 and 4-7, respectively. The City's share of the costs at the HERC and Elk River are $4,914,594 and $400,921, respectively.

The City's share of these expenses was determined by multiplying the total expense by the total waste delivered to each facility, by or on behalf of the City, divided by the total waste delivered by the County (less 3,360 tons delivered by the County, which was not City waste, but "deemed" Anoka County waste).

4.2.6 Step 6: Determine the Costs of Waste Sharing at the Newport and Eden Prairie Facilities

In FY 1992, the County participated in "waste sharing" arrangements with other neighboring counties. In particular, 488 tons of City waste were sent to the Newport facility at a processing cost of $30,246, or $61.98 per ton, which was the actual tipping fee. An additional 210 tons of City waste were sent to the Eden Prairie mixed waste processing facility at a processing cost of $17,010, or $81.00 per ton, which was the actual tipping fee.

4.2.7 Step 7: Determine the Costs of Christmas Tree Processing

The County contracted with Ceres Tree Company to process trees, including Christmas trees, into useful products such as wood chips, fireplace wood and lumber. In FY 1992, the County incurred a total expense of $494,487 for this service. This expense was partially offset by $263,331 in revenues received from the sale of the recovered materials. The average net cost for processing 20,815 tons of trees in FY 1992 was $11.11 per ton (i.e., $494,487 minus $263,331, divided by 20,815).

In FY 1992, the City delivered approximately 248 tons of Christmas trees to Ceres. The cost of processing these trees was estimated to be $2,759 (i.e., 248 tons times $11.11 per ton).

Table 4-6. HERC Facility Annual Cost Breakdown (FY 1992) [a]

Expenses/Revenues	County	City
Expenses		
Debt Service	$13,422,660	$3,309,898
Equity Contribution	(400,000)	(98,636)
Interest Income	(762,834)	(188,107)
Capital Charge	**$12,259,826**	**$3,023,155**
Operating Charge	$6,575,878	$1,621,548
HERC Energy Loss Factor	7,214	1,779
Subtotal	**$6,583,093**	**$1,623,327**
Pass Through Costs:		
Electricity	$163,529	40,325
Water	325,557	80,279
Sanitary Sewer	33,493	8,259
Sales, Use, Value Added Taxes	10,464	2,580
Other	110,064	27,141
Year End Settlement	[b]	0
Subtotal	**$643,103**	**$158,583**
Bypass/Residue Landfill:		
Anoka Landfill	21,881	5,396
Woodlake Landfill	1,380	340
Subtotal	**$23,262**	**$5,736**
Ash Transport	$4,620,384	$1,139,342
Ash Landfill	3,016,886	743,935
Interconnect	30,470	7,514
Total Gross O&M Cost	**$14,917,197**	**$3,678,437**
Total Gross O&M and Capital Cost	**$27,177,023**	**$6,701,591**
Revenues		
Electricity Sales	$1,804,895	$445,070
Capacity Sales	5,407,079	1,333,334
Subtotal	**$7,211,975**	**$1,778,403**
Ferrous Sales	$34,852	$8,594
Total Revenues	**$7,246,826**	**$1,786,997**
Total Net Cost	**$19,930,196**	**$4,914,594**
Average Cost Per Ton	**$54.43** [c]	**$54.43** [c]
Tons	**366,162** [d]	**90,292** [d]

Notes:

[a] Source: Hennepin County, "1992 HERC Billing By Month," Computer Output.

[b] A $26,803 year-end settlement was credited to the County in FY 1992 for expenses incurred in FY 91. This FY 1991 settlement is not included in this table. There was no year-end settlement for FY 1992 made in FY 1993.

[c] This does not represent the $95 per ton paid by the City to the County, but the real cost associated with processing the MSW.

[d] Tonnages include the "Secondary Processing" waste (e.g., non-processible waste from Elk River) that are processed at the HERC facility.

Table 4-7. Elk River Facility Annual Cost Breakdown (FY 1992) [a]

Expenses/Revenues	County [b]	City [b]
Expenses		
Debt Service	$2,863,198	$87,197
Anoka Bonds	101,832	3,101
Capital Charge	**$2,965,030**	**$90,298**
Fixed Base Fee	$4,167,089	$126,906
Hennepin MSW Sent to NSP as Anoka MSW [d]	110,839	0
Variable Base Processing Fee	215,315	6,557
Processing Balance of Contracted Waste	495,616	15,094
Ferrous Processing Cost	176,622	5,379
Seal Coat 165 Street in Elk River	794	24
Transfer of Bypass (surplus not processed)	297	9
Transfer of RDF	646,279	19,682
Transfer Non-Processible Waste	201,269	6,130
Transfer of Ash	204,453	6,227
Risk Requirement and Tax Recovery	1,399,900	42,633
Subtotal	**$7,618,473**	**$228,641**
Pass Through Costs:		
Property Taxes and Assessments	$248,420	$7,565
Cost Imposed by City of Elk River	15,539	473
Pollution Control and Monitoring Costs	663,428	20,204
Subtotal	**$927,387**	**$28,243**
Adjustments:		
Solid Waste Permit Fee	$2,270	$69
DNR Water Permit	18,265	556
Landfill Cleanup Fee	6,481	197
Tip Fees from RECOMP	0	0
Year-End Settlement	[b]	0
Subtotal	**27,016**	**823**
ByPass/Residue Landfill:		
Le Tourneau Tires	$1,134	$35
Anoka Landfill	402,761	12,266
Elk River Landfill	1,031,315	31,408
Hazardous and Unprocessible Waste	2,236	68
Subtotal	**$1,437,447**	**$43,777**
Ash Disposal	$1,607,491	$48,955
Subtotal	**$1,607,491**	**$48,955**
Gross O&M Cost	**$11,617,813**	**$350,439**
Gross O&M and Capital Cost	**$14,582,843**	**$440,737**
Revenues		
Energy Revenue Credit	**$1,307,385**	**$39,816**
Ferrous Metals	**0**	**0**
Total Revenues	**$1,307,385**	**$39,816**
Total Net Cost	**$13,275,458**	**$400,921**
Average Cost Per Ton	**$58.00** [c]	**$58.38** [c]
Tons	**228,876**	**6,868**

Notes:

[a] Source: Hennepin County, "1992 NSP ERRRF Billing By Month," Computer Printout.

[b] A $55,921 year-end settlement was credited to the County in 1993. Each cost category has been debited or credited with the actual year-end adjustment charged to or received by the County.

[c] This does not represent the $95 per ton paid by the City to the County, but the real cost associated with processing the MSW.

[d] In 1992, 3,359 tons of County MSW was sent to Elk River as part of a space allocation agreement with Anoka County for disposal at $33 per ton.

4.2.8 Step 8: Determine the Costs of MSW Landfill Disposal at the Anoka and Woodlake Landfills

In FY 1992, A total of 6,658 tons of City garbage was sent directly to the Anoka Landfill and another 224 tons was sent to the Woodlake Landfill.

The tip fees charged at the Anoka Landfill varied based on the average daily tonnage delivered by the County to the Anoka Landfill during each calendar month. In FY 1992, these tip fees ranged from $59.36 per ton for an average daily tonnage of less than 50 tons, to $30.50 per ton for an average daily tonnage of more than 800 tons. During FY 1992, the total cost of disposal at Anoka was $216,318, or an average of $32.49 per ton. The total cost of disposal at Woodlake was $8,846, or $39.49 per ton. The total landfill disposal cost of $225,164 is the sum of the Anoka and Woodlake Landfills' disposal costs (i.e., $216,318 plus $8,846.)

4.2.9 Step 9: Determine Household Hazardous Waste Collection and Processing Costs

In FY 1992, the County operated a permanent HHW collection center at its Brooklyn Park Transfer Station. The HHW center accepted flammables, aerosols, poisons, irritants, corrosives, oxidizers, latex and oil-based paint, lead acid batteries, household batteries, button batteries, tires, and oil. After the HHW was collected, it was bulked or lab packed and transported to appropriate recovery or disposal sites. In addition, the County held numerous community event collection days, two of which were held in the City in FY 1992.

In 1991, a survey conducted by the County determined the number of participants from the City that used the permanent Brooklyn Park HHW collection center. The number of City residents using the collection center facility in FY 1992 was estimated, based on the 1991 survey results. The permanent Brooklyn Park HHW collection center costs attributed to the City were estimated by the County using the estimated percentage of participants from the City. The two community event collection day costs were calculated by the County based upon the actual number of participants, which were counted, and the quantity of material collected. Table 4-8 presents the estimated costs (except for annualized capital costs) associated with both the permanent HHW center and the collection event days.

Table 4-8. The County's Cost Allocation to the City for HHW - FY 1992

Program Cost Item	Brooklyn Park Transfer Station Permanent HHW Collection Center	Community Event Collection Days in the City	Total Cost
Disposal Cost	$175,770	$208,120	$383,890
Staffing	32,980	34,305	67,285
Commodities	7,060	12,863	19,923
Facility Operation	35,775	0	35,775
Other Services	1,800	7,998	9,798
Total	**$253,385**	**$263,286**	**$516,671**
Participants	2,475	3,255	5,730
Gallons Collected	20,300	27,064	47,364

Source: "Hennepin County, Household Hazardous Waste Program — 1992 Actual Breakdown."

The Brooklyn Park Transfer Station opened in August 1990, and the total cost of the facility was about $10.1 million. Of this amount, $704,620 is attributed to the 3,500 square foot HHW collection, storage and processing area.[1] Using the methodology presented in Appendix C, an annualized capital cost of $66,510 is estimated by assuming a cost of capital of 7 percent and an expected useful life of 20 years.

The 1991 survey conducted by the County, as previously mentioned, indicated that about 20 percent of the HHW center's participants were from the City. Therefore, the capital cost attributed to the City in FY 1992 is about $13,294, or about 20 percent of $66,510.

In summary, the total HHW collection, processing, and disposal cost attributed to the City is estimated at $529,965 (i.e., the sum of the $516,671 O&M cost and the $13,294 annualized capital cost).

4.2.10 Step 10: Determine the Costs of Bins, Cans, and Bags

Each resident participating in the curbside recyclables collection program in FY 1992 was provided a single recycling bin by the City at a unit cost of $9.36. The City was reimbursed for a portion of the total costs through a County-sponsored recycling grant. Given that the City provided curbside collection to a reported 116,484 households, the estimated total purchase price of the bins is $1.09 million. Assuming a cost of capital of 7 percent, a useful life of ten years for the bins, and applying the methodology described in Appendix C, the estimated annualized capital cost of the bins is about $155,300.

Similarly, the 90-gallon carts used by residents to place their garbage at the curb were purchased by the City. The average cost of the 131,167 carts purchased by the City from 1989 through 1992 was $50.49. Therefore, the total purchase price of the 90-gallon carts was $6.62 million. Assuming a cost of capital of 7 percent, a useful life of ten years for the carts, and applying the methodology described in Appendix C, the estimated annualized capital cost of the carts is about $942,500.

In order to keep the analysis consistent, the costs incurred by individuals to purchase garbage cans and bags used for yard waste must also be estimated and included in the analysis. The costs of plastic bags and garbage cans is estimated by multiplying the cost of the bags or cans per ton of yard waste collected by the number of tons collected. Plastic bags are not reusable and are therefore consumed when the yard waste is picked up. On the other hand, garbage cans are capital goods similar to the recycling bins and 90-gallon carts. To estimate the costs of plastic bags and garbage cans, the following assumptions were used:

- Individuals used either or both 30-gallon plastic bags or 30-gallon garbage cans;
- Ninety percent of all residents used plastic bags, and 10 percent used garbage cans;
- A 30-gallon plastic bag and 30-gallon garbage could hold approximately 0.149 cubic yards or 0.022 tons of yard waste;

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[1] Memo from Robert Thomas, Environmental Management Division, Hennepin County, to Alan Cohen, October 25, 1994.

- The average cost of a 30-gallon plastic bag was about $0.13;
- The average cost of a 30-gallon garbage can was $20 and it had a useful life of 10 years; and
- The cost of capital is 7 percent.

Using the above assumptions, the costs of bags and cans (assumed used once a week for 26 weeks) was estimated to be about $5.90 per ton and $5.00 per ton of yard waste collected, respectively.

Therefore, the estimated cost of bags and cans to residents for the 16,159 tons of yard waste collected by the City in FY 1992 is:

$$[(0.90)(\$5.90) + (0.10)(\$5.00)](\$16,159) = \$93,880.$$

The factor "0.90" reflects the assumption that 90 percent of all individuals used plastic bags. The factor "0.10" reflects the assumption that 10 percent of individuals used garbage cans. The total cost for the bins, bags, and cans is about $1,191,680 million (i.e., $155,300 + $942,500 + $93,880).

4.2.11 Step 11: Determine the County's G&A Capital and O&M Expenses for Managing the City's Waste

The FY 1992 budgeted[2] administration cost of the County was reported to be $2,719,333, or 4.47 percent of the County's total FY 1992 budget of $60.9 million.[3] Assuming this percentage is applicable to the $95 per ton fee charged by the County to the City, then the County's average G&A cost for managing the City's waste was estimated to be $4.25 per ton. Multiplying the average cost of $4.25 times 104,458 tons of City MSW, including HHW and Christmas trees, results in an estimated $443,947 G&A operating cost for the County's Department of Public Works.

The G&A costs need to be increased to account for the capital assets used by the County's administrative personnel such as office space, office furniture, computers, fax machines, copier machines and other equipment. Since the County did not provide a fixed asset account, it was impossible to determine the cost of these capital assets. Based on data from other cities that do maintain fixed asset accounts, the capital costs of G&A expenses are approximately 10 to 15 percent of the G&A operating expenses. Therefore, for this analysis, the G&A capital costs are assumed to be 10 percent of the G&A operating expenses. As a result, the total County G&A capital expense for managing the City's waste is estimated to be $43,395 (i.e., $443,947 times 0.10).

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[2] The County did not provide CSI with a complete accounting of the costs incurred in FY 1992 including G&A expenses.

[3] Hennepin County, "Solid Waste Management Master Plan," 1993, page 74.

The County also spent $219,747 for education and promotional activities. Based on the ratio of people living in the City to the people living in the County, the assumed portion of these expenditures allocated to the City is $78,408 (i.e., 368,383 (City population), divided by 1,032,431 (County population), times $219,747).

The County's total G&A capital and O&M cost of $566,750 is equal to the sum of $443,947, $44,395, and $78,408.

4.2.12 Step 12: Determine the City's Indirect G&A Expenses Attributed to the Solid Waste and Recycling Division (Sanitation)

The Solid Waste and Recycling Division utilized from time to time the services of some of the City's offices and departments listed in Table 4-9 under "General Government."

Table 4-9 shows a breakdown of the City's G&A cost allocation. The $1,543,846 indirect City operating expenses shown in Table 4-9 attributed to the Solid Waste and Recycling Division were estimated by multiplying the Total Indirect Operating Expenses of $24,947,394 by 6.19 percent, which was calculated by dividing the Direct Operating Cost attributed to the Solid Waste and Recycling Division (or Sanitation) by the Total Direct Operating Expenses (i.e., $23,708,000 Direct Sanitation Operating Expenses divided by the $383,098,000 Total Direct Operating Expenses, or about 6.19 percent).

The City's indirect G&A operating costs also need to be increased to account for the capital assets used by the City's administrative personnel. Since the City did not maintain a fixed asset account, it was impossible to determine the cost of these capital assets. Based on data from other cities that do maintain fixed asset accounts the capital costs of G&A, expenses are approximately 10 to 15 percent of the G&A operating expenses. For this analysis, the G&A capital costs are assumed to be 10 percent of the G&A operating expenses. Therefore, the City's indirect G&A capital costs are estimated to be $154,400 (i.e., $1,544,000 times 0.10). The total City indirect G&A expenses, including capital cost is $1,698,246.

4.2.13 Step 13: Determine the Solid Waste and Recycling Division's G&A Annualized Capital Costs

The adjusted FY 1992 Administration expenses, exclusive of Worker's Compensation, of the Solid Waste and Recycling Division was $1.95 million (see Table 4-2). Based on the data from other cities, as mentioned previously, the G&A capital cost for the Solid Waste and Recycling Division is assumed to be 10 percent of this amount, or about $195,000.

The assets listed in Table 4-3 include only a portion of the office furnishings and equipment used by the Solid Waste and Recycling Division's administrative personnel. To avoid double counting of these costs, the G&A capital costs itemized in Table 4-3 are not added to the $195,000 estimated annualized capital cost.

Table 4-9. City General & Administrative Allocation FY 1992 [a]

Description	Total Special Revenue Funds	Total General Fund	Total Expenditures (b)	Personal Services	Capital Outlays	Direct Operating Expenses (c)	Indirect Operating Expenses (d)
GENERAL GOVERNMENT							
Mayor		$599,215	$599,215	$514,763	$15,586		$583,629
City Council		$785,052	$785,052	$766,552	$0		$785,052
City Assessor		$2,624,097	$2,624,097	$1,995,101	$109,235		$0
City Attorney		$6,382,076	$6,382,076	$4,314,423	$64,488		$6,317,588
City Clerk		$3,531,222	$3,531,222	$589,381	$39,214		$3,492,008
City Coordinator		$2,457,572	$2,457,572	$971,410	$48,674		$2,408,898
City Finance Officer		$4,461,956	$4,461,956	$1,210,481	$52,276		$4,409,680
Cable Communications		$810,416	$810,416	$574,880	$9,868		$0
Civil Rights		$1,255,000	$1,255,000	$1,124,000	$0		$1,255,000
Employment & Training		$222,591	$222,591	$100,717	$1,821		$220,770
Human Resources		$3,996,601	$3,996,601	$2,406,769	$58,700		$3,937,901
Licenses & Consumer Services		$2,726,480	$2,726,480	$2,028,216	$34,912		$0
Neighborhood Services		$75,970	$75,970	$0	$0		$75,970
Planning Commission		$1,506,677	$1,506,677	$1,313,133	$45,779		$1,460,898
Prior Year Pension Costs		$2,921,994	$2,921,994	$0	$0		$0
SUBTOTAL	$17,200,535 (e)	$34,356,919	$51,557,454	$17,909,826	$480,553		$24,947,394
PUBLIC SAFETY	$5,447,390 (e)	$110,418,197	$115,865,587	$85,126,788	$895,488	$114,970,099	
HIGHWAYS AND STREETS	$964,034 (e)	$29,171,504	$30,135,538	$15,524,845	$261,330	$29,874,208	
HEALTH AND WELFARE	$5,717,380 (e)	$5,736,623	$11,454,003	$3,989,176	$66,043	$11,387,960	
SANITATION		$25,233,499	$25,233,499	$5,258,681	$1,525,836	$23,707,663	
ECONOMIC DEVELOPMENT	$17,756,257 (e)	$576,150	$18,332,407	$19,362	$0	$18,332,407	
CULTURE AND RECREATION	$49,541,573 (e)		$49,541,573			$49,541,573	
URBAN REDEVELOPMENT AND HOUSING	$36,350,136 (e)		$36,350,136			$36,350,136	
DEBT SERVICE	$98,934,000 (f)		$98,934,000			$98,934,000	
TOTAL	**$231,911,305**	**$205,492,892**	**$437,404,197**	**$127,828,678**	**$3,229,250**	**$383,098,046**	**$24,947,394**
PERCENT SANITATION (g), (h)						**6.19%**	**$1,543,846**

(a) SOURCE: "Comprehensive Annual Financial Report, City of Minneapolis, Minnesota," For the Year Ended 12/31/92, pages 75-80.

(b) Equals Total Special Revenue Funds column plus Total Expenses column.

(c) Equals Total Expenses Column minus Capital Outlays.

(d) Equals Total Expenditures Column minus Capital Outlays except for line items shown as zero.

(e) From "Comprehensive Annual Financial Report, City of Minneapolis, Minnesota," For the Year Ended 12/31/92, page 84.

(f) From "Comprehensive Annual Financial Report, City of Minneapolis, Minnesota," For the Year Ended 12/31/92, page 112.

(g) The percent allocated to Sanitation is equal to the $23.7 million Sanitation Direct Operating Expenses divided by the $383 million Total Direct Operating Expenses.

(h) The estimated indirect City G&A allocated to Sanitation is equal to about 6.19 percent times the $24.9 million Indirect Operating Expenses.

4.2.14 Step 14: Summarize Total Net Costs

Column 1 in Table 4-10 summarizes the City's total net costs of MSW management.

4.3 Total Net Costs of Analyzed MSW Management and Costs by Functional Area

In order to allocate the net costs shown in Table 4-10, which are attributable to managing the 142,907 tons of Analyzed MSW, costs were first allocated into the following functional areas:

- General and Administrative;
- Collection;
- Transfer and Haul;
- Facilities (Processing);
- Landfill;
- Promotion, Education, and Public Relations; and
- Other.

All of the types of costs incurred were reviewed and allocated to one of the specific functional areas listed above. Then it was determined whether each cost could be classified as being either "applicable" or "not applicable" to Analyzed MSW. Typically, tonnage figures were used when necessary to determine the portion of total costs that should be allocated to Analyzed MSW.

The revenues generated were next analyzed to determine the portion that should be attributed to Analyzed MSW. Typically, tonnage figures were used when necessary to determine the portion of total revenues that should be allocated to Analyzed MSW. Please note that because of data limitations and contractual arrangements that do not explicitly account for revenues, Table 4-10 does not explicitly account for revenues. Rather, costs are shown as net costs (i.e., net of revenues).

Table 4-10 presents the results of this allocation of net costs on a functional basis and the amount of the net costs determined to be attributable to Analyzed MSW. About 4 percent, or $920,714 of the total net costs shown in Table 4-10 were determined to be not related to the management of the Analyzed MSW. These costs are identified as "not applicable" in Table 4-10. Of the amount identified as "not applicable," most of the costs were associated with the HHW, followed by self-haul garbage, and then costs associated with the management of tires.

Table 4-11 summarizes the net costs of managing Analyzed MSW by functional area. As shown in Table 4-11, the City's net costs associated with handling 142,907 tons of Analyzed MSW in FY 1992 was $23,798,129, or an average cost of $167 per ton.

Table 4-10. City of Minneapolis Total Costs (FY 1992) (a), (b)

Description	Total Costs	Not Applicable Costs	Total Costs For Analyzed MSW	Waste Type				Total Costs
				Garbage	Recyclables	Yard Waste	Bulky Waste	
General Administrative								
Operating & Maintenance:								
City Indirect	$1,543,846	$58,551	$1,485,295	$1,032,293	$229,192	$176,795	$47,015	$1,485,295
County Indirect	$443,947	$16,837	$427,110	$296,845	$65,906	$50,839	$13,519	$427,110
Solid Waste & Recycling Division	$2,289,612	$86,835	$2,202,777	$1,630,950	$439,905	$104,211	$27,712	$2,202,777
Subtotal	$4,277,405	$162,223	$4,115,182	$2,960,089	$735,003	$331,845	$88,246	$4,115,182
Capital Costs:								
City Indirect	$154,385	$5,855	$148,529	$103,229	$22,919	$17,680	$4,701	$148,529
County Indirect	$44,395	$1,684	$42,711	$29,685	$6,591	$5,084	$1,352	$42,711
Solid Waste & Recycling	$195,073	$7,398	$187,674	$130,435	$28,960	$22,339	$5,941	$187,674
Subtotal	$393,852	$14,937	$378,915	$263,349	$58,469	$45,102	$11,994	$378,915
General Administrative Total	**$4,671,257**	**$177,160**	**$4,494,097**	**$3,223,438**	**$793,472**	**$376,947**	**$100,240**	**$4,494,097**
Collection								
City Collection (c), (d)	$3,520,504	$0	$3,520,504	$1,701,531	$1,286,244	$399,881	$132,847	$3,520,504
Contract Collection (e)	$5,851,471	$0	$5,851,471	$3,666,358	$1,283,439	$593,071	$308,603	$5,851,471
Equipment Shop (f)	$771,922	$0	$771,922	$501,417	$1,500	$164,922	$104,083	$771,922
90-Gallon Refuse Cart O&M	$89,019	$0	$89,019	$89,019		$0	$0	$89,019
Plastic & Kraft Bags	$85,800	$0	$85,800	$0	$0	$85,800	$0	$85,800
Subtotal	$10,318,716	$0	$10,318,716	$5,958,325	$2,571,183	$1,243,675	$545,533	$10,318,716
Capital Costs:								
Maintenance Shop Equipment	$7,841	$0	$7,841	$5,093	$15	$1,675	$1,057	$7,841
Recycling Bins	$155,300	$0	$155,300	$0	$155,300	$0	$0	$155,300
Garbage Cans	$8,100	$0	$8,100	$0	$0	$8,100	$0	$8,100
90-Gallon Garbage Carts	$942,500	$0	$942,500	$942,500	$0	$0	$0	$942,500
Litter & Corner Cans	$0	$0	$0	$0	$0	$0	$0	$0
Garbage/Yard Waste Collection Vehicles & Equipment	$239,263	$0	$239,263	$194,711	$0	$44,552	$0	$239,263
Bulky Waste Collection Vehicles & Equipment	$2,865	$0	$2,865	$0	$0	$0	$2,865	$2,865
Recyclables Collection Vehicles & Equipment	$20,762	$0	$20,762	$0	$20,762	$0	$0	$20,762
Subtotal	$1,376,631	$0	$1,376,631	$1,142,305	$176,077	$54,327	$3,922	$1,376,631
Revenues								
Bulky Waste Revenues	$26,811	$0	$26,811	$0	$0	$0	$26,811	$26,811
Subtotal	$26,811	$0	$26,811	$0	$0	$0	$26,811	$26,811
Collection Total	**$11,668,536**	**$0**	**$11,668,536**	**$7,100,630**	**$2,747,260**	**$1,298,002**	**$522,644**	**$11,668,536**

Table 4-10 (Continued)

Description	Total Costs	Not Applicable Costs	Total Costs for Analyzed MSW	Waste Type				Total Costs
				Garbage	Recyclables	Yard Waste	Bulky Waste	
Transfer & Haul (i)								
South Transfer Station (j)	$63,729	$1,933	$61,796	$61,267	$0	$0	$529	$61,796
North Transfer Station	$35,023	$0	$35,023	$0	$0	$35,023	$0	$35,023
Operating Fee Paid to HTI (South TS)	$540,491	$16,391	$524,100	$519,613	$0	$0	$4,487	$524,100
BFI Contract North TFS O&M	$135,359	$0	$135,359	$0	$0	$135,359	$0	$135,359
Haul to HERC	$167,864	$5,091	$162,773	$161,380	$0	$0	$1,394	$162,773
Haul to Elk River	$160,069	$4,854	$155,214	$155,214	$0	$0	$0	$155,214
Haul to Newport	$1,595	$48	$1,547	$1,547	$0	$0	$0	$1,547
Haul to Eden Prairie	$2,130	$65	$2,066	$2,066	$0	$0	$0	$2,066
Haul to Anoka	$114,868	$3,484	$111,384	$111,384	$0	$0	$0	$111,384
Haul to Woodlake	$3,623	$110	$3,513	$3,513	$0	$0	$0	$3,513
Haul to Lynde & McLeod	$48,597	$0	$48,597	$0	$0	$48,597	$0	$48,597
Haul to Kraimer/Burnsville	$36,870	$0	$36,870	$0	$0	$36,870	$0	$36,870
Haul to Pine Bend	$30,158	$0	$30,158	$0	$0	$30,158	$0	$30,158
Haul to Hiawatha	$618	$0	$618	$0	$0	$618	$0	$618
Haul to Empire Organic	$92,345	$0	$92,345	$0	$0	$92,345	$0	$92,345
Haul Chistmas Tree	$1,275	$0	$1,275	$0	$0	$1,275	$0	$1,275
Subtotal	$1,434,615	$31,976	$1,402,639	$1,015,985	$0	$380,245	$6,409	$1,402,639
Capital Costs:								
South Transfer Station	$77,140	$2,339	$74,801	$74,801	$0	$0	$0	$74,801
North Transfer Station	$71,624	$0	$71,624	$0	$0	$61,085	$10,539	$71,624
Subtotal	$148,764	$2,339	$146,425	$74,801	$0	$61,085	$10,539	$146,425
Transfer & Haul Total	**$1,583,379**	**$34,315**	**$1,549,064**	**$1,090,786**	**$0**	**$441,330**	**$16,948**	**$1,549,064**
Facilities (k)								
Lynde & McLeod	$95,287	$0	$95,287	$0	$0	$95,287	$0	$95,287
Kraemer/Burnsville	$67,448	$0	$67,448	$0	$0	$67,448	$0	$67,448
Pine Bend	$41,111	$0	$41,111	$0	$0	$41,111	$0	$41,111
Mics. Yard Waste Processing	$4,221	$0	$4,221	$0	$0	$4,221	$0	$4,221
Empire Organic	$208,600	$0	$208,600	$0	$0	$208,600	$0	$208,600
Christmas Trees	$2,759	$0	$2,759	$0	$0	$2,759	$0	$2,759
Compost Site Rental	$30,000	$30,000	$0	$0	$0	$0	$0	$0
HHW Processing & Disposal	$516,671	$516,671	$0	$0	$0	$0	$0	$0

Table 4-10 (Continued)

Description	Total Costs	Not Applicable Costs	Total Costs for Analyzed MSW	Waste Type				Total Costs
				Garbage	Recyclables	Yard Waste	Bulky Waste	
HERC WTE O&M	$2,928,765	$51,723	$2,877,042	$2,861,046	$0	$0	$15,996	$2,877,042
NSP Elk River	$257,707	$7,815	$249,892	$249,892	$0	$0	$0	$249,892
NSP Newport	$30,246	$917	$29,329	$29,329	$0	$0	$0	$29,329
Eden Prairie	$17,010	$516	$16,494	$16,494	$0	$0	$0	$16,494
Material Recovery Facility (RMR)	$36,898	$0	$36,898	$0	$36,898	$0	$0	$36,898
Subtotal	$4,236,725	$607,643	$3,629,082	$3,156,761	$36,898	$419,427	$15,996	$3,629,082
Capital Costs:								
HERC Facility (l)	$3,023,155	$53,390	$2,969,764	$2,953,253	$0	$0	$16,511	$2,969,764
Elk River Facility	$90,298	$2,738	$87,560	$87,560	$0	$0	$0	$87,560
HHW Collection Center (Brooklin Park Transfer Statior	$13,294	$13,294	$0	$0	$0	$0	$0	$0
MRF	$0	$0	$0	$0	$0	$0	$0	$0
Subtotal	$3,126,747	$69,423	$3,057,324	$3,040,813	$0	$0	$16,511	$3,057,324
Revenues								
HERC Electricity (m)	$1,778,403	$31,407	$1,746,996	$1,737,283	$0	$0	$9,713	$1,746,996
HERC Ferrous (m)	$8,594	$261	$8,334	$8,287		$0	$46	$8,334
Elk River Electricity	$39,816	$1,207	$38,609	$38,609	$0	$0	$0	$38,609
Subtotal	$1,826,813	$32,876	$1,793,938	$1,784,179	$0	$0	$9,759	$1,793,938
Facilities Total	**$5,536,658**	**$644,190**	**$4,892,468**	**$4,413,395**	**$36,898**	**$419,427**	**$22,748**	**$4,892,468**
Landfill								
HERC Non-Processibles (m)	$5,736	$101	$5,635	$5,603	$0	$0	$31	$5,635
HERC Ash Disposal (m)	$743,935	$13,138	$730,797	$726,734	$0	$0	$4,063	$730,797
Elk River Non-processibles & Residue	$43,777	$1,328	$42,449	$42,449	$0	$0	$0	$42,449
Elk River Ash Disposal	$48,955	$1,485	$47,470	$47,470	$0	$0	$0	$47,470
Anoka Landfill	$216,318	$6,560	$209,758	$209,758	$0	$0	$0	$209,758
Woodlake Landfill	$8,846	$268	$8,577	$8,577	$0	$0	$0	$8,577
Landfill Total	$1,067,567	$22,880	$1,044,687	$1,040,593	$0	$0	$4,094	$1,044,687
Promotion/Education/PR								
Publication & Printing Recycle	$14,387	$0	$14,387	$0	$14,387	$0	$0	$14,387
Publication & Printing General	$74,270	$2,817	$71,453	$49,661	$11,026	$8,505	$2,262	$71,453
County Educ. & Promo.	$0	$0	$0	$0	$0	$0	$0	$0
Recycling	$37,125	$0	$37,125	$0	$37,125	$0	$0	$37,125
Waste Reduction & Reuse	$14,097	$14,097	$0	$0	$0	$0	$0	$0
HHW	$2,514	$2,514	$0	$0	$0	$0	$0	$0
Yard Waste	$8,456	$0	$8,456	$0	$0	$8,456	$0	$8,456

Table 4-10 (Continued)

Description	Total Costs	Not Applicable Costs	Total Costs for Analyzed MSW	Waste Type				Total Costs
				Garbage	Recyclables	Yard Waste	Bulky Waste	
Multi-Housing	$6,884	$6,884	$0	$0	$0	$0	$0	$0
Agriculture Education	$44	$44	$0	$0	$0	$0	$0	$0
Printing, postage, & supplies	$9,289	$3,163	$6,125	$0	$4,989	$1,136	$0	$6,125
Promotion/Education/PR Total	**$167,065**	**$29,519**	**$137,546**	**$49,661**	**$67,526**	**$18,097**	**$2,262**	**$137,546**
Other Costs								
Waste Disposal - Tires	$12,650	$12,650	$0	$0	$0	$0	$0	$0
Hazardous Waste	$11,731		$11,731	$0	$0	$0	$11,731	$11,731
Other Costs Total	**$24,381**	**$12,650**	**$11,731**	**$0**	**$0**	**$0**	**$11,731**	**$11,731**
NET COST	**$24,718,843**	**$920,714**	**$23,798,129**	**$16,918,502**	**$3,645,157**	**$2,553,803**	**$680,668**	**$23,798,129**
NET COST PER TON ($/TON)				**$166**	**$170**	**$158**	**$211**	

Notes:

[a] The procedure for the allocation of costs is as follows:

Step 1: Classifying each expenditure or revenue by function (i.e. G&A, Collection; Transfer Station and Haul; Facilities; Landfill; Promotion, Education and Public Relations; and Other).

Step 2: Determining expenditures that are totally or partially "applicable" or "not applicable" to the 142,907 tons of Analyzed MSW. Approximately 3.7% of the $ 28.3 million net cost was deemed "not applicable." This "not applicable" portion can be attributed to management of "not applicable" waste (i.e. self hauled waste and HHW).

Step 3: Allocating expenditures related to the Analyzed MSW to the management of Garbage, Recyclables, Yard Waste, and Bulky Waste. The allocations by facility were done in proportion to the waste delivery quantities to the facility. For example, Since the HERC receives 502 tons (or 0.56%) Bulky Waste, 0.56% of the total cost to process material at the HERC is allocated to Bulky Waste. The allocation of collection costs was based upon the City's reported hours spent to collect each waste.

[b] SOURCES:

1. City of Minneapolis, "Annual Report - Solid Waste & Recycling 1992 with Comparative Data for 1991," Department of Public Works.
2. City of Minneapolis, "Asset Inventories," Solid Waste & Recycling Division.
3. City of Minneapolis, "Annual Financial Report for the Year Ending December 31, 1992."
4. City of Minneapolis, "Monthly Invoices for MRI and HTL"
5. Summary of Monthly Recycling Material Fees Between Recycle Minnesota Resources and the City of Minneapolis," January 7, 1993.
6. Hennepin County, "Solid Waste Management Master Plan," 1993.
7. Hennepin County, "1992 NSP ERRRF Binnings by Month."
8. Hennepin County, "1992 HERC Billings by Month."
9. Conversations with various City and County officials

[c] Allocation of City collection costs is based upon the percentage of labor hours as reported by the City, spent to collect each type of waste.
[d] Allocation between garbage and yard waste is based on the percentage of truck hours devoted to each activity.
[e] Allocation of Contract Collection based on actual billings as reported by the City.
[f] Allocation of Maintenance Shop costs is based on allocation of these costs as reported by the City.
[g] Maintenance Shop Equipment capital cost is allocated based on O&M cost allocation.
[h] Garbage/Yard Waste collection vehicles and equipment capital cost is allocated based on hours of operation for each activity.
[i] The allocation of costs to "Not Applicable" is based on the percentage of tons that were self-hauled.
[j] The allocation of costs between Garbage and Bulky Waste is based on the percentage of tonnage delivered to the South Transfer Station that was Garbage and Bulky Waste respectively.
[k] The allocation of the Garbage between "Not Applicable" and "analyzed" is based on the fraction of tonnage that is self-hauled.
[l] Allocation of costs for the HERC facility is based on percentage of tonnage that is Garbage and Bulky Waste.
[m] Allocation of HERC costs/revenues between Garbage and Bulky Waste is based on tonnage.

Table 4-11 Net Costs of Managing Analyzed MSW by Functional Area (FY 1992$)

Functional Area	Applicable Tons of Analyzed MSW	Net Costs	$/ton	Percent of Net Costs
G&A		$4,494,097		19
Collection		11,668,536		49
Transfer and Haul		1,549,064		6
Facilities (Processing)		4,892,468		21
Landfill		1,044,687		6
Promotion, Education, and Public Relations		137,546		<1
Other		11,731		<1
Total	**142,907**	**$23,798,129**	**$167**	**100%**

4.4 Allocation of Analyzed MSW Management Costs by Type of Waste

Now that the net costs of managing Analyzed MSW have been determined, the costs can be allocated to various types of waste by using the following procedure. The procedure to allocate the $23,798,129 total net cost of managing the 142,907 tons of Analyzed MSW to the cost of managing garbage, yard waste, recyclables, and problem materials/bulky wastes was similar to the procedure used to determine which costs or proportion of costs were "applicable" or "not applicable" to Analyzed MSW. Specific costs that were 100 percent associated with the various types of MSW were identified and allocated accordingly. Generally, the data available were sufficient to allocate most costs using this approach. However, some costs were allocated to more than one type of waste. Table 4-12 shows the results of this allocation. The footnotes to Table 4-10 describe the variables used to determine the portion of total net costs apportioned to the various types of MSW. G&A expenses were allocated in direct proportion to the allocation of other costs.

4.5 Program Incremental Costs (Savings)

In this section, the estimated Program Incremental Costs (Savings) of the WTE facilities, curbside recycling, yard waste composting, mulching and landspreading programs, and bulky waste recycling programs are presented. A Program Incremental Cost (or Savings) is defined in these SWANA case studies as "the difference between the cost of managing MSW with and without the inclusion of a particular program." For purposes of the Case Studies, landfilling was considered the basic program that was not considered optional.

Therefore, an incremental cost was calculated for each program by assuming that the program had never been implemented and determining what the cost impact on the system would have been

Table 4-12. Total Net Costs Allocated by Type of Waste (FY 1992 $)

Type of Waste	Total Net Costs (without G&A)	Total G&A	Total Net Costs (with G&A)	Percent of Net Costs (with G&A) by Function	Percent of Net Costs (with G&A) By Waste Type	Applicable tons of Analyzed MSW	Net Costs (w/G&A) ($/ton)
Garbage							
Collection	$7,100,630	$1,671,291	$8,771,921	52%			
Transfer & Haul	$1,090,786	$256,741	$1,347,526	8%			
Facilities (Processing)	$4,413,395	$1,038,791	$5,452,186	32%			
Landfill	$1,040,593	$244,927	$1,285,519	8%			
Promotion, Education and Public Relations	$49,661	$11,689	$61,349	0%			
Other	$0	$0	$0	0%			
Subtotal	$13,695,064	$3,223,438	$16,918,502	100%	71%	102,030	$166
Recyclables							
Collection	$2,747,260	$764,416	$3,511,676	96%			
Transfer & Haul	$0	$0	$0	0%			
Facilities (Processing)	$36,898	$10,267	$47,165	1%			
Landfill	$0	$0	$0	0%			
Promotion, Education and Public Relations	$67,526	$18,789	$86,315	2%			
Other	$0	$0	$0	0%			
Subtotal	$2,851,685	$793,472	$3,645,157	100%	15%	21,498	$170
Yard Waste							
Collection	$1,298,002	$224,764	$1,522,765	60%			
Transfer & Haul	$441,330	$76,421	$517,751	20%			
Facilities (Processing)	$419,427	$72,629	$492,055	19%			
Landfill	$0	$0	$0	0%			
Promotion, Education and Public Relations	$18,097	$3,134	$21,231	1%			
Other	$0	$0	$0	0%			
Subtotal	$2,176,856	$376,947	$2,553,803	100%	11%	16,159	$158
Bulky Waste							
Collection	$522,644	$90,261	$612,906	90%			
Transfer & Haul	$16,948	$2,927	$19,875	3%			
Facilities (Processing)	$22,748	$3,929	$26,676	4%			
Landfill	$4,094	$707	$4,801	1%			
Promotion, Education and Public Relations	$2,262	$391	$2,652	0%			
Other	$11,731	$2,026	$13,757	2%			
Subtotal	$580,428	$100,240	$680,668	100%	3%	3,220	$211
TOTAL	**$19,304,032**	**$4,494,097**	**$23,798,129**	**N/A**	**100%**	**142,907**	**$167**

if the program had never been implemented. *It should be noted that in some instances, legislative plans precluded the "actual" ability to eliminate all management programs except landfilling.* For instance, landfilling or incinerating yard waste is banned in many states. In cases such as these, the incremental cost methodology can be interpreted as reflecting the cost of the ban. Each Program Incremental Cost (Savings) presented below reflects FY 1992 price levels and, unless otherwise specified, FY 1992 contractual relationships, and can be interpreted as the FY 1992 cost or savings caused by a particular program.

The results of the Program Incremental Costs analysis are provided in Tables 4-13 through 4-16. Each table shows in the first column the costs incurred by the City in FY 1992, which includes the costs of all of the Programs (i.e., "With Program"). The second column of each table (i.e., "Without Program") shows an estimate of the costs (or savings) that would have occurred if a given Program had never been implemented. The difference between the first two columns is shown in the third column and represents the Program Incremental Cost (or Savings).

Lastly, it should be noted that all of the Program Incremental Costs (Savings) presented below are highly dependent on the assumed landfill(s) location, and average tip fees. *The results presented assume that there would be sufficient capacity at a local landfill and that the prevailing tip fees would be similar to the FY 1992 tip fees.* However, because there is limited landfill capacity in the Minneapolis area, this may not be a reasonable assumption. For example, it is likely that without the WTE programs, the demand for landfill space would increase significantly and the distance travelled and tip fees paid would be higher than those that existed in FY 1992. Thus, the WTE Program Incremental Cost is probably overstated. Similarly, the other Program Incremental Costs (Savings) would be significantly affected if these assumptions are not valid.

4.5.1 Waste-to-Energy Program

The FY 1992 estimated Program Incremental Cost for the Waste-to-Energy Program is about $810,000, or $8 per ton for the 95,692 tons of City waste combusted at the HERC, Newport, and Elk River facilities combined. Table 4-13 shows costs with and without the WTE Program and the incremental cost for various cost categories.

A $217,500 G&A expense is assumed for the management of the WTE Program. This amount equals the cost of three full-time equivalent employees at a direct salary cost of $50,000 and fringe benefits of 45 percent (i.e., $217,500 equals $50,000 times 3 times 1.45).[4]

The $1.73 million Transfer and Haul incremental savings shown in Table 4-14 is equal to the sum of the estimated $421,100 avoided transfer cost and $1.31 million avoided haul cost. The basic assumption is that the 45,674 tons of garbage that was hauled directly to the HERC facility would, without the WTE Program, be delivered to a transfer station. In FY 1992, the average transfer

[4] The assumption that three-full time equivalent employees are devoted to the WTE Programs is based on a review of the County's organization. The 45 percent factor for fringe benefits is based upon the City data on the ratio of fringe benefits to direct salary. The $50,000 direct cost is an assumed cost.

Table 4-13. Incremental Cost (Savings) of the Waste-to-Energy Program

Cost Categories and Revenues	With Program		Without Program	Incremental Cost (Savings)
General & Administrative	$4,494,097	[a]	$4,276,597	$217,500
Collection	11,695,347	[b]	11,695,347	0
Transfer & Haul	1,549,064	[c]	3,283,961	(1,734,897)
Materials Recovery Facility	36,898	[d]	36,898	0
Waste-to-Energy Facilities	6,213,586	[e]	0	6,213,586
Composting Operations	324,139	[f]	324,139	0
Landspreading Operation	95,287	[g]	95,287	0
Landfill	1,044,687	[h]	3,334,067	(2,289,380)
Other	165,771	[i]	165,771	0
Revenues	(1,820,749)	[j]	(26,811)	(1,793,938)
TOTAL	$23,798,129		$23,185,258	$612,871
Tons Managed				95,692
Incremental Cost (Savings) per Ton ($/ton)				$6.40 [k]

[a] Total G&A from Table 4-10.
[b] Total Collection (excluding revenues) from Table 4-10.
[c] Total Transfer and Haul from Table 4-10.
[d] Facilities (Table 4-10), RMR MRF.
[e] Facilities (Table 4-10): HERC, Elk River, Newport - O&M
HERC, Elk River - Capital
[f] Facilities (Table 4-10): Kraemer/Burnsville, Pine Bend, Empire Organics, Miscellaneous Yard Waste Processing, and Christmas Tree Processing.
[g] Facilities (Table 4-10): Lynde & McLeod
[h] Total Landfill from Table 4-10.
[i] Total Other, Total Public Relations, and Eden Prairie Facility from Table 4-10.
[j] Revenues for Bulky Waste Collection, HERC Electricity & Ferrous recovery, and Elk River Electricity from Table 4-10.
[k] This value may be overstated because the demand for local landfill space is likely to have increased significantly, without the WTE program, resulting in greater average hauling distances.

or handling cost was $9.22 per ton.[5] The $421,100 incremental avoided transfer cost is, therefore, 45,674 tons times $9.22 per ton.

Without the WTE Program, it is assumed that all 95,692 tons of garbage hauled to the three WTE facilities in FY 1992 were hauled an average of 27 miles to a landfill(s). Therefore, without the WTE Program, this garbage would be hauled an estimated 2.583 million ton-miles (i.e., 95,656 times 27). With the WTE Program, the 49,982 tons of garbage reportedly transferred from the South Transfer Station to the three WTE facilities were hauled a total of 504,000 ton-miles. The difference between the estimated ton-miles hauled without the WTE Program and the ton-miles hauled with the WTE Program is 2.079 million ton-miles (i.e., 2.583 million minus .504 million). In FY 1992, BFI Waste Systems was paid an average of $0.632 per ton-mile to haul MSW from the South Transfer Station. Therefore, the estimated $1.31 million avoided haul cost is calculated by multiplying the 2.079 million ton-miles by $0.632 per ton-mile.

The assumed landfill tip fee for disposing of the 95,692 tons of garbage is $32.56 per ton. This was the approximate tip fee in FY 1992 at the Anoka Landfill for an average daily tonnage of 201 to 400 tons.[6] Therefore, the total cost of disposing of this garbage is 3.12 million. Adding this amount to the $209,758 and $8,577 actually paid in FY 1992 to dispose of garbage at the Anoka and Woodlake Landfills, respectively, results in an estimated $3.33 million landfill cost, without the WTE program, as shown in Table 4-13. The incremental landfill savings of $2.29 million is about equal to this estimated $3.33 million less the actual Anoka and Woodlake Landfill costs of $1.04 million paid in FY 1992.

The $6.21 million "With Program" cost of the WTE facilities is equal to the sum of the $2.88 million, $249,000, and $29,300 O&M fees for the HERC, Elk River, and Newport facilities, respectively, and the $2.97 million and $86,300 annualized capital costs (see Table 4-10) for the HERC and Elk River facilities, respectively. If there was no WTE Program, all of these WTE Facility expenses would have been avoided.[7]

The $1.79 million Revenue savings of the WTE Program due to the electricity and ferrous metal revenues attributed to the City as shown in Table 4-10. If there was no WTE Program, these WTE facilities revenues would be lost.

There is assumed to be no incremental collection, materials recovery facility, composting operation, landspreading operation, and other miscellaneous costs (or savings) associated with the WTE Program. There are no incremental costs (or savings) because these other activities are not affected by the WTE Program. It is assumed that there are no incremental collection costs (or savings) because the HERC facility is located within six miles of the South Transfer Station.

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[5] This is a weighted average of the $9.05/ton handling fee charged in January and February and the $9.33/ton handling fee charge for the balance of the year.

[6] Other prevailing tip fees were $65.40 at Burnsville; $37.00 at Elk River for an average daily tonnage between 201 and 400 tons; $71.40 per ton at Pine Bend, and $39.50 at Woodlake.

[7] When calculating costs without a program it is assumed that the program was never implemented. The costs of disbanding a program would be quite different because of existing contractual commitments and sunk costs.

4.5.2 Curbside Recycling Program

As discussed later in this subsection, a range of Program Incremental Costs are provided for the Curbside Recycling Program. The FY 1992 range of estimated Program Incremental Cost for the Curbside Recycling Program is $2.05 million, or $95 per ton to $1.14 million, or $53 per ton for the 21,498 tons of City collected materials that were recycled. Table 4-14 shows costs with and without the Curbside Recycling Program and the incremental cost for various cost categories.

The estimate of the Curbside Recycling Program Incremental Cost assumes that if there were no Curbside Recycling Program, all of the recycled materials would be collected as garbage and delivered to the South Transfer Station. From the South Transfer Station, it is further assumed that half of the City's recovered materials would have been taken to the Elk River WTE facility and half would have been delivered to the Anoka Landfill.[8]

The $268,210 incremental G&A cost is equal to the sum of the cost of one-full time equivalent administrative person at $60,000, the cost of the curbside recycling foreman at $84,631, the cost of the phone personnel at $57,520, and the prorated cost of clerical and support personnel at $66,059. These costs reflect G&A activities that were greater than 85 percent dedicated to the Curbside Recycling Program.[9]

If there were no Curbside Recycling Program, an additional 21,498 tons per year (an increase of 21 percent) of garbage would require collection by the City. Discussions with City staff indicate that there is insufficient data available to document the resulting cost impact on the garbage collection system resulting from the 21 percent increase. Garbage collection cost impacts will depend on many factors, including labor agreements, routing efficiency, collection vehicle type, etc. As a result of the lack of data, Table 4-14 shows a range of Incremental Programs Costs, which assume garbage collection costs increase by 0 percent to 15 percent. It is likely that the actual incremental cost will fall somewhere within this range.

If there were no Curbside Recycling Program, the City could have saved between $2.75 and $1.8 million in collection costs (see footnotes to Table 4-14), depending on the assumptions made regarding impacts on garbage collection costs.

Because the 21,498 tons of recovered materials would need to be collected as garbage, it is assumed that this material is delivered to the South Transfer Station and that half of the material is hauled to a landfill located 27 miles away (i.e., the distance to the Anoka landfill) and half the material is hauled 36 miles to the Elk River facility.

The $626,000 incremental Transfer and Haul savings is equal to an estimated $198,000 transfer savings and $428,000 haul savings. The $198,000 incremental transfer savings is equal to 21,498

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[8] Because the HERC facility was operating at its permit limit in FY 1992, none of this material was assumed to be delivered to the HERC facility.

[9] Telephone conversation with Cheryl Cline, City of Minneapolis, and Alan Cohen, November 1994.

Table 4-14. Incremental Cost (Savings) of the Curbside Recycling Program

Cost Categories and Revenues	With Program	Assuming a 0% Increase in Collection Costs		Assuming a 15% Increase in Collection Costs	
		Without Program	Incremental Cost (Savings)	Without Program	Incremental Cost (Savings)
General & Administrative	$4,494,097 [a]	$4,225,887	$268,210	$4,225,887	$268,210
Collection	11,695,347 [b]	8,948,102	2,747,245 [c]	9,857,705	1,837,642
Transfer & Haul	1,549,064 [d]	2,175,258	(626,194)	2,175,258	(626,194)
Materials Recovery Facility	36,898 [e]	0	36,898	0	36,898
Waste-to-Energy Facilities	6,213,586 [f]	6,312,369	(98,783) [g]	6,312,369	(98,783)
Composting Operations	324,139 [h]	324,139	0	324,139	0
Landspreading Operation	95,287 [i]	95,287	0	95,287	0
Landfill	1,044,687 [j]	1,393,922	(349,235) [k]	1,393,922	(349,235)
Other	165,771 [l]	98,245	67,526 [m]	98,407	67,364
Revenues	(1,820,749) [n]	(1,820,749)	0	(1,820,749)	0
TOTAL	$23,798,129	$21,752,462	$2,045,667	$22,662,227	$1,135,902
Tons Managed			21,498		21,498
Incremental Cost (Savings) per Ton ($/ton)			$95.16		$52.84

Notes:

[a] Total G&A from Table 4-10.

[b] Total Collection (excluding Revenues) from Table 4-10.

[c] Reference Table 4-10 ("Recyclables" column in Collection section) Equals sum of following:

City Collection	$1,286,244
MRI Collection	$1,283,439
Equipment Shop	$1,500
Caspital Costs - Bins	$155,300
Capital Costs - Recyclables	$20,762
TOTAL	$2,747,245

[d] Total Transfer and Haul from Table 4-10.

[e] Facilities (Table 4-10), RMR MRF.

[f] Facilities (Table 4-10): HERC, Elk River, Newport - O&M
HERC, Elk River - Capital

[g] Equals $9.19/ton times half of 21,498 tons.

[h] Facilities (Table 4-10): Kraemer/Burnsville, Pine Bend, Empire Organics, Miscellaneous Yard Waste Processing and Christmas Tree Processing.

[i] Facilities section (Table 4-10): Lynde & McLeod

[j] Total Landfill from Table 4-10.

[k] Equals $32.49/ton times half of 21,498 tons.

[l] Total Other, Total Public Relations, and Eden Prairie Facility from Table 4-10.

[m] Reference Table 4-10 "Recyclabes" column for the facilities section - Promotion and Education.

[n] Revenues for Bulky Waste Collection, HERC Electricity & Ferrous recovery, and Elk River Electricity from Table 4-10.

tons times $9.22 per ton, i.e., the average handling charge at the South Transfer Station in FY 1992. The $428,000 incremental haul savings is equal to an estimated 677,200 ton-miles time $0.632, i.e., the average haul cost fee at the South Transfer Station in FY 1992. The estimated 677,000 ton-miles was calculated by multiplying 10,749 tons by 27 miles (to the Anoka Landfill) and adding this to the product of 10,749 tons times 36 miles (to the Elk River facility).

The $36,898 incremental MRF cost is the payment made to RMR to process and market the recyclables. This is a net cost since the City's share of revenues derived from the sale of the recovered materials has been subtracted from the processing fee charge by RMR.

The $98,783 WTE facility savings is equal to 10,749 tons times the $9.19 incremental cost of processing garbage at the Elk River facility. The cost of processing additional garbage at Elk River is a function of the total amount of garbage delivered each month. In FY 1992, these incremental costs ranged from $5.32 to $12.15 per ton. The average incremental cost was $9.19 per ton.[10]

The $349,235 incremental landfill savings is equal to 10,749 tons times an assumed landfill tip fee of 32.49. (This was the average landfill tip fee paid at the Anoka Landfill in FY 1992.) The $67,364 Other incremental cost is equal to the promotion and education expenses allocated to recycling as shown in Table 4-10.

There is assumed to be no incremental composting and landspreading costs (savings) associated with the Curbside Recycling Program because these other activities are not affected by the Curbside Recycling Program.

4.5.3 Yard Waste Processing Program

As discussed later in the this subsection, a range of Program Incremental Costs are provided for the Yard Waste Processing Program. The FY 1992 range of estimated Program Incremental Cost for the Yard Waste Composting/Landspreading[11] Programs is $1.18 million, or $73 per ton to $571,394, or $35 per ton for the 16,159 tons of City yard waste that was composted or landspread. Table 4-15 shows costs with and without the Yard Waste Programs and the incremental cost for various cost categories.

The estimated Yard Waste Program Incremental Cost assumes that if there were no Yard Waste Composting and Landspreading Programs, then half of the City's yard waste would have been taken to the Elk River WTE facility and half would have been delivered to the Anoka Landfill via the South Transfer Station. Furthermore, it is assumed that: 1) yard waste would have been collected with garbage; 2) all the yard waste would be delivered to a transfer station; and 3) the transfer and hauling fees for the South Transfer Station would apply to all the yard waste.

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[10] Hennepin County, "1992 NSP ERRRF Billings by Month," Computer Spreadsheet.

[11] Christmas trees were chipped rather than composted or landspread. Christmas trees, however, represent less than 2 percent of the yard waste collected by or on behalf of the City.

If there were no Yard Waste Programs, an additional 16,159 tons per year (an increase of 16 percent) of garbage would require collection by the City. Discussions with City staff indicated that there is insufficient data available to document the resulting cost impact on the garbage collection system resulting from the 16 percent increase. Garbage collection cost impacts will depend on many factors, including labor agreements, routing efficiency, collection vehicle type, etc. As a result of the lack of data, Table 4-15 shows a range of Incremental Programs Costs, which assume garbage collection costs increase by 0 percent to 10 percent. It is likely that the actual incremental cost will fall somewhere within this range.

If there were no Yard Waste Program, the City could have saved between $1.20 million and $600,000 in collection costs (reference footnotes in Table 4-15), depending on the assumptions made regarding impacts on garbage collection costs.

In FY 1992, 15,753 tons of the yard waste were delivered to the North Transfer Station. The average transfer, or handling, fee was $8.59 per ton. The average transfer fee for garbage at the South Transfer Station was $9.22 per ton. If there were no Yard Waste Programs, it is assumed that the average transfer fee would have been $9.22 per ton, since it is assumed that the garbage would go to the South Transfer Station. Therefore, the estimated incremental transfer cost is 15,755 times the difference of $9.22 and $8.59, or $9,922. In addition, it is assumed that the 406 tons of yard waste that were not delivered to the North Transfer Station would also have to be handled at one of the transfer stations. The transfer cost for this tonnage is 406 times $9.22, or $3,743. In total, the incremental transfer cost is about $13,666.

The 15,753 tons of yard waste delivered to the North Transfer Station were hauled to various locations that were 18 to 32 miles away. The total charge for hauling this yard waste was about $210,000. If there were no Yard Waste Program, 8,080 (half of 16,159 tons) tons of yard waste is assumed to be hauled 36 miles to the Elk River facility and 8,080 (half of 16,159 tons) tons is assumed to be hauled 27 miles to a landfill. Using the average hauling fee of $0.632 per ton-mile results in an estimated haul cost of $321,713. The estimated incremental haul cost is, therefore, equal to about $111,713, (i.e., 321,713 minus $210,000).

The $125,379 incremental Transfer and Haul savings shown in Table 4-15 is equal to the sum of the avoided transfer and haul costs, i.e., about equal to $13,666 plus $112,000.

The $74,255 WTE facility savings is equal to 8,080 tons (half of the 16,159 tons) time the $9.19 incremental cost of processing garbage at the Elk River facility. The $262,519 incremental landfill savings is equal to 8,080 tons (half of the 16,159 tons) times an assumed landfill tip fee of 32.49 per ton.

The $324,140 incremental Composting Operations costs are the payments made to Kraemer, Pine Bend, Empire Organic and others. These are net costs in that the City's share of revenues derived from the sale of compost has been subtracted from the processing fee charged to the City. The $95,287 incremental Landspreading cost is the payment made to Lynde & McLead. Since there are no revenues associated with landspreading, this is a gross cost. The $18,000 Other

Table 4-15. Incremental Cost (Savings) of the Yard Waste Programs

Cost Categories and Revenues	With Program	Assuming a 0% Increase in Collection Costs		Assuming a 15% Increase in Collection Costs	
		Without Program	Incremental Cost (Savings)	Without Program	Incremental Cost (Savings)
General & Administrative	$4,494,097 [a]	$4,494,097	$0	$4,494.097	$0
Collection	11,695,347 [b]	10,492,921	1,202.426 [c]	11,099,323	596,024
Transfer & Haul	1,549,064 [d]	1,674,443	(125,379)	1,674,443	(125,379)
Materials Recovery Facility	36,898 [e]	36,898	0	36,898	0
Waste-to-Energy Facilities	6,213,586 [f]	6,287,841	(74,255) [g]	6,287,841	(74,255)
Composting Operations	324,139 [h]	0	324,139 [i]	0	324,139
Landspreading Operation	95,287 [j]	0	95,287 [k]	0	95,287
Landfill	1,044,687 [l]	1,307,206	(262,519) [m]	1,307,206	(262,519)
Other	165,771 [n]	147,674	18,097 [o]	147,674	18,097
Revenues	(1,820,749) [p]	(1,820,749)	0	(1,820,749)	0
TOTAL	$23,798,129	$22,620,333	$1,177,796	$23,226,735	$571,394
Tons Managed			16,159		16,159
Incremental Cost (Savings) per Ton ($/ton)			$72.89		$35.36

Notes:

[a] Total G&A from Table 4-10.

[b] Total Collection (excluding Revenues) from Table 4-10.

[c] Equals the sum of avoided yard waste collection costs of $399,881 (City) and $593,071 (MRI) Equipment costs of $164,922 allocated to yard waste and annualized capital cost of yard waste collection vehicles of $44,552 (Reference Table 4-10).

[d] Total Transfer and Haul from Table 4-10.

[e] Facilities (Table 4-10), RMR MRF.

[f] Facilities (Table 4-10): HERC, Elk River, Newport - O&M
HERC, Elk River - Capital

[g] Equals average FY 92 Elk River fee of $9.19 per ton times half of 16,159 tons.

[h] Facilities (Table 4-10): Kraemer/Burnsville, Pine Bend, Empire Organics, Miscellaneous Yard Waste Processing, Christmas Tree Processing.

[i] Payments made to Kaemer/Burnsville, Pine Bend, Empire Organics, etc. (Reference Table 4-10).

[j] Facilities section (Table 4-10): Lynde & McLeod

[k] Payments made to Lynde & McLeod (Reference Table 4-10).

[l] Total Landfill from Table 4-10.

[m] Equals average FY 92 Anoka Landfill tip fee of $32.49 per ton times half of 16,159.

[n] Total Other, Total Public Relations, and Eden Prairie Facility from Table 4-10.

[o] Reference Table 4-10 for Promotion/Education/PR for yard waste.

[p] Revenues for Bulky Waste Collection, HERC Electricity & Ferrous recovery, and Elk River Electricity from Table 4-10.

incremental cost is for promotional and education expenses allocated to the management of yard waste.

There is assumed to be no incremental G&A and Material Recovery Facility costs (or savings) associated with the Yard Waste Processing Programs because these other activities are not affected by the Yard Waste Processing Programs.

4.5.4 Bulky Waste/Problem Waste Recycling Program

The FY 1992 estimated Program Incremental **Savings** for the Bulky Waste/Problem Waste Recycling Program was about $187,000, or $69 per ton for the 2,718 tons of Bulky Waste collected and recycled by the City (note: "With" Program is less than "Without" Program costs and thus having the program **saves** expenses). Table 4-16 shows costs with and without the Bulky Waste/Problem Waste Recycling Program and the incremental cost for various cost categories.

For purposes of this analysis it was assumed that without the Bulky Waste/Problem Waste Recycling Program the City would not alter its collection and processing program. The Bulky Waste would still be processed to remove mercury switches, CFCs, and other hazardous material prior to disposing of the Bulky Waste. Therefore, there would be no incremental collection cost (or savings) associated with collection and processing.

After processing, it is assumed the City would deliver the Bulky Waste/Problem Waste to the South Transfer Station. It is also assumed that if there were no Bulky Waste/Problem Waste Recycling Program, then all of the Bulky Waste/Problem Waste would be disposed of at the Anoka landfill, located 27 miles away.

In summary, all costs would remain the same except for an increase in transfer (handling), hauling, and landfilling costs, and an elimination of revenues from the sale of recycled bulky waste. Incremental cost assumptions are footnoted in Table 4-16.

4.6 Summary of Results

Of the approximately 145,087 tons of waste managed by the City, about 142,907 tons, or about 99 percent, were analyzed to determine the cost of the City's IMSWMS. The total FY 1992 net cost to manage the Analyzed MSW was $23,798,129 or about $167 per ton.

The net cost was broken down by functional area in Table 4-11. The results are as follows:

- G&A: 19 percent
- Collection: 49 percent
- Transfer and Haul: 6 percent
- Facilities (Processing): 21 percent
- Landfill: 6 percent
- Promotion, Education, and Public Relations: <1 percent
- Other: <1 percent

Table 4-16. Incremental Cost (Savings) of the Bulky Waste/Problem Waste Recycling Program (FY 1992 $)

Cost Categories and Revenues	With Program	Without Program	Incremental Cost (Savings)
General & Administrative	$4,494,097 [a]	$4,494,097	$0
Collection	11,695,347 [b]	11,695,347	0
Transfer & Haul	1,549,064 [c]	1,620,504	(71,440) [d]
Materials Recovery Facility	36,898 [e]	36,898	0
Waste-to-Energy Facilities	6,213,586 [f]	6,213,586	0
Composting Operations	324,139 [g]	324,139	0
Landspreading Operation	95,287 [h]	95,287	0
Landfill	1,044,687 [i]	1,132,995	(88,308) [j]
Other	165,771 [k]	165,771	0
Revenues	(1,820,749) [l]	(1,793,938)	(26,811) [m]
TOTAL	$23,798,129	$23,984,688	($186,559)
Tons Managed			2,718 [n]
Incremental Cost (Savings) per Ton ($/ton)			($68.64)

Notes:

[a] Total G&A from Table 4-10.

[b] Total Collection (excluding Revenues) from Table 4-10.

[c] Total Transfer and Haul from Table 4-10.

[d] Sum of avoided transfer (handling) cost which equals $25,060 ($9.22 times 2,718 tons) and avoided haul cost which is equal to $46,380 (i.e. 27 miles times 2,718 tons times $0.632 per ton-mile). FY 92 average transfer (handling cost) milage to Anoka landfill and average haul cost are $9.22/ton, 27 miles, and $0.632 per ton-mile.

[e] Facilities (Table 4-10), RMR MRF.

[f] Facilities (Table 4-10): HERC, Elk River, Newport - O&M
HERC, Elk River - Capital

[g] Facilities: Kraemer/Burnsville, Pine Bend, Empire Organics, Miscellaneous Yard Waste Processing, and Christmas Tree Processing.

[h] Facilities (Table 4-10): Lynde & McLeod

[i] Total Landfill from Table 4-10.

[j] Avoided landfill tip fee assumed to be average FY 92 Anoka Landfill tip fee of $32.49 per ton (32.49 times 2,718 tons equals $88,308).

[k] Total Other, Total Public Relations, and Eden Prairie Facility.

[l] Revenues for Bulky Waste Collection, HERC Electrcity & Ferrous recovery, and Elk River Electricity from Table 4-10.

[m] Equals revenues from Bulky Wastes that are recovered.

[n] Sum of Bulky/Problem Wastes exclusive of tons not recovered.

This net cost was also broken down in Table 4-13 by Analyzed MSW category as follows:

- Garbage: 71 percent ($166 per ton of garbage in Analyzed MSW)
- Recyclables: 15 percent ($170 per ton of garbage in Analyzed MSW)
- Yard Waste: 11 percent ($158 per ton of garbage in Analyzed MSW)
- Bulky Waste: 3 percent ($211 per ton of OCC in Analyzed MSW)

The Program Incremental Costs analysis resulted in the following incremental costs per ton by program:

- WTE Program: $6 per ton
- Curbside Recycling Program: $53 - $95 per ton
- Yard Waste Programs: $35 - $73 per ton
- Bulky Waste/Problem Waste Programs: $69 per ton

5. Energy Usage Analysis

The energy consumed to manage the City's MSW during FY 1992 is discussed in this section. Due to the complexity of the management programs, much of the information presented in this section is limited by the availability of data.

Sections 5.1 through 5.5 present information on energy consumption by type of management program, as follows:

- Collection (Section 5.1);
- Transfer and hauling (Section 5.2);
- Transfer and hauling of RDF, residue, and ash generated from MSW (Section 5.3);
- MSW processing and disposal facilities (Section 5.4); and
- Transport of recovered materials to remanufacturers/end markets (Section 5.5).

In addition to information by type of program, these sections contain energy data by type of energy consumed. The forms of energy used within the IMSWMS include gasoline, diesel fuel, distillate (No. 2) fuel oil, natural gas, and electricity.

Energy consumed in the remanufacturing process for recovered materials is excluded from the analysis herein because it is beyond the scope of this study. Since many remanufacturing processes utilizing recovered material use less energy than processes utilizing virgin material this exclusion, may understate the overall energy efficiency of recycling. Conversely, for example, energy consumption for processing yard waste into compost or mulch is included in this study. The distinction is that yard waste, unlike recyclables, is not a remanufactured consumable with an alternate virgin material substitute. Thus, the energy consumed by the processing of yard waste is considered in this analysis to the extent that data is available. Energy consumption for management of HHW is excluded due to a lack of data.

Section 5.6 provides a summary of tonnage and available energy consumption data (in equivalent gallons of diesel fuel per ton[12]) by category of MSW. MSW categories include garbage, bulky waste, yard waste, and recyclables. Because energy consumption information was not available for a number of system components, it was not possible to provide totals of energy consumed by MSW category. Only actual data were used in the energy analysis to avoid misleading conclusions.

Energy generation in the IMSWMS is addressed in Section 5.7, and information on net and total energy generated from the combustion of garbage is presented. Energy conserved through the use of recyclables in the remanufacturing process is not considered, as discussed previously.

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[12] Equivalent gallons of diesel fuel is defined as the quantity of diesel fuel that would have to be consumed to equal the total energy used, measured in British thermal units (Btus), for all the types of fuels and electrical power.

5.1 Collection Vehicle Energy Consumption

Energy in the form of diesel fuel and gasoline is consumed in the IMSWMS for the collection of garbage, yard waste, bulky waste, and recyclables. The City provided energy data for the collection of all these categories of MSW; however, energy consumption data from MRI was only available for recyclables collection.

A list of the vehicles owned or leased by the City in FY 1992 and the type of fuel consumed is provided in Table 5-1. In FY 1992, the City did not maintain records on the fuel consumed by each of these vehicles, but aggregate data was available.

In total, the City purchased 60,033 gallons of unleaded gasoline and 48,476 gallons of diesel fuel for "sanitation" activities (e.g., garbage, yard waste, and bulky waste collection, and administration vehicles). Equivalent gallons of diesel were calculated by using Btus as an intermediate conversion. To calculate Btus, conversions factors of 127,650 Btu per gallon for gasoline and 146,390 Btu per gallon for diesel fuel were used.[13] The combination of these two conversion factors yields 0.872 equivalent gallons of diesel per gallon of unleaded gas. Thus, the total energy consumed by City sanitation vehicles was 100,830 equivalent gallons of diesel for collection of garbage, bulky waste, and yard waste.

Truck hour data provided by the City[14] were used to allocate the fuel consumption data for sanitation vehicles among garbage, yard waste, and bulky waste collection. The results of this allocation are provided in Table 5-2. These estimates include the fuel consumed by administration vehicles.

The City also purchased 16,841 gallons of unleaded gasoline and 13,681 gallons of diesel fuel for "recycling" activities (e.g., curbside collection and administrative vehicles).[15] This is equal to 28,370 equivalent gallons of diesel fuel. MRI's cost for diesel and gasoline related to recyclables collection was converted to gallons based on average prices of gasoline and diesel fuel estimated by MRI. Equivalent gallons of diesel were then calculated. As shown in Table 5-2, an estimated total of 59,070 equivalent gallons of diesel were consumed by MRI and the City to collect recyclables.

5.2 Energy Consumption for Transfer and Hauling of MSW

No data were available to determine the energy consumed to operate the North and South Transfer Stations. However, the operator of the transfer stations did provide data on energy consumed to

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[13] According to *Marks Standard Handbook for Mechanical Engineers*, 8th Edition, McGraw Hill Publishers, the energy content of gasoline is about 20,750 Btu/lb. At 6.152 pounds per gallon, the Btu per gallon is 127,650. Similarly the energy content of diesel fuel is about 18,400 Btu/lb. At 7.956 pounds per gallon, the Btu content per gallon is about 146,390.

[14] Data were provided at the request of CSI by Anne Davis of the Solid Waste and Recycling Division's accounting department.

[15] City of Minneapolis, "Fuel Usage Data," Computer Printout and "Gas Purchase from the Equipment Division – 1992."

Table 5-1. City Leased and Owned Vehicles and Related Equipment Used in FY 1992

Fleet Nos.	No.	Description	Year	Usage	Fuel Type
141-144	4	Intl. Harv. 14 Foot, 16 Cu. Yard Stake Side	1977	Bulky Waste	Gasoline
158	1	Ford 16 Cubic Yard Dump Truck	1978	Bulky Waste	Diesel
141-144	4	Crane Problem Material Trucks	1992	Bulky Waste	Diesel
199	1	Ford 25 Cubic Yard Rear Loader	1976	Garbage	Diesel
145	1	Intl. Harv. 16 Cubic Yard Rear Loader	1977	Garbage	Gasoline
169-173	5	Intl. Harv. 20 Cubic Yard Rear Loader	1978	Garbage	Gasoline
198	1	Intl. Harv. 20 Cubic Yard Rear Loader	1979	Garbage	Diesel
146-154	9	GMC 20 Cubic Yard Rear Loader	1980	Garbage	Diesel
187-189	3	Ford 25 Cubic Yard Rear Loader	1980	Garbage	Gasoline
175-186	12	Ford 20 Cubic Yard Rear Loader	1980	Garbage	Gasoline
190-191	2	Intl. Harv. 25 Cubic Yard Rear Loader	1986	Garbage	Diesel
155	1	Ottawa 20 Cubic Yard Rear Loader	1987	Garbage	Diesel
	25	Zoeller Lifting and Tipping Devices	1988	Garbage	--
001-003	3	Dodge Pickup with Hydraulic Dump Box	1989	Garbage	Gasoline
	2	Zoeller Lifting & Tipping Devices	1990	Garbage	--
	3	Zoeller Lifting & Tipping Devices	1991	Garbage	--
010-022	13	Crane 20 Cubic Yard Refuse Packers	1992	Garbage	Diesel
	2	Zoeller Lifting & Tipping Devices	1992	Garbage	--
004-005	2	Jeep	1984	G&A	Gasoline
201-204	4	Izuzu	1990	G&A	Diesel
	6	Blacksmith 7x12 Trailer (11 Cubic Yard)	1989	Recycling	--
	5	Falcon 6x12 Trailer (8 Cubic Yard)	1989	Recycling	--
	1	Check Point 5x12 Trailer (8 Cubic Yard)	1990	Recycling	--
	1	DTS Trailer (8 Cubic Yard)	1990	Recycling	--
632-633	2	Intl. Harv. 20 Cubic Yard Rear Loader	1991	Recycling	Diesel
740-742	3	Ford 20 Cubic Yard Rear Loader	1991	Recycling	Diesel
		Various Leased Trucks	1991	Recycling	
736	1	Ford 20 Cubic Yard Rear Loader	1991	Recycling	Diesel

Source: City of Minneapolis, "Hauler Vehicle Information," Computer Printout.

Table 5-2. Energy Consumption to Collect Garbage, Yard Waste, Bulky Waste, and Recyclables in the City (FY 1992)

Variables	Garbage	Bulky Waste	Yard Waste	Recyclables
City Truck Hours	41,089	6,247	9,402	
Percent of Truck Hours	72.42	11.01	16.57	
Tons Collected	48,355	3,220	7,823	21,499
Miilions of Btus	10,689	1,625	2,446	8,648
Diesel Fuel (Equivalent Gallons)	73,020	11,100	16,710	59,070
Gallons Per Ton	1.5	3.4	2.1	2.7

Sources:

1. City of Minneapolis, "Fuel Use Data," Computer Printouts.
2. Minneapolis Refuse, Inc., "Monthly Invoices," December 30, 1991 through December 31, 1992.

Notes:

a. Data for garbage, yard waste, and bulky waste are from the City only.
b. Data for Recyclables are for both the City and MRI.
c. MRI fuel consumption assumes average price of gasoline and diesel fuel were $1.10 and $1.25 per gallon, respectively. (Telephone conversation with Mr. D. Kruell, MRI, October 29, 1994).
d. Conversion to millions of Btus for diesel fuel assumes 146,390 Btus per gallon.
e. Conversion to millions of Btus for gasoline assumes 127,650 Btus per gallon.

transport garbage, bulky waste, and yard waste from the transfer stations to their subsequent destinations.

Based on data provided by HTI, the operator of both transfer stations, an average of 0.024 gallons per ton-mile was consumed to haul garbage/bulky waste, or yard waste in transfer trailers.[16] Because the average loads of either garbage/bulky waste or yard waste were about 18.6 tons, there was little or no difference in the fuel consumed to haul either garbage/bulky waste or yard waste. Table 5-3 shows that an estimated 17,110 gallons of diesel fuel were consumed in FY 1992 to transport 58,136 tons of garbage and 502 tons of bulky waste from the South Transfer Station. Similarly, an estimated 9,480 gallons of diesel fuel were consumed in FY 1992 to transport 15,753 tons of yard waste from the North Transfer Station to various composting or landspreading sites.

[16] Annual fuel consumption data from October 1992 through September 1993 was provided via telephone by Mr. Ron Larson of HTI, September 26, 1994.

Table 5-3. Energy Consumed to Transport MSW from Minneapolis' North and South Transfer Stations (FY 1992)

South Transfer Station				North Transfer Station			
Delivered To	Tons	Distance (Miles)	Gallons	Delivered To	Tons	Distance (Miles)	Gallons
HERC	44,189	6.0	6,363	Christmas Trees	248	19.0	113
Elk River	6,868	36.0	5,934	Lynde & McLeod	5,015	19.0	2,287
Newport	488	15.0	176	Kraemer/ Burnsville	3,109	21.0	1,567
Eden Prairie	210	16.3	82	Pine Bend	1,136	27.0	736
Anoka Landfill	6,658	27.6	4,410	Hiawatha	73	18.5	32
Woodlake Landfill	224	26.0	140	Empire Organic	6,172	32.0	4,740
Total	**58,638**		**17,106**	**Total**	**15,753**		**9,476**

Source: BFI Waste System Invoices, January 1992 through December 1992.

Note: Based upon average energy consumption of 0.024 gallons per ton-mile.

5.3 Energy Consumed to Transport RDF, Residue, and Ash Generated from MSW

RDF, residue, and ash are hauled among the various WTE facilities, mixed waste processing facilities, and landfills that comprise the IMSWMS. Some examples are: (1) the RDF produced at the Elk River facility was hauled in transfer trailers to either the UPA or Wilmarth power plants; (2) the ash generated at the UPA power plant was hauled about 18 miles in open top dump trucks to the Becker Landfill; (3) the ash generated at the HERC facility was hauled in open top dump trucks about 460 miles to the Laraway Landfill in Illinois; (4) rejects and heavies from the Eden Prairie facility and non-processible waste from Elk River were hauled to the HERC facility; and (5) residues from the Elk River and Eden Prairie facilities were hauled to landfills.

The only energy information available for the hauling of RDF, residue, and ash was the amount of fuel consumed to:

- Haul ash from the HERC facility to the Laraway Landfill; and
- Haul ash from the UPA, Wilmath, and Red Wing power plants to the Becker Landfill.

The average amount of fuel consumed in FY 1992 to haul ash in open top dump trucks was about 0.026 and 0.017 gallons per ton-mile to the Becker and Laraway Landfills, respectively.[17] The estimated total gallons of fuel consumed to haul this ash is shown in Table 5-4.

Table 5-4. FY 1992 Energy Consumed to Transport RDF, Residue, and Ash Generated from MSW

Material	Delivered To	Tons	Distance (Miles)	Gallons
Ash from HERC	Laraway Landfill	24,798	460	193,920
Ash from UPA	NSP Becker Landfill	1,164	18	545
Ash from Wilmarth	Ponderosa Landfill	301	11	86
Ash from Red Wing	NSP Red Wing Landfill	3	10	1
TOTAL GALLONS				632

Information on tonnages hauled and haul distances were available, except for those associated with the Newport facility and those associated with RDF and ash from the Eden Prairie facility. Table 5-5 presents tonnages hauled and haul distances and provides equivalent ton-miles for each program component for which there were data available. Assuming the gallons per ton-mile for hauling is relatively equivalent for each of the program components, the hauling of ash from the HERC facility to the landfill consumed by far the most fuel. The gallons per ton-mile for hauling of RDF, residue, non-processibles, and ash from the other facilities listed in Table 5-5 was relatively insignificant.

5.4 Energy Consumption at the MSW Processing and Disposal Facilities

The energy consumed in FY 1992 at the WTE and mixed waste processing facilities; yard waste composting, mulching and landspreading operations; and Woodlake, Becker, and Laraway Landfills is shown in Table 5-6. These energy consumption data were provided by representatives of the companies that own or operate each facility. Information could not be obtained for the Newport facility, the Anoka Landfill, the Empire Organic composting operation, Hiawatha yard waste processing site, the Pine Bend Landfill, the Ceres Tree Company, the Elk River Landfill, or the RMR MRF.

Note that the fuel used for mobile equipment, such as front-end loaders, in the HERC and Eden Prairie facilities is unknown. As a result, the total energy consumed for these facilities is slightly understated.

The energy consumed for each facility or operation is for combustion and processing of the tonnage indicated in the "Tons Processed" column of Table 5-6. For most facilities or operations, the *total* annual tonnage processed in FY 1992 is represented in Table 5-6, not just the City's tonnages. The UPA tonnage is the tons of RDF combusted in 1992. The tonnage for the Becker

[17] The average fuel consumed to haul ash to the Becker Landfill was estimated from the actual fuel consumed to haul ash in July and December of 1992 as provided by Mr. Roger Clark of NSP. The average fuel consumed to haul ash to the Laraway Landfill was estimated assuming a fuel efficiency of the trucks of 6 miles per gallon and an average load of 20 tons. Mr. Donald Briscoe of Briscoe Trucking indicted that his vehicles averaged between 5 to 7 miles per gallon and the loads ranged between 15 and 25 tons.

Landfill is for only two months in 1993, July and December. Energy consumed for space heating and lighting of separate office space, and consumption of lubricating oils, are not included in these estimates.

5.5 Energy Consumed to Transport Recovered Material to Remanufacturers/End Markets

No information was available to determine the energy consumed to haul compost or recyclables to market. However, data on selected quantities of recyclables and distances to markets were obtained, as shown in Table 5-7. The compost facility operators indicated that the majority of the compost was sold locally.

Table 5-7 reflects approximate ton-miles for hauling recyclables from the RMR MRF and resource recovery facility to market.

Table 5-5. FY 1992 Ton-Mile Equivalents to Transport RDF, Residue, and Ash Generated from Minneapolis' MSW

Material	Delivered To	Tons	Distance (Miles)	Ton-Miles
HERC				
Non-Processibles	Anoka or Woodlake Landfills	217	25	5,425
Ash	Laraway Landfill	24,798	460	11,407,080
Total Ton-Miles				**11,412,505**
ELK RIVER				
Refuse-Derived Fuel	United Power Associates	4,075	3	12,225
Refuse-Derived Fuel	Wilmarth	1,052	115	120,980
Refuse-Derived Fuel	Red Wing	10	95	950
Non-Processibles	HERC	144	31	4,464
Residue and Non Processibles	Anoka and Elk River Landfills	1,182	10	11,820
Ash from UPA	Becker Landfill	1,164	18	20,952
Ash from Wilmarth	Becker Landfill	301	11	3,311
Ash from Red Wing	Becker Landfill	3	10	30
Total Ton-Miles				**174,732**
EDEN PRAIRIE				
Rejects	HERC	5	16	80
Heavies	HERC	31	16	496
Residue	Unknown	77	10	770
Total Ton-Miles				**1,346**

Notes:
1. Because the Eden Prairie facility is currently being operated under new ownership, no information was available to estimate the haul distances for shipping RDF to market.
2. Haul distance to transfer RDF, non-processibles, and residue from the Newport facility are incomplete and are not included in this table.

Table 5-6. Energy Consumption by Function

Function	Total Tons Processed at Facility	Diesel Fuel (Gallons)	No. 2 Oil (Gallons)	Natural Gas (Kcuft)	Electricity (MWh)	Total Energy Consumed at Facility (MBtus)	Total Energy/Ton (Gal./Ton)
COMBUSTION AND PROCESSING							
HERC	364,996	Unknown		31,260		31,260	0.59
Elk River Processing	402,835	48,000		2,700	1,270	14,060	0.24
UPA Combustion (Tons of RDF)	254,362	24,025	40,700	87,315		96,790	2.60
Eden Prairie	105,597	Unknown		2,381	5,439	20,940	1.35
YARD WASTE PROCESSING							
Kraemer Composting	11,573	17,005				2,490	1.47
Lynde & McLeod landspreading	23,330	11,243				1,650	0.48
LANDFILL							
Woodlake Landfill (MSW)	124,400	37,288				5,460	0.30
Becker Landfill (Ash)	13,830	2,302				340	0.17
Laraway Landfill (Ash)	213,167	24,863				3,640	0.12

Notes:

1. Tons processed and total energy data are for all waste handled at the facility, not just the City's waste.
2. Diesel fuel consumed at the combustion and yard waste processing facilities and the landfills is for rolling stock, including pickup trucks.
3. Energy consumption data at each combustion and yard waste processing facility and the landfills were provided by the respective company officials.
4. No data were available on energy consumption from the MRF.
5. Data from Becker Landfill are for July and December 1993.
6. 1993 electricity consumption data for the Eden Prairie facility were converted to 1992 by assuming the average consumption per ton in 1993 is applicable to 1992.
7. Energy consumption at the Elk River and HERC facilities exclude in-plant power.
8. Conversion factors used to determine Total Energy Consumed at Facility (MBtus) are as follows: diesel = 146,390 Btus per gallon; natural gas = 1,000 Btu/cu ft; No. 2 oil = 146,390 Btus per gallon; and electricity = 3,413 Btu/kWhr. These conversion factors were used to be consistent with other case studies developed by CSI.

Table 5-7. FY 1992 Ton-Mile Equivalents for Transporting Recyclables

Recyclables	Tons	Miles	Ton-Miles
Curbside Recycling (sent from RMR MRF)			
Glass	5,912	15	88,680
Aluminum	512	450	230,400
Steel	1,143	10	11,430
Plastic	645	300	193,500
Newspaper	6,882	10	68,820
Corrugated	315	1,300	409,500
Total	**15,409**		**1,002,330**
Resource Recovery			
Metals from HERC	2,443	2	4886
Metals from Elk River	243	48	11,664
Total	**2,686**		**16,550**

Notes:

1. Of the 12,914 tons of newspaper collected, 6,032 tons were sent directly to the end user. The energy consumed in the transportation of the 6,032 tons is assumed to be covered by collection energy consumption. The energy consumed by the remaining 6,882 tons is the result of transporting this material from the RMR MRF to the market.
2. Transportation data for 57 tons of curbside collected magazines was not obtained and is excluded from this analysis.
3. Transportation data for the ferrous materials recovered at the Newport facility was not available and is excluded from this analysis.
4. Data for the recyclables recovered at the Eden Prairie facility was not available and is excluded from this analysis.

The weighted average distance recyclables were hauled from the MRF was 65 miles. Corrugated was hauled the farthest distance. Assuming the gallons per ton-mile consumed for hauling recyclables was approximately the same, the energy consumed to haul corrugated to market would be much higher than for the other materials.

5.6 Energy Consumed to Manage Garbage, Bulky Waste, Yard Waste, and Curbside Recyclables

Tables 5-8 through 5-11 show the equivalent gallons of diesel fuel per ton to manage (i.e. collect, transport, process, and deliver to end users) garbage, bulky waste, yard waste, and curbside recyclables, respectively. Much of the data needed to determine the total gallons of diesel fuel per ton for managing MSW are missing. Due to this lack of relevant data, a reasonable calculation of total equivalent gallons of diesel fuel used to manage waste cannot be performed. Tables 5-8 through 5-11 are intended to show exactly where data is missing.

The energy data used to develop Tables 5-8 through 5-11 are taken directly from information presented in Section 5.1 through 5.5.

Table 5-8. Energy Consumed to Manage the City's Garbage

	Tons	FY 1992 Equivalent Gallons of Diesel	Equivalent Gallons of Diesel Per Ton
COLLECTION			
City Collection	48,355	73,020	1.5
MRI Collection	50,703	–	–
Self-Haul	2,027	–	–
Special Collections	2,972	–	–
SOUTH TRANSFER STATION			
Facility	58,136	–	–
Transportation of Garbage to:			
HERC	43,687	6,363	0.1
Elk River	6,868	5,934	0.9
Newport	488	8,176	0.4
Eden Prairie	210	82	0.4
Anoka Landfill	6,658	4,078	0.6
Woodlake Landfill	224	140	0.6
HERC			
Facility	90,293	53,273	0.59
Transportation of:			
Recovered Ferrous to Market	2,444	–	–
Non-processibles to Landfill Disposal Sites	217	–	–
Ash to Landfill Disposal Site	24,798	193,920	7.8
ELK RIVER PROCESSING/COMBUSTION			
Processing Facility	6,868	1,648	0.2
Transportation of RDF to:			
UPA Power Plant	4,074	–	–
Wilmath Power Plant	1,052	–	–
Red Wing Power Plant	10	–	–
Transportation of Non-Processibles/Residue to:			–
Landfill Disposal Sites	1,182	–	–
HERC	144	–	
Transportation of Recovered Ferrous to Market	243	–	–
Power Generation Facilities:			
UPA	4,074	10,592	2.6
Wilmath	1,052	–	–
Red Wing	10	–	–
Transportation of Wet Ash to:			
Becker Monofill	1,164	545	0.5
Wilmath Monofill	301	141	0.5
Red Wing Monofill	3	1	0.3
NEWPORT PROCESSING/COMBUSTION			
Processing Facility	488	–	–

Table 5-8. Energy Consumed to Manage the City's Garbage

	Tons	FY 1992 Equivalent Gallons of Diesel	Equivalent Gallons of Diesel Per Ton
Transportation of RDF to:			
UPA Power Plant	1	–	–
Wilmath Power Plant	124	–	–
Red Wing Power Plant	239	–	–
Transportation of Non-Processibles/Residue to:			
Landfill Disposal Sites	111	–	–
HERC	144	–	–
Transportation of Recovered Ferrous to Market	13	–	–
Power Generation Facilities:			
UPA	1	3	3
Wilmath	124	–	–
Red Wing	239	–	–
Transportation of Wet Ash to:			
Becker Monofill	0	–	–
Wilmath Monofill	35	–	–
Red Wing Monofill	68	–	–
EDEN PRAIRIE PROCESSING/COMBUSTION			
Processing Facility	210	284	1.35
Transportation of RDF to Market	78	–	–
Transportation of Non-Processibles/Residue to:			
Landfill Disposal Sites	77	–	–
HERC	37	–	–
Compost Facility	2	–	–
Transportation of Recovered Materials to Market	9	–	–
Power Generation Facilities	78	–	–
Transportation of Wet Ash to Disposal Sites	–	–	–
LANDFILLS/MONOFILLS			
Anoka	–	–	–
Woodlake	–	–	0.3
Elk River	–	–	–
Becker	1,164	198	0.2
Wilmath	336	–	–
Red Wing	71	–	–
Laraway	24,798	2,976	0.1

Notes:
1. The energy consumption of HERC excludes diesel and electricity usage, but includes natural gas usage.
2. In-house electrical consumption at all power generation facilities is excluded.

Table 5-9. Energy Consumed to Manage the City's Bulky Waste

	Tons	FY 1992 Equivalent Gallons of Diesel	Equivalent Gallons of Diesel Per Ton
COLLECTION	3,220	11,100	3.4
NORTH TRANSFER STATION			
Facility	2,718	--	--
Transportation of Recovered Ferrous to Market	2,310	--	--
Transportation to Landfill Disposal Site	408	--	--
SOUTH TRANSFER STATION			
Facility	502	--	--
Transportation to HERC	502	72	0.1
LANDFILL	910	--	--

Table 5-10. Energy Consumed to Manage the City's Yard Waste

	Tons	FY 1992 Equivalent Gallons of Diesel	Equivalent Gallons Per Ton of Diesel
COLLECTION			
City Collection	7,823	16,710	2.1
MRI Collection	8,336	--	--
NORTH TRANSFER STATION			
Facility	15,753	--	--
Transportation of Yard Waste to:			
Ceres	248	113	0.5
L&M	5,015	2,287	0.5
Pine Bend	1,136	736	0.6
Hiawatha	73	32	0.4
Empire Organic	6,172	4,740	0.8
Burnsville	3,109	1,567	0.5
PROCESSING FACILITIES			
Ceres	248	--	--
L&M	5,015	2,407	0.5
Pine Bend	1,136	--	--
Hiawatha	73	--	--
Empire Organic	6,172	--	--
Burnsville	3,109	4,570	1.5

Notes:

1. Approximately 406 tons of yard waste bypass the North Transfer station and go directly to a processor. No data were acquired on where this material was ultimately processed. The tonnages for processing facilities shown above assume the yard waste bypassing the North Transfer Station did not go to any of these facilities.

Table 5-11. Energy Consumed to Manage the City's Curbside Recyclables

	Tons	FY 1992 Equivalent Gallons of Diesel	Equivalent Gallons of Diesel Per Ton
COLLECTION			
City Collection	10,834	28,370	2.6
MRI Collection	10,665	30,700	2.9
MRF			
Facility	15,466	--	--
Transportation of Recyclables to Market:			
Glass	5,912	--	--
Aluminum	512	--	--
Steel	1,143	--	--
Plastics	646	--	--
ONP	6,882	--	--
OCC	315	--	--
Magazines	57	--	--

Notes:

1. Of the total ONP collected, 6,032 tons were hauled directly to an end-user and 6,882 tons were taken to the RMR MRF. Energy consumption related to hauling the ONP directly to the end-user is included in the City's collection consumption.

Based on the available data, hauling ash from the HERC facility to the Laraway Landfill consumes the most energy of any IMSWMS component managing garbage. Other components consuming a relatively large amount of energy, in descending order, include City garbage collection, the HERC facility, and the UPA power generation facility.

Very little data on energy consumption related to bulky waste management were available. On an equivalent gallons of diesel per ton basis, City collection of bulky wastes consumed more than double the amount of energy consumed for City garbage collection.

Based on the data available, on an equivalent gallons of diesel per ton basis, collection of yard waste appears to consume the most energy, and is slightly higher than the City's energy consumption rate for garbage collection. Energy consumption at one of the processing facilities was also relatively high as compared to the energy consumption rates for other yard waste components.

Very little data on energy consumption related to curbside recyclables management were available. On an equivalent gallons of diesel fuel per ton basis, energy consumed for collecting recyclables curbside by the City is more than for collecting garbage and yard waste, but less than for collecting bulky wastes.

5.7 Energy Production at the HERC and UPA Power Plant

Energy production data were only available from the HERC facility and the UPA power plant. Data were not available form the Wilmath and Red Wing power plants nor the RDF market for the Lien Prairie facility.

The UPA power plant generated a total of 192,476 MWh of electricity during FY 1992 and sold 168,188 MWh. Based on the total tonnage processed during that time of 254,362 tons, the gross electrical generation rate was 757 kWh per ton and the net generation rate exclusive of in-plant usage was 661 kWh per ton. In-plant usage was approximately 13 percent of the total electricity generated.

Of the total tonnage combusted at the UPA power plant, approximately 4,075 tons, or 2 percent, was from the City's MSW. Therefore, the gross and net amount of electricity generated from the City's MSW during FY 1992 was 3,084 MWh and 2,694 MWH, respectively, based on the average per ton electrical generation rates for the UPA power plant.

The HERC facility generated a total of 261,781 MWh of electricity during FY 1992 and sold 227,488 MWh. Based on the total tonnage processed during that time of 364,996 tons, the gross electrical generation rate was 717 kWh per ton, and the net generation rate exclusive of in-plant usage was 623 kWh per ton. In-plant usage was approximately 13 percent of the total electricity generated.

Of the total tonnage combusted at the HERC facility, approximately 90,293 tons, or 25 percent was from the City's MSW. Therefore, the gross and net amount of electricity generated from the City's MSW during FY 1992 were 64,760 MWh and 56,276 MWh, respectively, based on the average per ton electrical generation rates for the HERC facility.

6. Environmental Regulations and Permit Requirements

The compliance with the environmental regulations and permit requirements discussed in this section are reflected in the costs and energy consumption levels reported in this Case Study. In FY 1992, the operation of all of the facilities comprising the Minneapolis (Hennepin County) IMSWM System were in general compliance with all of the environmental and safety regulations.

6.1 Overview of Federal Environmental Regulations

The potential environmental impacts of solid waste management facilities have led to the development of an extensive network of federal and state regulations. Embodied in many federal environmental laws is an implicit federal-state partnership whereby the federal government sets the agenda and standards for pollution abatement while the states carry out the day-to-day activities of implementation and enforcement.

The Clean Air Act, most recently amended in 1990, established programs for protecting public health and the environment from exposure to gaseous emissions, including toxic air pollutants.[18] The Clean Water Act, most recently amended in 1987, is the principal federal law protecting the nation's waterways from pollution.[19] The Safe Drinking Water Act, most recently amended in 1988, established programs for protecting public drinking water systems from harmful contaminants.[20] The Solid Waste Disposal Act and Resource Conservation and Recovery Act (RCRA) of 1976, most recently amended in 1992, is the main piece of federal legislation addressing landfill disposal regulation.[21] A brief summary of these four federal Acts as they apply to solid waste management facilities is given below.

In February 1991, the U.S. Environmental Protection Agency (EPA) issued final rules for municipal waste combustors in response to the Clean Air Act. These rules, commonly referred to as the New Source Performance Standards (NSPS), apply to municipal waste combustors with capacities of 250 tons per day or greater, and whose construction, reconstruction, or modification commenced after December 20, 1989.[22] The NSPS establish maximum emission levels for new or extensively modified major stationary sources. These emission levels were determined by "best adequately demonstrated" continuous control technology analysis and are presented in Table 6-1.[23] In addition to the NSPS, the EPA also proposed emissions limitations for existing (i.e., constructed, reconstructed, or modified prior to December 20, 1989) municipal waste combustors.

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[18] The Clean Air Act and Major Amendments are codified as 42 U.S.C. 7401-7671, 1990

[19] The Clean Water Act and Major Amendments are codified as 33 U.S.C. 1251-1387, 1987.

[20] The Safe Drinking Water Act and Amendments are codified as 42 U.S.C. 300f-300j-11, 1988.

[21] The Solid Waste Disposal/Resource Conservation and Recovery Act and Major Amendments are codified as 42 U.S.C. 6901-6991k, 1992.

[22] Federal Register, "Standards of Performance for New Stationary Sources: Municipal Waste Combustors," Vol. 56, No. 28, pages 5488-5527, 1991.

[23] Congressional Research Service, "Summary of Environmental Laws Administered by the Environmental Protection Agency," The Library of Congress, January 1993.

Table 6-1. New Source Performance Standards

Pollutant	Emission Limit[1]	Technology Basis[4]	Monitoring
Dioxins and Furans	30 ng/dscm	GCP, SD/FF	Annual Stack Test[2]
Particulate Matter	34 mg/dscm	FF	Annual Stack Test[2]
Opacity	10%	FF	CEMS, 6-min. avg.
Sulfur Dioxide	30 ppm or 80% reduction	SD/FF	CEMS, 24-hr. avg.
Hydrogen Chloride	25 ppm or 95% reduction	SD/FF	Annual Stack Test[2]
Nitrogen Oxides	180 ppmv[3]	SNCR	CEMS, 24-hr. avg.
Carbon Monoxide:			
Modular	50 ppmv	GCP	CEMS, 4-hr. avg.
Massburn	100 ppmv	GCP	CEMS, 4-hrs. avg.
Massburn/Rotary	100 ppmv	GCP	CEMS, 24-hr. avg.
Fluidized Bed	100 ppmv	GCP	CEMS, 4-hr. avg.
RDF/Full-Dedicated	150 ppmv	GCP	CEMS, 24-hr. avg.
RDF/Co-Fired	150 ppmv	GCP	CEMS, 4-hr. avg.

Notes:

Source: Federal Register, "Standards of Performance for New Stationary Sources: Municipal Waste Combustors," Vol. 56, No. 28, 1991.

[1] All emission limits are dry basis corrected to 7% O_2.

[2] In the case of small plants (less than 250 TPD), if compliance is demonstrated for two consecutive years, the facility need only conduct testing every third year. If a non-compliant result occurs, another two years of consecutive testing must be done before the facility can switch back to the three-year cycle.

[3] The NO_x standard applies to large plants only; small plants are exempt.

[4] Good Combustion Practice (GCP); Spray Dryer (SD); Fabric Filter (FF); Selective Non-Catalytic Converter (SNCR).

The owner/operator of a proposed municipal waste combustor must apply for a Prevention of Significant Deterioration (PSD) permit and conduct a Best Available Control Technology (BACT) analysis to determine the applicable level of emissions control. BACT analysis evaluates the energy, environmental, and economic impacts of various alternative control technologies. The PSD permit requirements reflect the principle which holds that areas where the air quality is better than required by the national ambient air quality standards (NAAQS) established for six criteria pollutants (ozone, sulfur, dioxide, NO_x, carbon monoxide, lead, and particulates) should be protected from significant new air pollution, even if the NAAQS would not be violated by a proposed new source. Areas not meeting NAAQS are called nonattainment areas and are subject to more stringent control requirements determined by "reasonable available control technology" (RACT).

Emissions from municipal waste combustors, in addition to meeting allowable limits, must also be monitored by the facility owner/operator. Monitoring requirements for existing facilities include continuous emissions monitoring for carbon monoxide and sulfur dioxide. Annual stack testing must be conducted for particulate matter, dioxin/furans, hydrogen chloride, and opacity.

The 1991 EPA regulations also required that chief facility operators and shift supervisors be certified in accordance with operating standards established by the American Society of Mechanical Engineers (ASME). While the states must develop certification programs with standards meeting those of ASME, no formal training requirement is included in the regulations.

Proposed changes to the Clean Air Act may apply to landfills used by the City of Minneapolis and Hennepin County. Specifically the Clean Air Act would require the installation of an active gas system at MSW landfills that (1) were operational on November 8, 1987, (2) have a capacity of 110,000 tons, and (3) discharge 167 tons per year of non-methane organic compounds (NMOC).

Pursuant to the Clean Water Act, a solid waste management facility cannot cause a discharge of pollutants that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES) into United States waters. The states are responsible for establishing water quality standards and are authorized to issue discharge permits. The NPDES permit requires the source to attain technology-based effluent limits, "best practicable control technology" (BPT), and "best available technology" (BAT). The initial BPT limitations focus on regulating discharges of conventional pollutants such as bacteria and oxygen-consuming materials. The BAT limitations emphasize controlling toxic pollutants such as heavy metals, pesticides, and other organic chemicals. Table 6-2 provides a listing of the pollutants regulated under the NPDES.

A separate permit is required to dispose of dredge or fill material into the waters, including wetlands. The U.S. Army Corps of Engineers administers this permit program. Other regulations promulgated under the Clean Water Act include guidelines for using and disposing of sewage sludge.

Pursuant to the Safe Drinking Water Act, a facility or practice cannot contaminate an underground drinking water source beyond the solid waste management facility boundary or beyond an alternate boundary. Table 6-3 provides the maximum contaminant levels as promulgated under this Act. The primary enforcement responsibility lies with the states, provided they adopt regulations as stringent as the federal requirements, develop adequate procedures for enforcement,

Table 6-2. Pollutants Regulated by the NPDES Permit Program

Oxygen Demand: Biochemical Oxygen Demand Chemical Oxygen Demand Total Oxygen Demands Total Organic Carbon Other	Metals: Aluminum Cobalt Iron Vanadium
Solids: Total Suspended Solids (Residues) Total Dissolved Solids (Residues) Other	Metals (All Forms) Other metals not specifically listed under Group 1
Nutrients: Inorganic Phosphorus Compounds Inorganic Nitrogen Compounds Other	Inorganic Cyanide Total Residual Chlorine
Detergents and Oils: MBAS NTA Oil and Grease Other Detergents or Algicides	Minerals: Calcium Chloride Fluoride Magnesium Sodium Potassium Sulfur Sulfate Total Alkalinity Total Hardness Other Minerals

Source: 40 CFR, EPA, Part 123--"Appendix A - Criteria for Reporting in the NPDES Programs."

Table 6-3. Maximum Contaminant Levels Promulgated Under the Safe Drinking Water Act

Chemical	MCL (mg/l)
Arsenic	0.05
Barium	1.0
Benzene	0.005
Cadmium	0.01
Carbon Tetrachloride	0.005
Chromium (Hexavalent)	0.05
2,4-Dichlorophenoxy Acetic Acid	0.1
1,4-Dichlorobenzene	0.075
1,2-Dichloroethabe	0.005
1,1-Cichloroethylene	0.007
Endrin	0.0002
Fluoride	4.0
Lindane	0.004
Lead	0.05
Mercury	0.002
Methoxyclor	0.1
Nitrate	10.0
Selenium	0.01
Silver	0.05
Toxaphene	0.005
1,1,1-Trichloroethane	0.2
Trichloroethylene	0.005
2,4,5-Trichlorophenoxy Acetic Acid	0.01
Vinyl Chloride	0.002

Source: 40 CFR, EPA, Part 257 - "Criteria for Classification of Solid Waste Disposal Facilities and Practices."

maintain records, and create plans providing emergency water supplies.

Pursuant to RCRA, criteria were established to determine which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on public health or the environment.[24] The objective of these criteria is to mitigate adverse effects through the protection of floodplains, endangered species, surface water, and groundwater. These criteria also provide guidelines for sludge utilization and disposal under the Clean Water Act.

Subtitle D of RCRA primarily addresses non-hazardous waste, whereas Subtitle C of RCRA addresses hazardous waste disposal. In October 1991, the EPA promulgated revised Subtitle D regulations applicable to municipal solid waste landfills, with an effective date of October 1993. In general, the new regulations require liners, leachate collection, groundwater monitoring, and corrective action at municipal landfills.[25]

The management of ash from municipal waste combustors is also governed by regulations established pursuant to RCRA. Much controversy surrounds the toxicity of incinerator ash and whether it should be classified as a hazardous waste under Subtitle C of RCRA, as a non-hazardous waste under Subtitle D of RCRA, or as a special waste. In 1991, the EPA began requiring the use of the Toxic Characteristic Leaching Procedure (TCLP) to determine the toxicity of ash. Currently, municipal waste combustor ash is regulated under Subtitle D as a "special waste" that requires special handling regardless of the TCLP results concerning toxicity. In the absence of sufficient federal guidance on municipal waste combustor ash disposal, some states have taken the lead in developing requirements and rules.[26]

Other federal regulatory agencies with permitting oversight of solid waste management facilities include: the Federal Aviation Administration (FAA), which reviews processing plants that require tall emission stacks, and the Federal Energy Regulatory Commission (FERC), which reviews processing plants that generate electric power.

6.2 Overview of State and Local Environmental Regulations

At a minimum, state regulations are required to adopt and enforce the federal environmental protection requirements. However, states may choose to impose more stringent or more extensive requirements. A brief summary of the State of Minnesota's regulations for solid waste management follows. Specific requirements for the facilities are then discussed as they apply to the individual components of the IMSWM System.

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[24] 40 CFR, EPA, Part 257--"Criteria For Classification of Solid Waste Disposal Facilities and Practices."

[25] On October 1, 1993, the Federal criteria for MSW landfills under subtitle D of RCRA were amended to extend the date of compliance for small landfills to April 9, 1994, and by delaying the effective date of subpart G, Financial Assurance, to April 9, 1995, for all MSW landfills. In addition, the MSW landfill criteria were amended by removing the exemption from the groundwater monitoring requirements and by delaying the date for compliance with all requirements of the MSW landfill criteria for two years for owners and operators of MSW landfill units in arid and remote areas that meet the qualifications of the small landfill exception in the MSW landfill criteria. (Federal Register, "Solid Waste Disposal Facility Criteria; Delay of Compliance and Effective Dates," Vol. 58, No. 189, pages 51536-51548, 1993.)

[26] On May 2, 1994, the U.S. Supreme Court ruled that ash from municipal waste combustors is not exempt from the Subtitle C requirements of RCRA as is MSW. Under RCRA, regular testing of ash, principally for toxic metals, lead, and cadmium, will be required. Ash deemed to be hazardous must be disposed of in licensed facilities that protect groundwater.

The goal of the Minnesota Waste Management Act of 1980[27] (the "Act") is to foster integrated waste management system in a manner appropriate to the characteristics of the waste streams managed. The following waste management practices are in order of preference:

1. Waste reduction and reuse;
2. Waste recycling;
3. Composting of yard waste and food waste;
4. Resource recovery through mixed MSW composting or incineration; and
5. Land disposal.

The Act prohibits the disposal of unprocessed MSW and bans certain items such as appliances, batteries, HHW, and yard waste from landfills or processing facilities. To comply with the Minnesota Rules promulgated pursuant to the Act, additional separate collections of yard waste, batteries, and bulky items were implemented.

Pursuant to the Act, each county within the seven-county Minneapolis/St. Paul metropolitan area was required to recycle a minimum of 35% by weight of total solid waste generation by December 31, 1993. In addition, each county will have a goal to recycle 45 percent by weight of total solid waste generation by December 31, 1996. Counties must ensure that residents have an opportunity to recycle. Opportunity to recycle means availability of recycling and curbside pickup or collection centers for recyclable materials at sites that are convenient for persons to use. Counties must also provide for the collection and processing of household hazardous waste and major appliances.

Counties must ensure that their residents have the opportunity to recycle used major appliances. Recycling includes: (1) the removal of capacitors that may contain PCBs; (2) the removal of ballasts that may contain PCBs; 3) the removal of chlorofluorocarbon refrigerant gas; and (4) the recycling or reuse of the metals, including mercury.

The Act is implemented and modified by the Legislative Commission on Waste Management. The Commission has jurisdiction over the Office of Waste Management, the Minnesota Pollution Control Agency (MPCA), and the Metropolitan Council as it relates to solid and hazardous waste management.

The Office of Waste Management was established in 1989 and is responsible for assisting development of the state's solid waste management system.[28] The Office of Waste Management does not regulate or enforce environmental laws, but instead provides both technical and financial assistance to help local governments and businesses better manage their waste.

The Minnesota Pollution Control Agency (MPCA) is responsible for the execution and enforcement of the provisions of the Act as contained in Minnesota Rules, Chapter 7035-MPCA,

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[27] Minnesota Statutes, Volume 9, Environmental Protection, Chapter 115A-Waste Management, Enacted 1980, most recently amended 1992.

[28] On July 1, 1994, the Office of Waste Management was renamed as the Office of Environmental Assistance.

Solid Waste Rules (referred to as the Solid Waste Rules, unless otherwise noted).[29] In accordance with the Solid Waste Rules, the Metropolitan Council is the governmental unit responsible for the environmental oversight of solid waste management policy in Minneapolis and the seven-county metropolitan area surrounding the City. This oversight includes the review of MSW disposal, transfer, energy recovery, and compost facilities (new or expansion projects).

In accordance with he Act, solid waste management districts were established to ensure the proper management of solid waste generated and to ensure the conservation and protection of natural resources. As a public corporation or political subdivision, a district is authorized to construct, equip, develop, enlarge, improve, and operate solid waste facilities and services and can negotiate contracts for the use of public or private facilities.

The Department of Environmental Management (DEM) acts as the solid waste management entity for Hennepin County. The Solid Waste Disposal Ordinance for Hennepin County (Number Two), adopted on July 17, 1976, and last amended on August 2, 1983, provides the County with the authority to license, regulate, and inspect all solid waste disposal facilities within the County. The ordinance includes design, construction, and operating requirements for solid waste facilities, and procedures for enforcement of the ordinance. The Solid Waste Surcharge Ordinance (Number Ten) provides the County with the authority to establish rules, regulations, and standards to collect a solid waste surcharge for operators of MSW facilities.

The Solid Waste Designation Ordinance (Number Twelve), adopted on December 10, 1985, and amended on April 24, 1990[30], requires DEM licensing of solid waste haulers and regulates all designated waste generated, collected, transported, or disposed of in Hennepin County. Designated waste is defined as "mixed MSW generated in the County and destined for in-state and out-of-state disposal, excluding hazardous waste, infectious waste, and undesignatable waste."[31] Exclusions from designation have been granted to solid waste facilities for the purpose of resource recovery, recycling, or composting. This ordinance requires that all MSW be delivered to one of the County's designated facilities; however, materials which are not recyclable and have no resource recovery value may be granted a DEM exception.

The Solid Waste Source Separation and Recycling Ordinance (Number Thirteen) regulates the separation of materials which must be separated from MSW by generators, before collection of such materials.

Municipalities, such as the City of Minneapolis, under their police powers, regulate the storage and collection of MSW within their boundaries. Individual permits, usually granted by regional or local jurisdictions and pertinent to such issues as wastewater and surface water, are also required The Metropolitan Waste Control Commission (MWCC), which operates the Metropolitan

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[29] Minnesota Rules, Chapter 7035-MPCA, Groundwater and Solid Waste Division-Solid Waste Rules; Adopted January 12, 1970; most recently amended March 18, 1991.

[30] Most recently, amended December 21, 1993 subsequent to the study period of FY 1992.

[31] Hennepin County Board of Commissioners, Bureau of Public Service, Ordinance Number Twelve Solid Waste Designation for Hennepin County, Adopted on December 10, 1985, amended on April 24, 1990 (subsequently amended December 21, 1993).

Wastewater Treatment Plant, provides review for the discharge of industrial waste into public sewers within Minneapolis.

6.3 Permit Requirements for Selected IMSWM Facilities

This section briefly summarizes the permit requirements applicable to selected facilities included in the Minneapolis/Hennepin County IMSWM System: the two transfer stations in Minneapolis; the MRFs; the HERC facility; the Elk River/UPA facility; the yard waste landspread and composting facilities; and the Laraway, Becker, Anoka, and Woodlake landfills.

A solid waste management facility permit or permit modification is required by the MPCA to: (a) treat, store, process, or dispose of solid waste; b) establish, construct, or operate a solid waste management facility; or (c) change, add, or expand a permitted solid waste management facility. A permit is effective for a fixed term not to exceed five years.[32]

In accordance with the General Technical Requirements,[33] solid waste management facility personnel must successfully complete a program of classroom instruction or on-the-job training. The program prepares facility personnel to deal effectively with problems at the site including: using, inspecting, and repairing emergency and monitoring equipment; activating communication and alarm systems; activating automatic waste feed cutoff systems; responding to fires; responding to facility failures; accepting and managing waste other than MSW approved for storage or disposal at the facility; and rejecting waste not permitted at the facility.

In accordance with the General Technical Requirements, the owner or operator of a solid waste management facility must submit an annual report covering all activities during the previous calendar year to the MPCA.

6.3.1 Transfer Stations

Minneapolis' North and South transfer stations operate under a permit from the MPCA, with the City and HTI as co-permittees. In accordance with the Specific Technical Requirements[34], the transfer stations provide the operational appurtenances necessary to maintain a clean and orderly operation. They are staffed at all times the facilities are open with employees trained in the safe operation of equipment . The transfer stations must have effective barriers (e.g., fences) and procedures to prevent unauthorized entry and dumping.

In 1992, the transfer stations were issued renewal licenses for the 1992-1993 year from the DEM. DEM inspections of these facilities verified continued compliance with licensing conditions.

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[32] Minnesota Rules, Chapter 7001-MPCA, Permits-Solid Waste Management Facility Permits; Adopted November 7, 1988; Amended March 18, 1991.

[33] Minnesota Rules, Chapter 7035-MPCA, Groundwater and Solid Waste Division, Solid Waste-Solid Waste Management Facility General Technical Requirements; Adopted November 7, 1988; Amended March 18, 1991.

[34] Minnesota Rules, Chapter 7035-MPCA, Solid and Hazardous Waste Division, Solid Waste Management Facility Specific Technical Requirements, Adopted November 7, 1988.

6.3.2 Hennepin Energy Resource Company Waste-to-Energy Facility

HERC operates under a MPCA Combined Air and Solid Waste permit which was issued in 1987 and renewed in 1992. The PSD determination was received in October 1989 from MPCA. The HERC facility performed well within all emission limits during environmental testing conducted in 1992 as shown in Table 6-4.

HERC is permitted to discharge wastewater into public sewers that feed into the Metropolitan Wastewater Treatment Plant in accordance with the MWCC Waste Discharge Rules and allowable discharge limitations listed on Table 6-5. Pursuant to HERC's NPDES permit conditions, effluent limitations and monitoring requirements are listed on Table 6-6.

6.3.3 Elk River Resource Recovery Facility

In 1992, Elk River applied to MPCA for the reissuance of the facility permit. In November, 1992 UPA conducted emission tests for particulate matter, hydrogen chloride, sulfur dioxide, and mercury. The permit limits and the results of the November test are provided in Table 6-7. The UPA facility met all FY 1992 MPCA standards.

6.3.4 Materials Recovery Facility

Pursuant to the provisions of "permits-by-rule," of the Minnesota Rules, Chapter 7001-MPCA, Permits,[35] the owner or operator of a recycling facility is deemed to have obtained a solid waste management facility permit. No application for a permit is required, simply a letter to the MPCA notifying them of the existence of the facility.

6.3.5 Landspreading and Composting Facilities

Pursuant to the provisions of "permits-by-rule," of the Minnesota Rules, Chapter 7001-MPCA, Permits,[36] the owner or operator of a compost or landspreading facility (receiving yard waste only), is deemed to have obtained a solid waste management facility permit. No application for a permit is required, simply a letter to the MPCA notifying them of the existence of the facility. Furthermore, there are no regulations governing the quality of the compost generated from yard waste, although site set-up and operations are regulated.

6.3.6 MSW and Ash Landfills

Ash from the HERC facility was disposed of at the Laraway landfill located in Elwood, Illinois. In general, this landfill is in compliance with Subtitle D requirements of RCRA.

Ash from the UPA power plant (i.e., the Elk River/UPA waste-to-energy facility) was disposed of at the Becker ash monofill. This landfill also complies with Subtitle D requirements of RCRA.

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[35] Minnesota Rules, Chapter 7001-Minnesota Pollution Control Agency, Permits-Solid Waste Management Facility Permits; Adopted November 7, 1988; Amended March 18, 1991.

[36] Minnesota Rules, Chapter 7001-MPCA, Permits-Solid Waste Management Facility Permits; Adopted November 7, 1988; Amended March 18, 1991.

Table 6-4. 1992 HERC Emission Limits and Test Results

Emission	Permit Maximum Limit	Emission as Percent of Limit
Dioxins	1.0 ug/dscm	1.22
Hydrocarbons	3.0 lb/hr	18.67
Particulate	0.02 gr/dscf	7.00
Lead	0.007 lb/ton	0.08
Hydrogen Chloride	50.0 ppm	8.00
Mercury	0.002 lb/ton	40.33
Sulphur Dioxide	20.83 ppm	14.89
Nitrous Oxide	250.0 ppm	62.30
Carbon Monoxide	100.0 ppm	15.50
Opacity	10%	17.20

Units:
ug/dscm = microgramper dry standard cubic meter
lb/hr = pounds per hour
gr/dscf = grains per dry standard cubic foot
lb/ton = pounds per ton
ppm = ppm

Table 6-5. HERC Wastewater Discharge Limitations

Parameter	Standard (mg/l)
Cadmium (Cd)	2.0
Chromium - total (Cr)	8.0
Cyanide - total (CN)	6.0
Lead (Pb)	1.0
Mercury (Hg)	0.1
Nickel (Ni)	6.0
Zinc (Zn)	8.0
pH - Maximum	11.0
pH - Minimum	5.0

Source: Industrial Discharge Permit

Table 6-6. HERC Effluent Discharge Limitations

Parameter	Standard (mg/l)
Temperature	50°C (122°F)
Total Residual Chlorine	0.038 mg/l
pH - Maximum	9.0
pH - Minimum	6.0
Floating Solids	None
Visible Foam	Trace amounts only
Oil or Other Substances	No visible color film

Source: NPDES/State Disposal System Permit

Note: For the purpose of this permit, the above discharges are limited solely to noncontact cooling waste free from process and other wastewater discharges.

Table 6-7. 1992 UPA Emission Limits and Test Results

Emission	Permit Maximum Limit	Emissions (Nov. 92)
Dioxins (PCDD & PCDF) @ 12% CO_2 as 2378, TE	125.0 ng/dscm 3 ng/dscm	0.793 0.014
Particulate	0.02 gr/dscf	0.007
Hydrogen Chloride	50 ppm	11.8
Carbon Monoxide	400 ppm	120[a]
Opacity	20%	0.35
Sulfur Dioxide	N/A ppm @ 7% O_2	28[a]
Mercury	N/A ug/dscm @ 7% O_2	3.71[a]
Nitrous Oxide	N/A ppm @ 7% O_2	249[b]

Notes:
[a] Test results for February 1994
[b] Test results for June 1994

Units:
ng/dscm = nanograms per dry standard cubic meter
ug/dscm = micrograms per dry standard cubic meter
gr/dscf = grains per dry standard cubic foot
ppm = parts per million

The Anoka and Woodlake landfills were used to dispose of a small percentage of Minneapolis' garbage and the residue and non-processible waste that was landfilled in FY 1992. Both of these landfills are currently closed and little information was made available about the design and operation of these landfills during the study period.

6.4 Overview of Occupational Health and Safety Regulations

6.4.1 Federal Regulations

The Occupational Safety and Health Act of 1970[37] imposes two basic duties on private employers. State and local governments in their roles as employers are not required to comply with these duties, which are:

(1) To comply with occupational safety and health standards developed by the Occupational Safety and Health Administration (OSHA) pursuant to the Occupational Safety and Health Act; and

(2) To comply with the General Duty Clause, Section 5(a)(1), which requires that employers protect their employees from recognized hazards not regulated by an OSHA standard.

Pursuant to the Occupational Safety and Health Act, OSHA, created within the Department of Labor, is responsible for promulgating legally enforceable standards. These OSHA standards require conditions, or the adoption or use of one or more practices, means, methods, or processes, reasonably necessary and appropriate to protect workers on the job. These standards include the General Industry Standards, 29 CFR Part 1910, which apply to all workplaces unless more specific OSHA standards apply. The General Industry Standards are applicable to solid waste processing facilities and are listed in Table 6-8.

Periodic inspections, either routine or in response to complaints, are conducted by OSHA to ensure that specific applicable standards are being met and that the workplace is generally free from recognized hazards likely to cause serious injury or death. When OSHA compliance officers discover areas of non-compliance resulting in hazards, employers may be issued citations, and penalties and abatement periods may be proposed.

6.4.2 State and Local Safety Requirements

OSHA provisions, as previously mentioned, do not apply to state and local governments in their role as employers. The Act does provide that any state desiring to gain OSHA approval for its private sector occupational safety and health program must provide a program that covers its state and local government workers and that is at least as effective as its program for private employees. State plans may also cover only public sector employees.

As previously discussed, all private employers are required to comply with the General Industry Standards developed by OSHA. Thus, the privately owned and operated IMSWM System facilities must comply with OSHA standards. The State of Minnesota does have an OSHA approved state plan. In addition, the MPCA, in cooperation with the Office of Waste Management and the Metropolitan Council, has prepared and distributed a guide for the operation of a recycling or yard waste composting facility to protect the environment and public health.

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[37] Occupational Safety and Health Act of 1970, 5 USC 5108, 1970, most recently amended October 1992.

Table 6-8. OSHA Standards and Rules

OSHA Standards and Rules	Requirement
Cadmium Standard	29 CFR 1910.1027
Chemical Safety and Handling	29 CFR 1910.120
Confined Space	29 CFR 1910.146
CPR/First Aid	29 CFR 1910.151
Crane Operation	29 CFR 1910.179
Electrical Policy	29 CFR 1910.300
Emergency Response Drill	29 CFR 1910.157
Eye Protection	29 CFR 1910.133
Fire Extinguishers and 1.5" Hose	29 CFR 1910.157(g)
Flammable Materials	29 CFR 1910.120h (1&2)
Hazard Communication	29 CFR 1910.120h (1&2)
HazMat Emergency Response Team	29 CFR 1910.1201(2)i
Lead Standard	29 CFR 1910.1025
Lock Out/Tag Out	29 CFR 1910.147
Machine Operating and Guarding	29 CFR 1910.212
Noise (Hearing Protection)	29 CFR 1910.95(k)
Powered Industrial Truck	29 CFR 1910.178(1)
Respirator Training	29 CFR 1910.134(b)(3)
Nuclear	10 CFR Part 31 & 32
Scaffolding	29 CFR 1926.451

Source: 29 CFR, OSHA, Part 1901--"Occupational Safety and Health Standards.

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Appendix A - Glossary of Terms

ALLOCATED COST ($/year):	That portion of the Total Cost that is expended or apportioned to a specific activity such as the management of garbage, trash, recyclables, yard waste, or household hazardous waste.
ANALYZED MSW:	Portion of the MSW stream for which the cost of items such as collecting, hauling, processing, marketing, and/or disposing of such waste is known or can be reasonably estimated.
AVERAGE COST ($/ton):	Total of Allocated Cost divided by the tons of MSW, garbage, trash, recyclables, or yard waste, as appropriate.
AVERAGE PROGRAM INCREMENTAL COST (SAVINGS) ($/ton):	The Program Incremental Cost divided by the number of tons of materials diverted from the landfill by the program.
BULKY WASTE:	Oversized items, including white goods and furniture, that have been separated from the MSW stream for separate collection.
COMMERCIAL MSW:	Municipal solid waste that is generated by sources other than households, including businesses (e.g., offices, restaurants, retail stores, and industry); institutions (e.g., schools and government establishments; and public areas (e.g., train stations, airports, and litter from roadside).
DEMOLITION WASTE:	Materials resulting from the construction, remodeling, repair or demolition of buildings, bridges, pavements and other structures as well as bulky wastes, wood wastes, brush and tires.
GARBAGE:	Garbage is all MSW exclusive of source-separated trash, recyclables, yard waste, household hazardous waste, and bulky waste.
HAZARDOUS WASTE:	Waste which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed and is defined as such in accordance with federal and state laws. Does not include Household Hazardous Waste.
HOUSEHOLD HAZARDOUS WASTES (HHW):	Materials that are separated from Residential MSW as household hazardous wastes for separate collection and treatment. Such materials may include paints and solvents, pesticides, herbicides, and propane tanks.

ALLOCATED COST ($/year):	That portion of the Total Cost that is expended or apportioned to a specific activity such as the management of garbage, trash, recyclables, yard waste, or household hazardous waste.
INTEGRATED SOLID WASTE MANAGEMENT:	A practice of using several (i.e., two or more) alternative waste management techniques to treat, process, and/or dispose of the Municipal Solid Waste stream. Alternative waste management techniques include source reduction, recycling, composting, combusting, and landfilling.
MATERIALS RECOVERY:	A term describing the extraction and utilization of materials from a waste stream.
MUNICIPAL SOLID WASTE (MSW):	Non-hazardous solid wastes generated by households, commercial and business establishments, institutions, and light industry; it excludes industrial process wastes, agricultural wastes, mining wastes, construction and demolition debris, offal, sludges, and ashes, except ashes derived from the combustion of MSW. In practice, specific definitions vary across jurisdictions.
NON-PROCESSIBLE WASTE	Solid waste that a processing facility receives but cannot process due to the physical nature of the waste. Non-processibles are either sent to a landfill or another waste processing facility.
PROGRAM INCREMENTAL COST (SAVINGS) ($/year):	The difference between the cost of managing MSW with or without a particular program (e.g., curbside collection, processing, and marketing of recyclables).
RECOVERED MATERIALS:	Recyclable or reusable materials that are recovered from MSW and may also include some contamination.
RECYCLABLE MATERIALS OR RECYCLABLES:	Materials that still have useful physical or chemical properties after serving their usefulness for a given individual or firm and can, therefore, be reused or recycled for the same or other purposes.
RECYCLE:	To convert discarded materials into useful products through reuse and remanufacturing.
RESIDENTIAL MSW:	Municipal solid waste that is generated by households.
RESIDUE:	That portion of processed MSW that is ultimately disposed of in a landfill.
RESOURCE RECOVERY:	A term describing the extraction and utilization of energy or materials from a waste stream.
SECONDARY MATERIAL:	A material that is used in place of a primary or raw material in manufacturing a product; often handled by dealers and brokers in "secondary markets."

ALLOCATED COST ($/year):	That portion of the Total Cost that is expended or apportioned to a specific activity such as the management of garbage, trash, recyclables, yard waste, or household hazardous waste.
SELF-HAUL:	The delivery of MSW or other wastes to an integrated municipal solid waste management system by a private firm or individual that is not under contract to a municipality, authority, utility, or other public entity responsible for municipal solid waste management to make such deliveries.
TOTAL NET COST OR TOTAL COST ($/year):	The aggregate of all expenditures incurred to manage municipal solid waste, inclusive of general and administrative, planning, capital, collection, processing, transfer and haul, marketing, promotion and education, and disposal costs, less any revenues derived from resource recovery activities.
WHITE GOODS:	That portion of bulky waste which consists of large appliances, such as refrigerators, stoves, washing machines, and dryers.

Appendix B - Supplemental Tables to Section 3, Municipal Solid Waste Quantities and Flow

Table B-1. Hennepin Energy Resource Company

	County (tons) [a]	Percent Tons Processed	City (tons)
Tons Processed			
Primary Garbage	343,134	93.69%	90,112
Elk River Non-Processibles	4,744	1.30%	144
EPR Rejects	2,546	0.72%	5
EPR Heavies	15,737	4.30%	31
Subtotal	**366,161**	**6.31%**	**90,292**
Recovered Materials			
Pre-Combustion Recyclables	307	0.08%	76
Post-Combustion Metals	9,602	2.62%	2,368
Subtotal	**9,909**	**2.71%**	**2,443**
Landfill Disposal			
Non-Processibles	879	0.24%	217
Ash	100,563	27.46%	24,798
Subtotal	**101,442**	**27.70%**	**25,015**

Sources:

Hennepin County Department of Public Works, Environmental Management Division, "Facilities Development and Operations Program, 1992 Annual Report;" and County Solid Waste Operations staff review and input.

Notes:

[a] Includes total materials within the County that were processed, including City of Minneapolis generated materials.

Table B-2. Elk River RDF Resource Recovery Facility

Variable	County Total (tons)	% Tons Processed	City Total (tons)
Tons Processed [a]	226,237		6,868
Ferrous	8,004	3.54%	243
RDF	169,177	74.78%	5,136
Nonprocessibles to HERC	4,744	2.10%	144
Nonprocessibles to Landfill and Transfer Loadout	3,385	1.50%	103
Residue	35,677	15.77%	1,083
Shrinkage	5,250	2.32%	159
TOTAL	**1,746**	**100.00%**	**6,868**
Wet Ash from Combustion Facility [b]			
UPA	38,338	79.32%	1,164
Wilmarth	9,902	20.49%	301
Redwing/Other	95	0.20%	3
TOTAL	**48,335**	**100.00%**	**1,467**

Sources:

Hennepin County Department of Public Works, Environmental Management Division, "Facilities Development and Operations Program, 1992 Annual Report" and Solid Waste Operations staff review and input.

Notes:

[a] Hennepin County tonnage includes 701 tons delivered in 1991 and processed in 1992. Minneapolis tonnage only includes waste delivered in 1992.

[b] The tonnage of ash generated at Wilmarth and Red Wing are estimates based on the amount of ash generated at UPA per ton of RDF combusted.

Table B-3. Newport RDF Resource Recovery Facility

Variable	County Total (tons)	% Tons Processed	City Total (tons)
Tons Processed	1,746		488
Ferrous	48	2.76%	13
RDF	1,301	74.51%	364
Nonprocessibles to HERC	0	0.00%	0
Nonprocessibles to Landfill and Transfer Loadout	260	14.88%	73
Residue	137	7.86%	38
Shrinkage	0	0.00%	0
TOTAL	**1,746**	**100.00%**	**488**
Wet Ash from Combustion Facility			
UPA	1	0.24%	0
Wilmarth	127	34.15%	35
Redwing/Other	244	65.61%	68
TOTAL	**372**	**100.00%**	**104**

Sources:

Hennepin County Department of Public Works, Environmental Management Division, "Facilities Development and Operations Program, 1992 Annual Report" and Solid Waste Operations staff review and input.

Table B-4. EPR Mixed Waste Processing Facility

	County (tons)	Percent	City (tons)
Tons Processed	105,597	100.00%	210
Recovered Materials			
Aluminum	153	0.15%	0.30
Plastic	61	0.06%	0.12
Corrugated	1,933	1.83%	3.84
Ferrous	1,293	1.22%	2.57
Scrap Metal	1,007	0.95%	2.00
Subtotal	**4,447**	**4.21%**	**9**
Refuse Derived Fuel			
D-RDF	36,097	34.18%	71.79
Fluff RDF	2,961	2.80%	5.89
Subtotal	**39,058**	**36.99%**	**78**
Compost (Fines)	1,219	1.15%	2
Combustion			
HERC (Rejects)	2,679	2.54%	5.33
HERC (Heavies)	15,709	14.88%	31.24
Subtotal	**18,388**	**17.41%**	**37**
Landfill Disposal			
Landfill (Heavies)	13,897	13.16%	27.64
Landfill (Rejects)	4,224	4.00%	8.40
Landfill (Fines)	20,387	19.31%	40.54
Subtotal	**38,508**	**36.47%**	**77**
Shrinkage	3,977	3.77%	8

Source: EPR, Inc. "Abatement Performance Report," 1992.

Appendix C - Capital Cost Calculation[38]

A capital expense is the purchase of an asset or service with a useful life of greater that one year. Accountants report capital expenses as capital outlays, i.e., the actual payment made during the year, or as depreciated/amortized expenses. One depreciation method is straight line depreciation, wherein the capital outlay is divided by the useful life of the asset.

Capital assets may be purchased entirely with cash, financed over time using borrowed funds, or a combination of the two. If totally or partially financed, interest payments on borrowed funds are reported by accountants as interest expenses.

Following these accounting practices the cost of a capital asset in a given reporting period (e.g., fiscal year) is reported as either the capital outlay incurred, or the depreciation/amortization expense incurred in the reporting period, plus interest paid, if any, on borrowed funds to finance the capital asset. Some financial reports, such as a cash flow analysis, also report the actual debt service, i.e., principal plus interest payments, on borrowed funds.

Although these approaches are appropriate for generating financial statements of non-profit organizations, none is an appropriate measure of the economic capital costs of the asset. The reporting of capital outlays does not recognize that a capital asset will be used over two or more years and, therefore, its costs should be spread over the assets useful life. The depreciation/amortization approach does not adequately distinguish between the same asset purchased with cash or with borrowed funds. Because loan repayment and debt service payments, and in particular the interest portion of such payments, can vary significantly from year to year based solely on the means of borrowing funds and not the use of the asset, these expenses are not an appropriate measure of the capital cost of the asset.

The approach used in the report was to calculate capital costs is to "annualize" or "capitalize" capital outlays over the useful life of the asset using a cost of capital of seven percent.[2] Generally, the cost of capital reflects the rate of return expected on invested funds.

Using this approach the capital cost of an asset is independent of the method used to pay for the asset, and has the same annual value over the useful life of the asset.

To illustrate the method used to calculate capital costs and compare it to the other ways of reporting capital expenses, consider a transfer tractor and trailer with a 5 year useful life and a purchase price of $105,000.

To estimate the annual capital cost the purchase price (i.e., capital outlay) of $105,000 is multiplied by

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[38] Methodology and test developed by CSI Resource Systems, Incorporated.

[2] The cost of capital is related to the rates of return that can be earned on invested funds and the rates of interest that must be paid on borrowed funds. As the economy changes and interest rates increase or decrease, the cost of capital may also change over time. The 7-percent cost of capital is about the mid-point of cost of capital often used for public entities.

the following capitalization factor:

$$\frac{r}{1-[1/(1+r)^n]}$$

where "r" is the cost of capital, or .07 in this analysis, and "n" is the useful life of the asset in years.

Substituting .07 for "r" and 5 for "n" in the above equation results in a capitalization factor of:

$$0.2539 = \frac{.07}{1-[1/(1.07)^5]}$$

Multiplying $105,000 by this capitalization factor results in an annual capital cost of $25,610. Capitalization factors for various costs of capital and useful lives of assets are provided in Table C-1.

Table C-1. Capitalization Factors

	Cost of Capital					
Number of Years	**5%**	**6%**	**7%**	**8%**	**9%**	**10%**
2	0.5378	0.5454	0.5531	0.5608	0.5685	0.5762
3	0.3672	0.3741	0.3811	0.3880	0.3951	0.4021
4	0.2820	0.2886	0.2952	0.3019	0.3087	0.3155
5	0.2310	0.2374	0.2439	0.2505	0.2571	0.2638
10	0.1295	0.1359	0.1424	0.1490	0.1558	0.1627
15	0.0963	0.1030	0.1098	0.1168	0.1241	0.1315
20	0.0802	0.0872	0.0944	0.1019	0.1095	0.1175
30	0.0651	0.0726	0.0806	0.0888	0.0973	0.1061
40	0.0583	0.0665	0.0750	0.0839	0.0930	0.1023
50	0.0548	0.0634	0.0725	0.0817	0.0912	0.1009

Table C-2 shows the difference between the capital cost calculated above for this tractor/trailer over its 5 year useful life and the capital expenses reported using various accounting procedures. This table clearly shows that the differences among these reporting procedures vary significantly. Also note that the capital cost as calculated above is identical to the a loan repayment or debt service schedule on a 7 percent loan with a constant annual repayment schedule as shown in Case 7.

Table C-2. Comparison of Capital Costs and Other Accounting Methods Purchase of Tractor/Trailer with 5 Years Useful Life for $105,000

Year	Calculated "Capital Cost"	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8
1	25,609	105,000	112,350	112,350	21,000	28,350	28,350	25,609	28,350
2	25,609	0	6,072	5,880	21,000	27,072	26,880	25,609	26,880
3	25,609	0	4,704	4,410	21,000	25,704	25,410	25,609	25,410
4	25,609	0	3,241	2,940	21,000	24,241	23,940	25,609	23,904
5	25,609	0	1,675	1,470	21,000	22,675	22,470	25,609	22,470

Definition of Cases:

CALCULATED "CAPITAL COST"
Uses formula:

$$\frac{r}{1-[1/(1+r)^n]}$$

CASE 1 Capital Outlay reporting. Purchased with cash.

CASE 2 Capital Outlay reporting. Financed with borrowed funds. Interest rate of 7 percent. Constant annual payments.

CASE 3 Capital Outlay reporting. Financed with borrowed funds. Interest rate of 7 percent. Constant principal payment, interest paid on unpaid balance.

CASE 4 Straight line depreciation/amortization reporting. Purchased with cash.

CASE 5 Straight line depreciation/amortization reporting. Financed with borrowed funds. Interest rate of 7 percent. Constant annual payments.

CASE 6 Straight line depreciation/amortization reporting. Financed with borrowed funds. Interest rate of 7 percent. Constant principal payments.

CASE 7 Debt Service reporting. Financed with borrowed funds. Interest rate of 7 percent. Constant annual payments.

CASE 8 Debt Service reporting. Financed with borrowed funds. Interest rate of 7 percent. Constant annual principal payments.

REPORT DOCUMENTATION PAGE

Form Approved
OMB NO. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	November 1995	Final Subcontract Report

4. TITLE AND SUBTITLE
Integrated Solid Waste Management of Minneapolis, Minnesota

5. FUNDING NUMBERS
(C) AR-2-12242
(TA) WM41.1010

6. AUTHOR(S)

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

SWANA
1100 Wayne Ave.
Silver Spring, MD 20910

8. PERFORMING ORGANIZATION REPORT NUMBER

DE96000483

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

National Renewable Energy Laboratory
1617 Cole Blvd.
Golden, CO 80401

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

NREL/TP-430-20473

11. SUPPLEMENTARY NOTES

NREL technical monitor: Philip Shepherd, (303) 275-2929

12a. DISTRIBUTION/AVAILABILITY STATEMENT

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

12b. DISTRIBUTION CODE

UC-1414

13. ABSTRACT *(Maximum 200 words)*

Report documents an evaluation of the environmental, economic, and energy impacts of integrated municipal solid waste management in Minneapolis, MN. The primary objective of this case study, and five other stud ies, was to develop and present consistent cost, resource use (especially energy), and environmental regulatory information on each operating IMSWM system. The process is defined as using two or more alternative waste management techniques. Detailed reports on each system are available.

14. SUBJECT TERMS

energy conservation, material recovery facilities, municipal solid waste management, water quality

15. NUMBER OF PAGES
300

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT